

**CLIMATE SCIENCE:
ASSUMPTIONS, POLICY IMPLICATIONS,
AND THE SCIENTIFIC METHOD**

HEARING
BEFORE THE
COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES
ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

MARCH 29, 2017

Serial No. 115-10

Printed for the use of the Committee on Science, Space, and Technology



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**CLIMATE SCIENCE: ASSUMPTIONS, POLICY
IMPLICATIONS,
AND THE SCIENTIFIC METHOD**

WEDNESDAY, MARCH 29, 2017

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to call, at 10:03 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Lamar Smith [Chairman of the Committee] presiding.

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

2321 RAYBURN HOUSE OFFICE BUILDING

WASHINGTON, DC 20515-6301

(202) 225-6371

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Full Committee

*Climate Science: Assumptions, Policy Implications, and the
Scientific Method*

Wednesday, March 29, 2017

10:00 a.m. – 12:00 p.m.

2318 Rayburn House Office Building

Witnesses

Dr. Judith Curry, President, Climate Forecast Applications Network; Professor Emeritus, Georgia Institute of Technology

Dr. John Christy, Professor and Director, Earth System Science Center, NSSTC, University of Alabama at Huntsville; State Climatologist, Alabama

Dr. Michael Mann, Distinguished Professor of Atmospheric Science and Director, Earth System Science Center (ESSC), The Pennsylvania State University

Dr. Roger Pielke Jr., Professor, Environmental Studies Department, University of Colorado

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

HEARING CHARTER

March 27, 2017

TO: Members, Committee on Science, Space and Technology
FROM: Majority Staff, Committee on Science, Space, and Technology
SUBJECT: Full Committee Hearing: "Climate Science: Assumptions, Policy Implications, and the Scientific Method"

The Committee on Science, Space and Technology will hold a hearing titled *Climate Science: Assumptions, Policy Implications, and the Scientific Method* on Wednesday, March 29, 2017, at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose:

The purpose of this hearing is to examine the scientific method and process as it relates to climate change. The hearing will also focus on the underlying science that helps inform policy decisions.

Witness List

- **Dr. Judith Curry**, President, Climate Forecast Applications Network; Professor Emeritus, Georgia Institute of Technology
- **Dr. John Christy**, Professor and Director, Earth System Science Center, NSSTC, University of Alabama at Huntsville; State Climatologist, Alabama
- **Dr. Michael Mann**, Distinguished Professor of Atmospheric Science and Director, Earth System Science Center (ESSC), The Pennsylvania State University
- **Dr. Roger Pielke Jr.**, Professor, Environmental Studies Department, University of Colorado

Staff Contact

For questions related to the hearing, please contact Majority Staff at 202-225-6371.

Chairman SMITH. Good morning to everyone. The Committee on Science, Space, and Technology will come to order.

Without objection, the Chair is authorized to declare recesses of the Committee at any time.

Welcome to today's hearing called "Climate Science: Assumptions, Policy Implications, and the Scientific Method." I'll recognize myself for five minutes for an opening statement, and then the Ranking Member.

Today we will examine the scientific method as it relates to climate change. We must ensure that the underlying science that informs policy decisions is based on credible scientific methodology.

I believe the climate is changing and that humans play a role. However, I also believe significant questions remain as to the extent. Our actions must be based on sound science. This is the only way we will be able to better address climate change.

Before we impose costly government regulations, we should evaluate scientific uncertainties and ascertain the extent to which they make it difficult to quantify humans' contribution to climate change.

Far too often, alarmist theories on climate science originate with scientists who operate outside of the principles of the scientific method. The scientific method is a simple process that has been used for centuries. It involves identifying a question, developing a hypothesis, constructing an experiment, and analyzing the results. If the results do not align with the original hypothesis, the hypothesis must be reexamined. The scientific method welcomes critiques so theories can be refined, and it avoids speculation about distant events for which there is no hard proof.

Alarmist predictions amount to nothing more than wild guesses. The ability to predict far into the future is impossible. Anyone stating what the climate will be in 500 years or even at the end of the century is not credible.

All too often, scientists ignore the basic tenants of science in order to justify their claims. Their ultimate goal appears to be to promote a personal agenda, even if the evidence doesn't support it.

The scientific method is regarded as the foundation of modern science. It ensures that scientific experimentation is neither arbitrary nor subjective, and that results can be replicated.

In the field of climate science, there is legitimate concern that scientists are biased in favor of reaching predetermined conclusions. This inevitably leads to alarmist findings that are wrongfully reported as facts.

The scientific method also requires that for a hypothesis to become a theory, a repeated validation of the results, called reproducibility, should be possible. However, a recent survey found that 70 percent of scientific researchers have tried and failed to reproduce the experiments conducted by other scientists. The lack of reproducibility is a warning that the scientific method is not being followed and that the theory may lack credibility.

To restore faith in science, we must uphold the principles of scientific integrity. For example, the Science Committee heard from whistleblowers that National Oceanic and Atmospheric Administration (NOAA) employees put their "thumb on the scale" during the analysis of data. This was done to arrive at politically correct re-

sults that would disprove the absence of global temperature increases from 1998 to 2012.

More recently, NOAA admitted to Committee staff that there was no legal justification for not complying with the Committee's lawfully issued subpoena requesting information. In fact, we learned that it was simply a political decision to halt any further debate on the subject. This is professional misconduct, if not worse.

A similar event unfolded in 2009. Emails from East Anglia University scientists were uncovered and revealed that they frequently violated principles of scientific integrity and attempted to halt debate about climate science.

Much of climate science today appears to be based more on exaggerations, personal agendas, and questionable predictions than on the scientific method. Those who engage in such actions do a disservice to the American people and to their own profession. Only when scientists follow the scientific method can policymakers be confident that they are making the right decisions. Until then, the debate should continue.

[The prepared statement of Chairman Smith follows:]



COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
 Lamar Smith, Chairman

For Immediate Release
 March 29, 2017

Media Contact: Kristina Baum
 (202) 225-6371

Statement of Chairman Lamar Smith (R-Texas)

Climate Science: Assumptions, Policy Implications, and the Scientific Method

Chairman Smith: Today we will examine the scientific method as it relates to climate change. We must ensure that the underlying science that informs policy decisions is based on credible scientific methodology.

I believe the climate is changing and that humans play a role. However, I also believe significant questions remain as to the extent.

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The scientific method is regarded as the "foundation of modern science." It ensures that scientific experimentation is neither arbitrary nor subjective, and that results can be replicated.

In the field of climate science, there is legitimate concern that scientists are biased in favor of reaching predetermined conclusions.

This inevitably leads to alarmist findings that are wrongfully reported as facts.

The scientific method also requires that for a hypothesis to become a theory, a repeated validation of the results – called reproducibility – should be possible. However, a recent survey found that 70% of scientific researchers have tried and failed to reproduce the experiments conducted by other scientists.

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Much of climate science today appears to be based more on exaggerations, personal agendas, and questionable predictions than on the scientific method. Those who engage in such actions do a disservice to the American people and to their own profession.

Only when scientists follow the scientific method can policy-makers be confident that they are making the right decisions. Until then, the debate should continue.

###

Chairman SMITH. That concludes my opening statement, and the Ranking Member, the gentlewoman from Texas, Eddie Bernice Johnson, is recognized for hers.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and I thank you for calling today's hearing on climate science. I also want to thank our witnesses for being here.

I want to start off today by placing our current situation in some historical perspective. The existence of the greenhouse effect was first proposed in the early 1800s. By the late 1800s scientists began to theorize that increases in carbon dioxide in our atmosphere could lead to global warming. By 1960, scientists had shown that carbon dioxide was in fact increasing in the atmosphere and humans were at least in part responsible for the increase.

Scientific evidence of human-induced climate change rapidly increased through the 1970s. By 1982, even oil giant Exxon's own scientists were reporting to management that climate change due to carbon dioxide emissions was likely to occur, and that the effects of this climate change could be catastrophic.

Since the early 1980s when Exxon internally acknowledged the reality of climate change, the scientific evidence confirming human caused climate change has piled up at an incredible rate. The current scientific consensus on human caused climate change is based on thousands of scientific studies conducted by thousands of scientists all across the globe.

What does that word—consensus—actually mean? It means the Intergovernmental Panel on Climate Change, the IPCC, which is composed of scientists from around the world, has concluded that warming of the climate system is unequivocal, and that it is extremely likely that human influence was the dominant cause of global warming.

The IPCC is not alone. The National Academies of Sciences has reached the same conclusion. In fact, the national academies of sciences in virtually every major country on Earth has endorsed the IPCC's central conclusions on climate change. Most relevant scientific societies, including AAAS, the American Physical Society, the American Geophysical Union, the American Meteorological Society, and a host of others have also affirmed the overwhelming scientific evidence for human-caused climate change.

Unfortunately, the long-established scientific understanding of the reality of climate change ends at the doorstep of the Republican National Committee. Republicans in Congress overwhelmingly reject or minimize the scientific consensus on climate change. In this, they follow the leader of the Republican Party, President Trump, who once claimed that climate change was a hoax perpetrated by China. Even on this Committee on Science, Republican Members have postulated sometimes unique theories about climate change, some of which have become punchlines on late night television.

It saddens me, really, that Majority Members of Congress and of this Committee in particular, consistently ignore the thousands of scientists around the world who maintain mainstream climate science views, instead repeatedly calling a handful of preferred witnesses who are here today over and over again to testify. For instance, the three witnesses called by the Majority today have col-

lectively appeared in front of Congress at least 20 times over the past decade.

Disturbingly, the Majority's unwillingness to accept the strong scientific consensus on climate change has led them to harass scientists who disagree with them. For example, the Majority on this Committee has issued subpoenas for the emails of climate scientists at NOAA, taking a page out of the playbook of fossil industry funded front groups who have harassed climate scientists across the country. In the process our Majority has brought condemnation upon this once great committee from across the scientific community.

Perhaps in retaliation for this inconvenient truths, climate scientists are now being targeted with massive budget cuts by Republicans in the White House and Congress. These cuts would devastate our ability to understand and mitigate the future effects of climate change. I sincerely hope that someday soon the Committee on Science will cease lecturing and harassing scientists, and instead return to listening to and supporting them. America will be far better off if we do.

And finally, I'm attaching a report prepared by the Democratic staff to my opening statement. This report details the Majority's nearly 2-year-long investigation into climate science paper that was prepared by NOAA scientists and published in the *Journal of Science* in June of 2015.

I thank you, and yield back.

[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT**Ranking Member Eddie Bernice Johnson (D-TX)**

House Committee on Science, Space, and Technology
"Climate Science: Assumptions, Policy Implications, and the Scientific Method"
March 29, 2017

Thank you Chairman Smith for calling today's hearing on Climate Science. I also want to thank our witnesses for being here today.

I want to start off today by placing our current situation in some historical perspective. The existence of the "greenhouse effect" was first proposed in the early 1800's. By the late 1800's scientists began to theorize that increases in carbon dioxide in our atmosphere could lead to global warming. By 1960 scientists had shown that carbon dioxide was in fact increasing in the atmosphere and humans were at least in part responsible for the increase. Scientific evidence for human induced climate change rapidly increased throughout the 1970's.

By 1982, even oil giant Exxon's own scientists were reporting to management that climate change due to carbon dioxide emissions was likely to occur, and that the effects of this climate change could be catastrophic. Since the early 1980's when Exxon internally acknowledged the reality of climate change, the scientific evidence confirming human caused climate change has piled up at an incredible rate. The current scientific consensus on human caused climate change is based on thousands of scientific studies conducted by thousands of scientists all across the globe.

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Disturbingly, the Majority's unwillingness to accept the strong scientific consensus on climate change has led them to harass scientists who disagree with them. For example, the Majority on this Committee has issued subpoenas for the emails of climate scientists at NOAA- taking a page out of the playbook of fossil industry funded front groups who have harassed climate scientists across the country. In the process our Majority has brought condemnation upon this once great committee from across the scientific community.

Perhaps in retaliation for their inconvenient truths, climate scientists are now being targeted with massive budget cuts by Republicans in the White House and Congress. These cuts would devastate our ability to understand and mitigate the future effects of climate change. I sincerely hope that someday soon the Committee on Science will cease lecturing and harassing scientists, and instead return to listening to and supporting them. America will be far better off if we do.

I yield back.

Chairman SMITH. Thank you, Ms. Johnson. Do you want that report made a part of the record?

Ms. JOHNSON. Yes.

Chairman SMITH. Okay. Without objection, that report will be made a part of the record, and I might also add that I know the Commerce Committee is conducting in their own investigation. If nothing else, it probably all proves that the science is not yet settled.

[The information appears in Appendix II]

Chairman SMITH. We'll now recognize the gentleman from Arizona, Mr. Biggs, the Chairman of the Environment Subcommittee, for his opening statement.

Mr. BIGGS. Thank you, Chairman Smith. Thank you, panelists, for being with us today. I appreciate it. Thank you for calling this important hearing.

As we move forward as policymakers in this new Congress and with a new Administration, it is important that we have the best available data to make informed decisions. It is also important that this data is grounded in sound science that is not biased politically or part of a larger political agenda.

Our nation's climate change policy cannot be taken lightly, because the stakes are enormous. We simply must eliminate costly, unjustifiable regulations. For example, President Obama's climate change actions, such as the Clean Power Plan, have been estimated to cost billions annually, while having a negligible impact on the environment. It is for this very reason that President Trump issued an Executive order yesterday requiring the EPA to revisit this regulation.

Not only did the previous Administration mute honest discussions that went against Obama's politicized climate change legacy, but it also perpetuated scandal in the industry. Dr. Bates' concerns regarding the Karl Study at NOAA is one such instance. The American economy should not be trifled with. If we are to make farsighted laws and regulations, the findings of climate research need to be clear, not muddled with bad science, name-calling, or scandals.

Unfortunately, this muddling has tarnished the reputation of science and made many Americans wary of supporting climate change regulations, understanding that the underlying science is subject to manipulation. Rigorous scientific debate should never be silenced, and we must vigorously confront instances in which scientific integrity falls short.

I look forward to an honest, level-headed discussion today not just about what we know about climate change, but also about the uncertainties that still need to be addressed.

Thank you, Chairman Smith. I yield back the balance of my time.

[The prepared statement of Mr. Biggs follows:]



COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
 Lamar Smith, Chairman

For Immediate Release
 March 29, 2017

Media Contact: Kristina Baum
 (202) 225-6371

Statement of Environment Subcommittee Chairman Andy Biggs (R-Ariz.)

Climate Science: Assumptions, Policy Implications, and the Scientific Method

Chairman Biggs: Thank you, Chairman Smith, for calling this important hearing. As we move forward as policymakers in this new Congress and with a new Administration, it is important that we have the best available data to make informed decisions. It is also important that this data is grounded in sound science that is not biased or part of a larger political agenda.

Our nation's climate change policy cannot be taken lightly, because the stakes are enormous. We simply must eliminate costly, unjustifiable regulations. For example, President Obama's climate change actions, such as the Clean Power Plan, have been estimated to cost billions annually, while having a negligible impact on the environment. It is for this very reason that President Trump issued an Executive Order yesterday requiring the EPA to revisit this regulation.

Not only did the previous administration mute honest discussions that went against Obama's politicized climate change legacy, but it also perpetuated scandal in the industry. Dr. Bates' concerns regarding the Karl Study at NOAA is one such instance. Our economy is not a toy to play with. If we are to make far-reaching laws and regulations, the findings of climate research need to be clear, not muddled with bad science, name-calling, or scandals.

Unfortunately, this muddling has tarnished the reputation of science and made me weary of supporting climate change regulations, fearing that the underlying research is being manipulated. Rigorous scientific debate should never be silenced, and we must vigorously confront instances in which scientific integrity falls short. I look forward to an honest, level-headed discussion today not just about what we know about climate change, but also about the uncertainties that still need to be addressed. I thank Chairman Smith and yield back the balance of my time.

###

Chairman SMITH. Thank you, Mr. Biggs.

And the gentlewoman from Oregon, Ms. Bonamici, the Ranking Member of the Environment Subcommittee, is recognized for an opening statement.

Ms. BONAMICI. Thank you very much, Mr. Chairman.

It's truly unfortunate that the Science Committee is holding this hearing today. We're spending valuable time on efforts to try to discredit science and question the scientific process when we should be looking for ways to advance scientific research.

Climate change is not a partisan issue. People who fish in Oregon, farmers in Oklahoma, servicemen and women in Virginia and around the country are all living with the results of climate change, regardless of their political affiliation. The economic, human health, and environmental consequences of climate change are well known, and our understanding about how to address the causes of climate change continues to improve.

At a time when people in the United States and around the world are facing threats from rising sea levels, oceans that are becoming more acidic, more frequent and severe weather events, record droughts and flooding, and rising global temperatures, it's critical that we support scientific research about climate, and that we build on rather than break down decades worth of progress on this issue.

Fortunately, 17 of my colleagues on the other side of the aisle have introduced legislation with a commitment to address climate change. The Science Committee should return to being a forum for robust discussions about our nation's scientific priorities, celebration of our scientific achievements, and development of bipartisan legislation that improves our understanding of science. Over the years, these efforts have helped grow the economy and created new jobs and new industries. Let's return to that Science Committee, rather than one where science is attacked and there is not enough focus on bipartisan work that benefits the millions of American people who are concerned that increased carbon emissions threaten our country and our planet.

This hearing is going to follow a familiar pattern, with familiar faces offering fringe perspectives. We have heard from the three Majority witnesses in the past. Based on the testimony they've submitted, their positions on this issue have not changed.

Science is not about trust or belief or personal agendas. Science is about knowledge and understanding. Scientists put their research and findings through rigorous peer review, and constantly seek to improve our understanding of the world through scientific process. Characterizing well-understood science as a trust exercise undermines the general principle of scientific integrity.

There is a difference between a political position that denies the reality of climate change and scientific fact that climate change is real. Too often there is confusion about those distinctions in this room. Again, we should focus on solutions to the climate change problem not distractions from the reality.

I look forward to hearing about possible solutions from Dr. Michael Mann today, a distinguished climate scientist who has been at the forefront of the international scientific community's efforts to examine, understand and respond to global warming and the

consequences it has brought to our planet. And I hope that the day comes soon when we can all focus on and discuss solutions to climate change, and as the Chair of the Environment Subcommittee said, the stakes are enormous. I hope it's not too late for our children, our grandchildren, and generations to come.

Thank you, Mr. Chairman, and I yield back.

[The prepared statement of Ms. Bonamici follows:]

OPENING STATEMENT
Ranking Member Suzanne Bonamici (D-OR)
of the Subcommittee on the Environment

House Committee on Science, Space, and Technology
"Climate Science: Assumptions, Policy Implications, and the Scientific Method"
March 29, 2017

Thank you Mr. Chairman.

It is truly preposterous that the Science Committee is holding this hearing today to undermine science and the scientific process. Unfortunately we are spending valuable time trying to discredit science when we should be looking for ways to advance scientific research.

Climate change is not a partisan issue. People who fish in Oregon, farmers in Oklahoma, servicemen and women in Norfolk, Virginia, are all living with the results climate change - regardless of their political affiliation. The economic, human health, and environmental consequences of climate change are well known, and our understanding about how to address the causes of climate change continues to improve. At a time when people in the United States and around the world are facing threats from rising sea levels, oceans that are becoming more acidic, more frequent and severe weather events, record droughts and flooding, and rising global temperatures, it is critical that we support scientific research about climate, and that we build on rather than break down decades worth of progress on this issue.

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The Science Committee should be return to being a forum for robust discussions about our nation's scientific priorities, celebration of our scientific achievements, and development of bipartisan legislation that improves our understanding of science. These efforts helped to fuel our economy and created new jobs and new industries. Let's return to that Science Committee, rather than one where science is attacked and there is little appetite for bipartisan work that benefits the millions of American people who are concerned that increased emissions threaten our country and our planet.

This hearing is going to follow a familiar pattern, with familiar faces offering fringe perspectives. We have heard from the three Majority witnesses in the past. Based on the testimony they've submitted, their positions on this issue have not changed.

Science is not about trust or belief. Science is about knowledge and understanding. Scientists put their research and findings through rigorous peer-review, and constantly seek to improve our understanding of the world through the scientific process. Trust is not a factor. Characterizing well-understood science as a simple trust exercise undermines the general principle of scientific integrity.

There is a difference between a political position that denies the reality of climate change and scientific fact that climate change is real. Too often there is confusion about those distinctions in this room. We should focus on solutions to the climate change problem not distractions from this reality.

I look forward to hearing from Dr. Michael Mann today, a distinguished climate scientist who has been at the forefront of the international scientific community's efforts to examine, understand and respond to global warming and the consequences it has brought to our planet. And I hope that the day comes soon when we can talk about and work on solutions to climate change.

Thank you and I yield back.

Chairman SMITH. Thank you, Ms. Bonamici.

We have a particularly distinguished panel today, and let me introduce our witnesses. Our first witness is Dr. Judith Curry, President of the Climate Forecast Applications Network, and Professor Emeritus at the Georgia Institute of Technology. Dr. Curry performs extensive research that focuses on air and sea interactions, climate feedback processes associated with clouds and sea ice, and the climate dynamics of hurricanes. Dr. Curry also recently served on the NASA Advisory Council Earth Science Subcommittee, the DOE Biological and Environmental Research Advisory Committee, the National Academies Climate Research Committee, the Space Studies Board, and the NOAA Climate Working Group. Dr. Curry received her Ph.D. in atmospheric science from the University of Chicago.

Our second witness is Dr. John Christy, Professor and Director of the Earth Systems Science Center at the University of Alabama at Huntsville and Alabama's State Climatologist. Dr. Christy has served as Lead Author, Contributing Author and Reviewer of the United Nations Intergovernmental Panel on Climate Change Assessments. In addition, he was awarded NASA's Medal for Exceptional Scientific Achievement. In 2002, he was elected a Fellow of the American Meteorological Society. Dr. Christy received his master's degree and Ph.D. in atmospheric sciences from the University of Illinois.

Our third witness today is Dr. Michael Mann, Distinguished Professor of Atmospheric Science and Director of the Earth Systems Science Center at Pennsylvania State University. Dr. Mann's research involves the use of theoretical models and observational data to understand Earth's climate system. In addition, he was a Lead Author on the Observed Climate Variability and Change Chapter of the IPCC Third Scientific Assessment report in 2001. Dr. Mann is a Fellow of the American Geophysical Union, the American Meteorological Society, and the American Association for the Advancement of Science. Dr. Mann received his bachelor's degree in physics and applied math from the University of California at Berkeley, his master's degree in physics from Yale University, and his Ph.D. in geology and geophysics from Yale University.

Our final witness is Dr. Roger Pielke, Professor of the Environmental Studies Department at the University of Colorado. Dr. Pielke is the Founding Director and a Faculty Affiliate of the Center for Science and Technology Policy Research, and from 2001 to 2016 was a Fellow of the Cooperative Institute for Research and Environmental Sciences. Dr. Pielke previously served as a Scientist at the National Center for Atmospheric Research. In addition, Dr. Pielke is a Senior Fellow of the Breakthrough Institute and has held several academic appointments. Dr. Pielke received his bachelor's degree in mathematics, his master's degree in public policy, and his Ph.D. in political science, all from the University of Colorado.

We welcome you all, and Dr. Curry, we'll begin with your testimony.

**TESTIMONY OF DR. JUDITH CURRY, PRESIDENT,
CLIMATE FORECAST APPLICATIONS NETWORK;
PROFESSOR EMERITUS, GEORGIA INSTITUTE OF
TECHNOLOGY**

Dr. CURRY. I thank the Chairman and the Committee for the opportunity to offer testimony on this important topic.

Prior to 2010, I felt that supporting the IPCC consensus on human-caused climate change was the responsible thing to do. That all changed for me in November 2009 following the leaked Climategate emails that illustrated the sausage making and even bullying that went into building that consensus.

I came to the growing realizing that I had fallen into the trap of groupthink in supporting the IPCC consensus. I began making an independent assessment of topics in climate science that had the most relevance to policy. I concluded that the high confidence of the IPCC's conclusions were not justified and that there were substantial uncertainties in our understanding of how the climate system works.

I realized that the premature consensus on human-caused climate change was harming scientific progress because of the questions that don't get asked and the investigations that aren't made. We therefore lack the kinds of information to more broadly understand climate variability and societal vulnerabilities.

As a result of my analyses that challenge the IPCC consensus, I have been publicly called a serial climate disinformant, anti-science, and a denier by a prominent climate scientist. I've been publicly called a denier by a U.S. Senator. My motives have been questioned by a U.S. Congressman in a letter sent to the president of Georgia Tech.

While there is much noise in the media and blogosphere and professional advocacy groups, I'm mostly concerned about the behavior of other scientists. A scientist's job is to continually challenge their own biases and ask how could I be wrong? Scientists who demonize their opponents are behaving in a way that is antithetical to the scientific process. These are the tactics of enforcing a premature theory for political purpose.

There is enormous pressure for climate scientists to conform to the so-called consensus. This pressure comes from federal funding agencies, universities and professional societies and scientists themselves. Reinforcing this consensus are strong monetary, reputational and authority interests. Owing to these pressures and the gutter tactics of the academic debate on climate change, I recently resigned my tenured faculty position at Georgia Tech.

The pathology of both the public and scientific debates on climate change motivated me to research writings on the philosophy and sociology of science, argumentation from the legal perspective, the policy process, and decision-making under deep uncertainty. My analysis of the problems in climate science from these broader perspectives have been written in a series of posts in my blog, Climate Et Cetera, and also in four published journal articles. My reflections on these issues are summarized in my written testimony.

The complexity of the climate change problem provides much scope for disagreement among reasonable and intelligent people.

Why do scientists disagree about the causes of climate change? The historical data is sparse and inadequate. There's disagreement about the value of different classes of evidence, notably, the value of global climate models and paleoclimate reconstructions. There's disagreement about the appropriate logical framework for linking and assessing the evidence. And scientists disagree over assessment of areas of ambiguity and ignorance.

Policymakers bear the responsibility of the mandate that they give to panels of scientific experts. In the case of climate change, the U.N. Framework Convention on Climate Change framed the problem too narrowly. This narrow framing of the climate change problem essentially preordained the conclusions from the IPCC assessment process.

There are much better ways to assess science for policymakers than a consensus-seeking process that serves to stifle disagreement and debate. Expert panels with diverse perspectives should handle controversies and uncertainties by assessing what we know, what we don't know, and where the major areas of disagreement and uncertainties lie. Let's make scientific debate about climate change great again.

This concludes my testimony.

[The prepared statement of Dr. Curry follows:]

STATEMENT TO THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
OF THE UNITED STATES HOUSE OF REPRESENTATIVES

Hearing on
Climate Science: Assumptions, Policy Implications and the Scientific Method

29 March 2017

Judith A. Curry
Climate Forecast Applications Network
Georgia Institute of Technology
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Major points:

- Scientific progress is driven by the creative tension spurred by disagreement, uncertainty and ignorance.
- Progress in understanding the climate system is being hampered by an institutionalized effort to stifle this creative tension, in the name of a 'consensus' that humans have caused recent climate change.
- Motivated by the mandate from the UN Framework Convention on Climate Change (UNFCCC), the climate community has prematurely elevated a scientific hypothesis on human-caused climate change to a ruling theory through claims of a consensus.
- Premature theories enforced by an explicit consensus building process harm scientific progress because of the questions that *don't* get asked and the investigations that *aren't* undertaken. As a result, we lack the kinds of information to more broadly understand climate variability and societal vulnerabilities.
- Challenges to climate research have been exacerbated by:
 - Unreasonable expectations from policy makers
 - Scientists who are playing power politics with their expertise and trying to silence scientific disagreement through denigrating scientist who do not agree with them
 - Professional societies that oversee peer review in professional journals are writing policy statements endorsing the consensus and advocating for specific policies
- Policymakers bear the responsibility of the mandate that they give to panels of scientific experts. The UNFCCC framed the climate change problem too narrowly and demanded of the IPCC too much precision – where complexity, chaos, disagreement and the level of current understanding resists such precision.
- A more disciplined logic is needed in the climate change assessment process that identifies the most important uncertainties and introduces a more objective assessment of confidence levels.
- Expert panels with diverse perspectives can handle controversies and uncertainties by assessing what we know, what we don't know, and where the major areas of disagreement and uncertainties lie.

STATEMENT TO THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
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Climate Science: Assumptions, Policy Implications and the Scientific Method

29 March 2017

Judith A. Curry
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I thank the Chairman and the Committee for the opportunity to offer testimony today on 'Scientific Method as it Relates to Climate Change.' I am Professor Emeritus of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. I have devoted four decades to conducting research on a variety of topics related to weather and climate. In recent years my focus has been on uncertainty and the interface between climate science and policy. As President of Climate Forecast Applications Network LLC, I have been working with decision makers to use weather and climate information to reduce vulnerability to extreme weather and climate events.

I am increasingly concerned that both the climate change problem and its solution have been vastly oversimplified. The result of this simplified framing of a complex, wicked problem is that we lack the kinds of information to more broadly understand climate variability and societal vulnerabilities.

Motivated by the mandate from the UN Framework Convention on Climate Change (UNFCCC) to address dangerous human-caused climate change, the climate community has worked for more than 20 years to establish a scientific consensus on human-caused climate change, which has prematurely elevated a scientific hypothesis to a ruling theory. Premature theories enforced by an explicit consensus building process harm scientific progress because of the questions that *don't* get asked and the investigations that *aren't* undertaken.

Challenges to climate research have been exacerbated by:

- Expectations from policy makers
- Scientists who are playing power politics with their expertise and trying to silence scientific disagreement through denigrating scientists who do not agree with them
- Professional societies (that oversee the peer review in professional journals) who are writing policy statements endorsing the consensus and advocating for specific policies

Motivated by these concerns, my testimony focuses on the following issues of central relevance to the issues of climate science and the scientific method:

- Scientific method for complex environmental systems
- How scientists fool themselves
- Disagreement and reasoning about climate uncertainty
- The interface between climate science and policy

Scientific method for complex environmental systems

My perspective on the scientific method is based on four decades as a scientist and extensive readings on the philosophy and sociology of science. Over the past seven years, I have been exploring these issues as they relate to climate science in a series of blog posts¹ and several publications.² My perspective is summarized below.

Science is a *process* for understanding how nature works. The scientific process can be summarized as: ask a question or pose a hypothesis, set up an objective test or experiment, and make a scientific argument – and then repeat. A scientific argument uses logic to combine assumptions and evidence. Science is often *mis*characterized as the assembly and organization of data and as a collection of facts on which scientists agree. Science is *correctly* characterized as a process in which we keep exploring new ideas and changing our understanding of the world, to find new representations of the world that better explain what is observed. Part of science is to do calculations and to make predictions, but another part of science is to ask deep questions about how nature works.

‘Scientifically proven’ is a contradiction in terms – science does not prove anything. Scientists have a vision of reality that is the best they have found so far, and there may be substantial disagreement among individual scientists. Science works just fine when there is more than one hypothesis to explain something – in fact, disagreement spurs scientific progress through creative tension and efforts to resolve the disagreement. Science is driven by uncertainty, disagreement and ignorance – the best scientists actively cultivate doubt. Scientists do not concentrate on what they know, but rather on what they don’t know. Science is an ongoing process of revision that may be incremental, occur in fits and starts, or through an unexpected breakthrough. Scientists tackle ignorance in formulating their research approach through challenging assumptions and presuppositions, curiosity, imagination, identifying connections with other research, and revisiting apparently settled questions.

How do we evaluate scientific theories, which are collections of hypotheses? All theories are underdetermined by data. Theories are evaluated based on independent corroboration, effectiveness in explaining phenomena and making predictions. Aspects of science that are reasonably settled are reliably used as assumptions for other scientific investigations and often enter into the realm of engineering.

What is the status of climate science as it relates to the nature and causes of variations on timescales from decades to centuries?

The foundation of climate science rests on fundamental laws such as Newton’s laws of motion, Planck’s Law and the Stefan Boltzmann Law, the first and second laws of thermodynamics, ideal gas laws, gravitation, and conservation of mass and energy. There are numerous theories of complex processes (collections of hypotheses) that contribute to our understanding of climate science, including the theory of rotating fluids, the theory of boundary layers, the theory of gaseous infrared spectroscopy and radiative transfer. These theories are widely accepted.

The meta-theory of greenhouse warming of the climate system incorporates many hypotheses and theories about how components of the climate system work. It is an empirical fact that the Earth’s climate has warmed overall for at least the past century. However, we do not know how much humans have contributed to this warming and there is disagreement among scientists as to whether human-caused emissions of greenhouse gases is the dominant cause of recent warming, relative to natural causes.

¹ <https://judithecurry.com/category/scientific-method/>

² Curry, JA and Webster PJ 2011: Climate science and the uncertainty monster. *Bull Amer Meteorol. Soc.*, 92, 1667-1682.

Complexity

Scientific arguments in physics, chemistry and cell biology are typically based on controlled laboratory experiments, where explanation and prediction can be based on a few variables. There are elements of climate science that can be addressed using these methods, notably in atmospheric chemistry and the physics and chemistry of aerosol and cloud particles.

However, scientific investigations of the dynamics of the entire climate system have more in common with systems biology and economics than with laboratory physics and chemistry, owing to the complexity of the systems under investigation and the inability to conduct controlled experiments. Complexity of the climate system arises from chaotic behavior and the nonlinearity of the equations for motions in the atmosphere and ocean, high dimensionality of the system (many different variables, varying in three dimensions and with time), and the linking of multiple subsystems (e.g. atmosphere, oceans, land surface, glacier ice).

The aggregate properties and changes of complex systems cannot be determined from sum of the individual components, owing to interactions among the components and the different scales of organization within the system. Complex systems are studied using information theory and computer simulation models (e.g. global climate models.) While some of the equations in climate models are based on the laws of physics, many key processes in the model are only approximated and are not directly related to physical laws.

Global climate models are used by scientists to represent aspects of climate that are difficult to observe, experiment with theories in a new way by enabling hitherto infeasible calculations, understand a system of equations that would otherwise be impenetrable, and explore the system to identify unexpected outcomes. As such, global climate models are an important element of climate research. For models of a complex system, the notion of a correct or incorrect model is not well defined. The relevant issue is whether the model 'works' and is fit for its intended purpose.

Assessment of climate models

In a recent report 'Climate Models for Laymen,'³ I described how climate models are useful tools for conducting scientific research to understand the climate system. However, I argued that current global climate models are not fit for the purpose of attributing the causes of recent warming or for predicting global or regional climate change on timescales of decades to centuries, with any high level of confidence. Concerns about the utility of climate models include:

- Predictions of the impact of increasing CO₂ on climate cannot be rigorously evaluated for order of a century.
- Failure of climate models to provide a consistent explanation of the early 20th century warming and the mid-century cooling.
- Inability of climate models to simulate the magnitude and phasing of large-scale ocean oscillations on decadal to century timescales
- Insufficient exploration of climate model uncertainties.
- Extremely large number of unconstrained choices in terms of selecting model parameters and parameterizations.
- Evaluation of climate models against the same observations used for model tuning.
- Concerns about a fundamental lack of predictability in a complex nonlinear system.

³ Curry, J. 2017: Climate Models for the Layman <http://www.thegwpf.org/content/uploads/2017/02/Curry-2017.pdf>

How scientists fool themselves

Prior to 2010, I accepted and supported the consensus conclusions from the Assessment Reports published by the Intergovernmental Panel on Climate Change (IPCC) – I felt that this was the responsible thing to do. However, following the revelations of ClimateGate,⁴ I realized that I had fallen victim to ‘groupthink’ – a pattern of thought characterized by conformity to group values and the manufacture of consensus that results in self-deception. I undertook an investigation into the ways that scientists can fool themselves, by examining deceptions from other fields of science and reading analyses from the perspectives of psychology and the philosophy and sociology of science. Below are my reflections on how climate scientists can fool themselves, and what they can do about it.

Cognitive biases

Because of the complexity of the climate problem, scientists use different mental models for evaluating the interconnected evidence. Biases can abound when reasoning and making judgments about such a complex problem. Bias can occur by excessive reliance on a particular piece of evidence, the presence of cognitive biases in reasoning shortcuts, failure to account for indeterminacy and ignorance, and logical fallacies and errors including circular reasoning.

Cognitive biases relate to self-deception. Cognitive biases of particular relevance to the science of climate change include:

- *Confirmation bias*: the tendency to search for or interpret information in a way that confirms one’s preconceptions
- *Self-serving bias*: a tendency for people to evaluate information in a way that is beneficial to their interests
- *Belief bias*: evaluating the logical strength of an argument based on belief in the truth or falsity of the conclusion
- *Framing*: using a narrow approach that pre-ordains the conclusion
- *Overconfidence*: unjustified, excessive belief
- *Illusory correlations*: false identification of relationships with rare or novel occurrences

A recent article by statistician Regina Nuzzo in *Nature* summarizes the problem:

*This is the big problem in science that no one is talking about: even an honest person is a master of self-deception. In today’s environment, our talent for jumping to conclusions makes it all too easy to find false patterns in randomness, to ignore alternative explanations for a result or to accept ‘reasonable’ outcomes without question — that is, to ceaselessly lead ourselves astray without realizing it.*⁵

Simply, scientists are human and subject to biases. Further, they have personal and professional stakes in the outcomes of research – their professional reputation and funding is on the line. Assuming that individual scientists have a diversity of perspectives and different biases, then the checks and balances in the scientific process including peer review will eventually see through the biases of individual scientists. However, when biases become entrenched in the institutions that support science – the professional societies, scientific journals, universities and funding agencies – then that subfield of science may be led astray for decades and make little progress.

⁴ Mosher and Fuller (2010) ClimateGate: The CRUTape letters https://www.amazon.com/dp/B003552M76/ref=dp_kindle-redirect?_encoding=UTF8&btkr=1

⁵ <http://www.nature.com/news/how-scientists-fool-themselves-and-how-they-can-stop-1.18517>

Premature theories and manufactured consensus

A scientific argument can evolve prematurely into a ruling theory if cultural forces are sufficiently strong and aligned in the same direction. Science policy expert Daniel Sarewitz describes the process:

*"Like a magnetic field that pulls iron filings into alignment, a powerful cultural belief is aligning multiple sources of scientific bias in the same direction. The belief is that progress in science means the continual production of positive findings. All involved benefit from positive results, and from the appearance of progress. Scientists are rewarded both intellectually and professionally, science administrators are empowered and the public desire for a better world is answered."*⁶

I have argued that cognitive biases in the context of the IPCC's consensus building process surrounding human-caused climate change have resulted in the consensus becoming increasingly confirmed in a self-reinforcing way, to the detriment of the scientific process.⁷

Princeton philosopher Thomas Kelly provides some general insights into the sources of confirmation bias and belief polarization⁸ that are relevant to the climate change consensus. Kelly argues that belief held at earlier times can skew the total evidence that is available at later times, via characteristic biasing mechanisms, in a direction that is favorable to the initial belief. All else being equal, individuals tend to be significantly better at detecting fallacies in an argument for a conclusion that they disbelieve, than when the same fallacy occurs in an argument for a conclusion that they believe. Of particular relevance to the IPCC's consensus on human-caused climate change:

*"As more and more peers weigh in on a given issue, the proportion of the total evidence which consists of higher order psychological evidence [of what other people believe] increases, and the proportion of the total evidence which consists of first order evidence decreases . . . At some point, when the number of peers grows large enough, the higher order psychological evidence will swamp the first order evidence into virtual insignificance."*⁹

So what are the implications of Kelly's arguments for the IPCC's consensus on human-caused climate change? Cognitive biases in the context of an institutionalized consensus building process have arguably resulted in the consensus becoming increasingly confirmed in a self-reinforcing way. An extended group of scientists derive their confidence in the consensus in a second-hand manner from the institutional authority of the IPCC and the emphatic nature in which the consensus is portrayed. This 'invisible hand' marginalizes skeptical perspectives and is operating to the substantial detriment of climate science, as well as biasing policies that are informed by climate science.

Premature theories enforced by an explicit consensus building process harm scientific progress because of the questions that *don't* get asked and the investigations that *aren't* undertaken. Overconfident assertions take away the motivation for scientists to challenge the consensus, particularly when they can expect to be called a 'denier' for their efforts and see their chances diminish for professional recognition and research funding. As a result of the enforced consensus, there is little independent thought that seeks to advance fundamental understanding or develop an independent aggregate understanding of how the climate system works.

⁶ Foreword to Science on the Verge http://www.andreasaltelli.eu/file/repository/Foreword_Dan_Sarewitz.pdf

⁷ Curry JA, 2013: Climate change: No consensus on consensus. *CAB Reviews*, 8, 001.

⁸ Kelly T (2005) 'The epistemic significance of disagreement.' *Epistemology*, 19, 179–209

⁹ Kelly T (2008) 'Disagreement, dogmatism and belief polarization'. *J Philosophy* 611–633

When a field of science becomes entangled with politics and public policy debates – such as climate science – the stakes for diverging from the consensus point of view become much higher. Rather than encouraging scientific debate, there are attempts by scientists, the media and politicians to end debate by insisting that a large majority of scientists support a consensus, referring to those that disagree as ‘deniers’. Sound theory does not need to demonize its opponents; rather these are the tactics of elevating a premature theory to dogma and enforcing it for political purposes.

Overcoming bias

A scientist’s job is to continually challenge his/her own biases and ask ‘How could I be wrong?’ Playing ‘devil’s advocate’ helps a scientist examine how their conclusions might be misguided and how they might be wrong. Overcoming one’s own biases is difficult; an external devil’s advocate can play a useful role in questioning and criticizing the logic of the argument.

T.C. Chamberlain’s method of ‘multiple working hypotheses’¹⁰ is a strategy that brings into view every rational explanation of the phenomena. The value of multiple working hypotheses lies largely in its suggestiveness of lines of inquiry that might otherwise be overlooked. More formal methods include ‘Red Team’ and ‘Team B’ approaches that provide competitive analyses to challenge the dominant ones. I have participated in two interesting experiments along these lines for climate science, which are described below.

In 2014, the American Physical Society (APS) held a Workshop to consider its statement on climate change. A committee of eminent physicists, each with no particular expertise in climate science or an apparent dog in the public debate, selected six climate scientists with diverse perspectives (Isaac Held, Ben Santer, William Collins, Judith Curry, Richard Lindzen, John Christy) to address specific questions prepared by the committee that were related to the IPCC 5th Assessment Report. The APS produced a complete transcript of the Workshop.¹¹ This transcript is a remarkable document — it provides, in my opinion, the most accurate portrayal of the scientific debates surrounding climate change.

Organized under the auspices of the Dutch Ministry of Infrastructure and the Environment, Climate Dialogue¹² offered a blog platform for discussions between scientists on important climate topics that are of interest to both fellow scientists and the general public. The goal was to explore the full range of views that scientists have on the selected issue. Each discussion was initiated by a short introduction written by the editorial staff, followed by guest essays by two or more invited scientists. The scientists reacted to each other’s essays and to questions posed by the editorial staff. The public (including other climate scientists) could comment on a separate thread. After the online discussion, Climate Dialogue editors wrote a summary, describing the areas of agreement and disagreement between the discussants. I participated in the inaugural dialogue on Arctic sea ice, and there were a total of six dialogues before the effort was terminated. Each of these dialogues is a testament to the importance of this kind of scientific dialogue and debate in terms illuminating and clarifying the scientific issues and uncertainties.

Beyond overcoming bias, the dialectical nature of science can play an important role in solving problems of societal relevance. When scientific input is sought on a socially relevant issue, we need to acknowledge that there are competing hypotheses and theories that are of practical consequence. Societal problem solving would benefit greatly from forums that bring together the proponents of these competing inquiries for debate and joint problem solving.

¹⁰ <http://www.auburn.edu/~tds0009/Articles/Chamberlain%201965.pdf>

¹¹ <http://www.aps.org/policy/statements/upload/climate-seminar-transcript.pdf>

¹² <http://www.climatedialogue.org/>

Disagreement and reasoning about climate uncertainty

During my investigation of arguments and evidence being used to support the IPCC statement on the causes of recent climate change, it became apparent to me that there were rational reasons for disagreement about many aspects of these arguments. I concluded that reasoning about a complex system with many uncertainties is not at all straightforward. My investigations on this topic included reading about argumentation and disagreement from the perspectives of philosophy and law, as well as logical inference and network theory. I published two articles on these topics.^{13,14} My reflections on disagreement, uncertainty and reasoning about the complex climate problem are summarized below.

Disagreement

Science proceeds just fine with indefinite conclusions, disagreement and multiple hypotheses. In fact, science works best under the creative tension of competing hypotheses. Disagreement among scientists and support for rival hypotheses can arise from:

- Insufficient and inadequate observational evidence
- Disagreement about the value of different classes of evidence (e.g. paleoclimate reconstructions, global climate models)
- Disagreement about the appropriate logical framework for linking and assessing the evidence
- Overconfidence and differing assessments of areas of ambiguity and ignorance
- Belief polarization as a result of cultural pressures and the politicization of the science

In the context of disagreement, it is important to distinguish between disbelief – believing an argument is false – and nonbelief – believing that the argument is not true. Disbelief is actually a case of belief, whereas nonbelief is a state of suspended judgment of neither believing the argument true nor believing it false. A failure to make this distinction was the recent media coverage of statements made by EPA Administrator Scott Pruitt:

*“I think that measuring with precision human activity on the climate is something very challenging to do and there’s tremendous disagreement about the degree of impact, so no, I would not agree that it’s a primary contributor to the global warming that we see. But we don’t know that yet. We need to continue the debate and continue the review and the analysis.”*¹⁵

The media characterized this statement as “EPA Head Scott Pruitt Denies That Carbon Dioxide Causes Global Warming.”¹⁶ Pruitt’s statement was incorrectly characterized as a statement of disbelief, when it was clearly a statement of non-belief.

Reasoning about climate uncertainty

Reasoning about a complex system with many uncertainties is not at all straightforward. The general reasoning underlying the IPCC’s arguments for human-caused climate change is described by Oreskes¹⁷ as a ‘consilience of evidence’ argument, which consists of independent lines of evidence that are explained by the same theoretical account. Oreskes draws an analogy for the consilience of evidence approach with what happens in a legal case. Continuing with the legal analogy, legal scholar James

¹³ Curry, JA 2011: Reasoning about climate uncertainty. *Climatic Change*, 108, 723-732

¹⁴ Curry, JA 2011: Nullifying the climate null hypothesis. *WIREs Climate Change*, 2, DOI: 10.1002/wcc.141

¹⁵ <http://www.cnbc.com/2017/03/09/epa-chief-scott-pruitt.html>

¹⁶ https://www.theguardian.com/environment/2017/mar/09/epa-scott-pruitt-carbon-dioxide-global-warming-climate-change?CMP=share_btn_tw

¹⁷ Oreskes, N. (2007) The scientific consensus: how do we know we’re not wrong? *Climatic Change*
<http://www.cpp.edu/~aebresnock/acbres/ee435/oreskespaper.pdf>

Johnston¹⁸ characterized the IPCC's arguments as a legal brief, designed to persuade, in contrast to a legal memo that is intended to objectively assess both sides. Along the lines of a legal memo, the consilience of evidence argument is not convincing unless it includes parallel evidence-based analyses for competing hypotheses. Any evidence-based argument that is more inclined to admit one type of evidence or argument rather than another tends to be biased. Multiple lines of evidence that produce a high confidence level for each of two opposing arguments is referred to as the 'ambiguity of competing certainties.' If uncertainty and ignorance are acknowledged adequately, then the competing certainties disappear. Disagreement and clarification of uncertainties then becomes the basis for focusing research in a certain area, and so moves the science forward.

The complexity of the climate system makes the concept of 'consilience failure' rather challenging. If one of the lines of evidence turns out to be flawed, then how does this influence the overall argument? The 'doesn't matter' versus 'death knell' interpretations can be explained by the use of two different logics represented by the 'jigsaw puzzle analogy'¹⁹ and the 'house of cards analogy.'²⁰ Consider a partially completed jigsaw puzzle, with many pieces in place, some pieces tentatively in place, and some missing pieces. Default reasoning allows you to infer the whole picture from an incomplete puzzle if there is not another picture that is consistent with the puzzle in its current state. Under a monotonic logic, adding new pieces and locking existing pieces into place increases what is known about the picture. For a climate scientist having a complex mental model of interconnected evidence and processes represented by the jigsaw puzzle, the evidence in the North Report²¹ critical of the paleo-temperature reconstructions (so-called 'hockeystick') merely jiggled loose a few puzzle pieces but didn't change the overall picture. Skeptics, lacking the same puzzle frame but focused on the specific conclusions of the North Report, viewed the evidence as collapsing the house of cards and justifying major belief revision on the subject. Which frame is 'correct'? Well, both are overly simplistic heuristics used in the absence of formal logical arguments.

The ways of combining evidence and the associated uncertainties and logics becomes critical in determining how one would even go about falsifying the theory or inferring anything about the theory from comparison of model predictions and observations. I have found that most disagreement on topics related to climate change is associated with different mental models for assessing and combining evidence to make inferences. A more disciplined logic is needed to assess the relative merits of the different arguments through identifying the most important uncertainties and introducing a more objective assessment of confidence levels.

In 'Reasoning About Climate Uncertainty',²² I argued that a useful approach would be the development of hierarchical logical hypothesis models that provides a structure for assembling the evidence and arguments in support of the main hypotheses or propositions. A logical hypothesis hierarchy (or tree) links the root hypothesis to lower level evidence and hypotheses. While developing a logical hypothesis tree is somewhat subjective and involves expert judgments, the evidential judgments are made at a lower level in the logical hierarchy. Essential judgments and opinions relating to the evidence and the arguments linking the evidence are thus made explicit, lending structure and transparency to the assessment. To the extent that the logical hypothesis hierarchy decomposes arguments and evidence to the most elementary propositions, the sources of disagreement are easily illuminated and potentially minimized.

¹⁸ Johnson, J (2010) Global warming advocacy science: a cross examination.

http://scholarship.law.upenn.edu/faculty_scholarship/315/

¹⁹ <http://sciencepoliticsclimatechange.blogspot.com/2006/10/puzzle-analogy.html>

²⁰ <http://sciencepoliticsclimatechange.blogspot.com/2006/10/house-of-cards-analogy.html>

²¹ Surface Temperature Reconstructions for the last 2000 years. (2006) National Academy Reports <https://www.nap.edu/read/11676/chapter/1>

²² Curry, JA 2011: Reasoning about climate uncertainty. *Climatic Change*, 108, 723-732 <http://link.springer.com/article/10.1007/s10584-011-0180-z>

An issue of central importance for the use of scientific research in policy making is uncertainty management and elucidation of the elements of uncertainty. My paper 'Reasoning about Climate Uncertainty'²³ describes several such approaches that comprehensively describe the pedigree and quality of the relevant data sets and methods, and characterize uncertainty in a manner that covers the range from complete numerical formalization of probabilities to ignorance, and includes the possibility of unspecified but surprising events.

The interface between climate science and policy

I first became caught up in the political debate about climate change following publication of our paper in 2005 relating hurricane intensity with global warming.²⁴ The uncanny timing of publication of this paper was three weeks after Hurricane Katrina devastated New Orleans. While global warming was mentioned only obliquely in the paper, the press focused on the global warming angle and a media and political furor followed. My reflections on this were published in a paper 'Mixing Politics and Science in Testing the Hypothesis that Greenhouse Warming is Causing a Global Increase in Hurricane Intensity.'²⁵ In recent years, I have continued to investigate the interface between climate science and policy, and have become increasingly concerned about its dysfunction.

In the 1990's, the world's nations embarked on a path to prevent dangerous anthropogenic climate change by stabilization of the concentrations of atmospheric greenhouse gases, which was codified by the 1992 UN Framework Convention on Climate Change (UNFCCC) treaty.²⁶ This objective has led to a focus on identifying human influences on climate, dangerous environmental and socio-economic impacts of climate change, and stabilization of CO₂ concentrations in the atmosphere. The IPCC has become conflicted by its makeup and its mandate from the UN – to focus on a change of climate that is attributed to human activity. If the IPCC found that climate change was *not* being affected by human alteration of the atmosphere or that it is not 'dangerous,' the UNFCCC would not need it to exist. Findings of 'dangerous human-caused climate change' seem inevitable with this framing of the climate change problem and the mandate from policy makers.

In the early 1990's there was belief in the feasibility of reducing uncertainties in climate science and climate models, and a consensus seeking approach was formalized by the IPCC. Global climate models were elevated to a central role through investigations of climate change impacts and applications. Very substantial investments have been made in further developing climate models, with the expectation that these models will provide actionable information for policy makers.

The hope, and the potential, of climate models for providing actionable information for policy makers have not been realized. With the failure of climate models to reduce uncertainty about the sensitivity of the climate system to CO₂ and the failure to accurately simulate decadal and regional climate variability,²⁷ we have arguably reached the point of diminishing returns from this particular path of climate modeling – not just for decision support but also for scientific understanding of the climate system. The climate modeling community, the funding agencies and policy makers have locked themselves into a single climate modeling framework that has been very expensive in terms of funding and personnel.

²³ Curry, J. Reasoning About Climate Uncertainty, op. cit.

²⁴ Webster, P, G. Holland, J Curry and HR Chang 2005: Changes in tropical cyclone number, duration and intensity. *Science*. <http://science.sciencemag.org/content/309/5742/1844.full>

²⁵ Curry, J.A., et al, 2006: Mixing Politics and Science in Testing the Hypothesis that Greenhouse Warming is Causing an Increase in Hurricane Intensity. *Bull. Amer. Meteorol. Soc.*, <http://journals.ametsoc.org/doi/abs/10.1175/BAMS-87-8-1025>.

²⁶ UNFCCC Treaty (1992) <https://unfccc.int/resource/docs/convkp/conveng.pdf>

²⁷ Curry, J. 2017: Climate Models for the Layman <http://www.thegwpf.org/content/uploads/2017/02/Curry-2017.pdf>

An unintended consequence of this strategy is that there have been very few resources left over for true climate model innovations and fundamental research into climate dynamics and theory. Such research would not only support improved climate modeling systems, but would also lay the foundations for disruptive advances in our understanding of the climate system and our ability to predict emergent phenomena such as abrupt climate change. With climate science focusing on climate model outputs rather than on climate dynamics and theory, we've lost a generation of climate dynamicists. As a result, we are lacking the intellectual resources to understand important and challenging issues such as: the effects of the sun on climate, the network of natural internal variability on multiple time scales, the mathematics of extreme events, and predictability of a complex system characterized by spatio-temporal chaos.

Decision makers needing regionally-specific climate change information are being provided with either nothing or potentially misleading predictions from climate models that are not fit for this purpose. Hoping and expecting to rely on information from climate models about projected regional climate change to guide adaptation responses has diverted attention from using observational, historical and paleoclimate data from the region to develop the basis for future scenarios. Further, increased scientific focus on subseasonal (weeks) and seasonal (months) weather/climate forecasts²⁸ could produce the basis for tactical adaptation practices with substantial societal benefits.

How and why did we land between a rock and a hard place on the issue of climate science? There are probably many contributing reasons, but the most fundamental and profound reason is arguably that both the problem and solution were vastly oversimplified back in the early 1990's by the UNFCCC, who framed both the problem and the solution as irreducibly global in terms of human-caused global warming. This framing was locked in by a self-reinforcing consensus-seeking approach to the science and a 'speaking consensus to power' approach for decision making that pointed to a single course of policy action – radical emissions reductions.

The climate community has worked for more than two decades to establish a scientific consensus on human-caused climate change, prematurely elevating a hypothesis to a ruling theory. The IPCC's consensus-seeking process and its links to the UNFCCC emissions reduction policies have had the unintended consequence of hyper-politicizing the science and introducing bias into both the science and related decision making processes. The result of this simplified framing of a wicked problem is that we lack the kinds of information to more broadly understand climate variability and societal vulnerabilities.

The politicization of climate science has contaminated academic climate research and the institutions that support climate research, so that individual scientists and institutions have become activists and advocates for emissions reductions policies. Scientists with a perspective that is not consistent with the consensus are at best marginalized (difficult to obtain funding and get papers published by 'gatekeeping' journal editors) or at worst ostracized by labels of 'denier' or 'heretic.'

Policymakers bear the responsibility of the mandate that they give to panels of scientific experts. In the case of climate change, the UNFCCC demanded of the IPCC too much precision where complexity, chaos, disagreement and the level current understanding resists such precision. Asking scientists to provide simple policy-ready answers for complex matters results in an impossible situation for scientists and misleading outcomes for policy makers. Unless policy makers want experts to confirm their preconceived bias, then expert panels should handle controversies and uncertainties by assessing what we know, what we don't know, and where the major uncertainties lie.

²⁸ <https://www.nap.edu/catalog/21873/next-generation-earth-system-prediction-strategies-for-subseasonal-to-seasonal>

Imagine if, circa 1990, the UN had framed the climate change problem in the following way: ‘There are a number of causes of climate change, including manmade causes. Climate science should work to understand all causes of climate variability change that are relevant on decadal to century timescales, and the impact of climate variability and change on societies and ecosystems.’ Such a framing would have arguably led to better understanding of the climate system and a much more rational approach in developing policies related to reducing our vulnerabilities to extreme weather and climate variations.

A better social problem-solving framework is needed for managing risk under conditions of deep uncertainty, that employs a broader systems analysis and explicitly incorporates uncertainty to identify paths to a flexible, robust and economical outcome. Social science research is needed to analyze ways of incorporating scientific understanding with all of its uncertainties into decision making related to complex, wicked problems.

The war on science

I read Chris Mooney’s book ‘The Republican War on Science’²⁹ shortly after it was published in 2005. It really resonated with me at the time, when I was in the midst of the ‘hurricanes and global warming war’. Although the book has ‘Republican’ in the title, much of the content was really about a bipartisan war on science. The ‘war on science’ is being fought on two fronts: politicians ignoring science; and using bad science to justify a political agenda. The notion of ‘war of science’ is also about the naivete of scientists regarding the role of science and evidence in policy making.³⁰

With the advent of the Trump administration, concerns about ‘war on science’ have become elevated, with a planned March for Science on 22 April 2017.³¹ Why are scientists marching?³² The scientists’ big concern is ‘silencing of facts’. This concern apparently derives from their desire to have their negotiated ‘facts’ – such as the IPCC consensus on climate change – dictate public policy. These scientists also fear funding cuts and challenges to the academic scientific community and the elite institutions that support it.

The ‘war on science’ that I am most concerned about is the war from *within* science – scientists and the organizations that support science who are playing power politics with their expertise and passing off their naïve notions of risk and political opinions as science. When the IPCC consensus is challenged or the authority of climate science in determining energy policy is questioned, these activist scientists and organizations call the questioners ‘deniers’ and claim ‘war on science.’ These activist scientists seem less concerned with the integrity of the scientific process than they are about their privileged position and influence in the public debate about climate and energy policy. They do not argue or debate the science – rather, they denigrate scientists who disagree with them. These activist scientists and organizations are perverting the political process and attempting to inoculate climate science from scrutiny – this is the *real* war on science.

²⁹ Mooney, C. (2005) The Republican War on Science <http://www.waronscience.com/home.php>

³⁰ <https://www.amazon.com/Politics-Evidence-Based-Policy-Making/dp/1137517808>

³¹ <http://www.marchforscience.com>

³² <https://www.theguardian.com/us-news/2017/feb/19/epa-trump-boston-science-protest>

Conclusion

In the midst of disagreement among policy makers about the response to climate change, climate science has been caught in the crossfire. Challenges to climate research have been exacerbated by unreasonable expectations from policy makers, as well as by the behavior of climate scientists and professional societies who are using their professional expertise and preferred political outcomes as the basis for attempting to pervert the political process and inoculate climate science from scrutiny and debate.

My concern is that the integrity and objectivity of climate research is being compromised. As a result, we have oversimplified by the climate change problem and its solutions. This oversimplification has:

1. Biased scientific research through politicization and funding priorities.
2. Undercut the political process and dialog necessary for real solutions in a highly complex world.

We need to rethink the social contract between scientists and government, and develop a new model for policy-relevant science. This is needed to insure the integrity of science and to improve the basis for science to inform the policy process. Here are some recommendations:

1. Embrace science as an iterative process, not a collection of 'facts.' Scientists that engage the public across the political spectrum and invite them to engage in the process of science can help build public support for science.
2. New incentive structures for scientists working in fields that are policy relevant can focus on careful management of bias and uncertainty, public engagement, responsible interactions with the media, and participation in the policy process as an honest broker.
3. Scientists interested in engaging with the policy process need a much better understanding of the policy process, the role that science plays, and how complexity, pluralism and uncertainty in science is accommodated in the policy process.
4. Scientists need better guidelines on the ethical implications of using their expertise for political purposes and a code of conduct for communicating uncertainty and responsibilities for making public statements related to their expertise.
5. Bias and advocacy by institutions such as professional societies is a major concern for the integrity of science.
6. For policy-relevant science and regulatory science, more formal methods of uncertainty characterization and management should be used in scientific research and assessments.
7. For policy-relevant and/or regulatory science where there is substantial uncertainty or disagreement about key conclusions, a Red Team or Team B approach for assessments can clarify the strength of the arguments and key areas of disagreement. Avoid consensus-seeking approaches.
8. Narrow framing of research priorities on topics where there are widespread uncertainties and debate can bias the research. Funding for Red Team or Team B approaches would help overcome such systematic biases.
9. Funding priorities in climate research that support observing systems (surface and satellite-based), fundamental climate dynamics research and research to improve short-term climate predictions (sub-seasonal to interannual) would support improved climate models and lay the foundations for disruptive advances in our understanding of the climate system and our ability to predict emergent phenomena such as abrupt climate change.
10. A better social problem-solving framework that employs a broader systems analysis and explicitly incorporates uncertainty can provide paths to flexible, robust and economical outcomes.

I'm hoping that these recommendations and this Hearing will open up a dialogue on how the federal government can better support research into the complex climate system that in turn supports improved policy outcomes in reducing our vulnerability to climate variability.

Short Biography

Judith Curry
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Dr. Judith Curry is President of Climate Forecast Applications Network (CFAN) and Professor Emeritus of Earth and Atmospheric Sciences at the Georgia Institute of Technology. Dr. Curry received a Ph.D. in atmospheric science from the University of Chicago in 1982. Prior to joining the faculty at Georgia Tech, she held faculty positions at the University of Colorado, Penn State University and Purdue University. Dr. Curry's research interests span a range of topics in weather and climate. She has authored over 180 scientific papers, and is author of the textbooks *Thermodynamics of Atmospheres and Oceans*, and *Thermodynamics, Kinetics and Microphysics of Clouds*. She is a prominent public spokesperson on issues associated with the integrity of climate science, and is proprietor the weblog Climate Etc. judithcurry.com. Dr. Curry has recently served on the NASA Advisory Council Earth Science Subcommittee, the DOE Biological and Environmental Research Advisory Committee, and the National Academies Climate Research Committee and the Space Studies Board and the NOAA Climate Working Group. Dr. Curry is a Fellow of the American Meteorological Society, the American Association for the Advancement of Science, and the American Geophysical Union.

Financial declaration

Funding sources for Curry's research have included NSF, NASA, NOAA, DOD and DOE. Recent contracts for CFAN include a NOAA contract to improve subseasonal weather forecasts, a DOE contract to develop extended range regional wind power forecasts and a DOD contract to predict extreme events associated with climate variability/change having implications for regional stability. CFAN contracts with private sector and other non-governmental organizations include energy and power companies, reinsurance companies, other weather service providers, nongovernmental organizations and development banks. Specifically with regards to the energy and power companies, these contracts are for medium-range (days to weeks) forecasts of hurricane activity, surface temperatures, hydropower generation and wind power generation. CFAN has not received any funds from energy companies related to climate change or any topic related to this testimony.

For more information:

<http://curry.eas.gatech.edu/>
<http://www.cfanclimate.com/>
<http://judithcurry.com/about/>

Chairman SMITH. Thank you, Dr. Curry.
Dr. Christy.

**TESTIMONY OF DR. JOHN CHRISTY,
PROFESSOR AND DIRECTOR,
EARTH SYSTEM SCIENCE CENTER, NSSTC,
UNIVERSITY OF ALABAMA AT HUNTSVILLE;
STATE CLIMATOLOGIST, ALABAMA**

Dr. CHRISTY. Thank you, Chairman Smith, and Committee Members for this opportunity to speak about climate change.

I'm John Christy, Professor of Atmospheric Science at the University of Alabama in Huntsville, and Alabama State Climatologist. I have served in many climate roles including Lead Author of the United Nations IPCC. My main research is building data sets from scratch to help understand what the climate is doing.

Of concern today is the proposition that the traditional scientific method has not been consistently followed in today's pronouncements about climate change made by so-called official panels. Science is simply a method that describes a pathway to discover information. In the method, the scientist makes a claim or a hypothesis about something and then proceeds to test that claim against independent data to see if the claim is false or not.

In the first figure next, I show a vertical cross-section of the atmospheric temperature trends. Surface is at the bottom, stratosphere at the top, and the poles on either end, tropics in the middle. This figure is simply a claim common to climate models that the bulk atmosphere in the last 38 years should show considerable atmospheric warming due to extra greenhouse gases, especially in the outlined tropical section. So here we have a testable claim because we have observations with which to compare.

In the next figure, I show the temperature progression from 32 model groups with their average in red of that tropical section. We are interested in the red curve because that is the consensus upon which claims of future climate change are based. But don't overlook the widespread of model results in the dash lines. They're all over the place. There is no clear certainty on what the climate might do in the future.

I also show observations on this chart of the bulk atmospheric trend you see with symbols, circles, squares and diamonds based upon three different types of measuring systems: balloons, satellites and merged product used in weather forecasting called reanalyses. Each of these methods has three or four different groups contributing a result. This figure looks confusing, so to simplify the test of the claim, I show the next figure, which is just the trend lines that are being compared. What is obvious is that the warming hypothesized and claimed by climate models to have already occurred has not. The warming is clearly overstated. When these trends are formally tested, the scientific conclusion is that the consensus of the climate models—the red line—fails to represent reality of the actual changes in the bulk atmosphere, and that's a foundational climate metric.

Little known to many is that this result was displayed in the most recent IPCC buried deep and without comment in chapter 10, supplementary information. In my written testimony, is how that using that IPCC diagram, the same result as shown here, occurs. The warming rate of models on which policy is based can be scientifically falsified as representing reality.

Interestingly, the IPCC result, in that result, the models without extra greenhouse gases reproduce the actual observations very well. Indeed, I am a co-author of a report in which we used a statistical model to reproduce to a large degree the atmospheric temperature trends without the need for extra greenhouse gases. In other words, it seems that Mother Nature can cause such temperature trends on her own, which should be no surprise.

It is astounding and disturbing that such contradictory evidence to the IPCC's main model-based conclusion that humans caused most of the recent warming could be ignored so gallantly and willfully. In my view, the dispassionate analysis of scientific results on which policy decisions are based was sidetracked by those in control of the IPCC documents.

This problem is pervasive in climate science. Grand compilations such as the IPCC, the National Climate Assessment, pronouncements from scientific societies, who never do any scientific work on the problem, by the way, for their results and even EPA's endangerment finding are on the whole written by those who are not scientifically dispassionate, and as such, the traditional method of science was circumvented, in my opinion.

I'll close by noting that when someone says that precisely measuring the role of "human activity on the climate is something very challenging to do and there's tremendous disagreement about the degree of impact" that person is making a scientifically defensible statement as demonstrated by my testimony.

Thank you.

[The prepared statement of Dr. Christy follows:]

U.S. House Committee on Science, Space & Technology
29 Mar 2017
Testimony of John R. Christy
Professor of Atmospheric Science, Alabama State Climatologist
University of Alabama in Huntsville.

Summary

“Science” is not a set of facts but a process or method that sets out a way for us to discover information and which attempts to determine the level of confidence we might have in that information. In the method, a “claim” or “hypothesis” is stated such that rigorous tests might be employed to test the claim to determine its credibility. If the claim fails a test, the claim is rejected or modified then tested again. When the “scientific method” is applied to the output from climate models of the IPCC AR5, specifically the bulk atmospheric temperature trends since 1979 (a key variable with a strong and obvious theoretical response to increasing GHGs in this period), I demonstrate that the consensus of the models fails the test to match the real-world observations by a significant margin. As such, the average of the models is considered to be untruthful in representing the recent decades of climate variation and change, and thus would be inappropriate for use in predicting future changes in the climate or for related policy decisions.

The IPCC inadvertently provided information that supports this conclusion by (a) showing that the tropical trends of climate models *with* extra greenhouse gases failed to match actual trends and (b) showing that climate models *without* extra greenhouse gases agreed with actual trends. A report of which I was a co-author demonstrates that a statistical model that uses only natural influences on the climate also explains the variations and trends since 1979 without the need of extra greenhouse gases. While such a model (or any climate model) cannot “prove” the causes of variations, the fact that its result is not rejected by the scientific method indicates it should be considered when trying to understand why the climate does what it does. Deliberate consideration of the major influences by natural variability on the climate has been conspicuously absent in the current explanations of climate change by the well-funded climate science industry.

One way to aid congress in understanding more of the climate issue than what is produced by biased “official” panels of the climate establishment is to organize and fund credible “Red Teams” that look at issues such as natural variability, the failure of climate models and the huge benefits to society from affordable energy, carbon-based and otherwise. I would expect such a team would offer to congress some very different conclusions regarding the human impacts on climate.

U.S. House Committee on Science, Space & Technology
29 Mar 2017
Testimony of John R. Christy
University of Alabama in Huntsville.

I am John R. Christy, Distinguished Professor of Atmospheric Science, Alabama's State Climatologist and Director of the Earth System Science Center at The University of Alabama in Huntsville. I have served as Lead Author, Contributing Author and Reviewer of United Nations IPCC assessments, have been awarded NASA's Medal for Exceptional Scientific Achievement, and in 2002 was elected a Fellow of the American Meteorological Society.

It is a privilege for me to offer my analysis of the current situation regarding atmospheric temperature datasets and whether the traditional scientific method using these datasets has been applied in climate science regarding the pronouncements about climate change used in policy. I addressed other aspects of climate change including extreme events, crop production, impact of regulation (there is none on the climate) and data confidence in my last Senate (Commerce, Science and Transportation, 8 Dec 2015) and House (Science, Space and Technology, 2 Feb 2016) appearances.

My research area might be best described as building datasets from scratch to advance our understanding of what the climate is doing and why – an activity I began as a teenager over 50 years ago. I have used traditional surface observations as well as measurements from balloons and satellites to document the climate story. Many of our UAH datasets, generated by myself and UAH colleagues Drs. Roy Spencer and W. Daniel Braswell, are used to test hypotheses of climate variability and change.

(1) Applying the scientific method to climate models from the IPCC AR5

In my last appearance before this committee (2 Feb 2016) I addressed the active campaign of negative assertions made against the various sources of data we use to monitor the temperature of bulk atmosphere. I demonstrated that main assertions were incorrect and that we can have confidence in the observations and one reason was that we now have several independent sources from around the world providing data with which to inter-compare. In this testimony I shall focus on the temperature of the bulk atmospheric layer from the surface to about 50,000 ft. – a layer which is often called by its microwave profile name T_{MT} (Temperature of Mid-Troposphere). This layer is particularly important because it captures the atmospheric region that is anticipated to warm rapidly and unambiguously if greenhouse theory is well-understood. As such, if the impact of extra

greenhouse gases (GHGs) is to be detected, it should be detected here. In Fig. 1 I show an example from a climate model simulation (Canadian Climate Model run CanESM2_rcp45_r3i1p1) of the anticipated temperature change for the period 1979-2016.

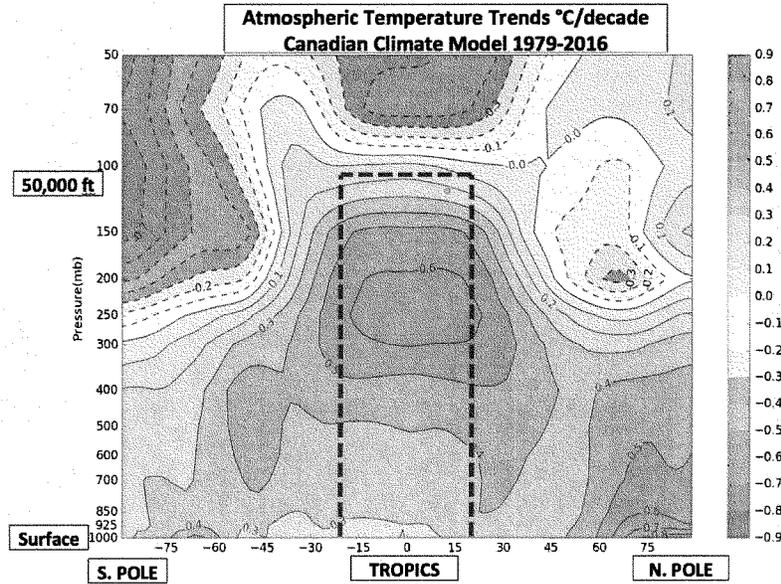


Figure 1 Temperature trends (°C/decade) for 1979-2016 of the cross-section of the atmosphere as simulated by the Canadian Climate Model. The tropical band (20°S-20°N) is outlined for the bulk layer (surface to 50,000 ft) that represents the microwave T_{MT} measurement (Temperature Mid-Troposphere). This outlined-layer is the region of prominent warming for the 1979-2016 period as depicted in all models and thus is the region to examine relative to observations (Figure by Rob Junod, UAH).

Figure 1 indicates that, according to theory, the tropical region should have experienced significant warming over the past 38 years due to extra GHGs. (There were 102 model runs to check and they all indicated a warming tropical atmosphere but to different degrees as shown later.) To test this result we follow the traditional scientific method in which a claim (hypothesis) is made and then is tested against independent information to see if the claim can be sustained or whether it is falsified. If the claim is confirmed, then we generally look for another test to confirm the claim again. If many tests are consistent

with the claim, then we may have confidence in it. If the claim fails a test, we look for reasons why and modify or reject the original claim and start over. Since the thrust of this Hearing is to see how the scientific method was or was not applied in the pronouncements about climate science, this will serve as an excellent example because it deals with a foundational climate metric that should reveal significant change if theory is correct – the temperature of the bulk atmosphere.

(2) Observational data used to test climate models

Recall that the results from climate models are simply hypotheses (claims) about how the climate should have evolved in the past. The claim here is, “**The bulk atmospheric temperature trend since 1979 of the consensus of the IPCC AR5 climate models represents the actual trend since 1979.**” (1979 is the beginning of the satellite temperature era.) To test this claim we compare the T_{MT} model trends against T_{MT} from several observational datasets. The first type of observational dataset is built from satellites that directly measure the bulk atmospheric temperature through the intensity of microwave emissions. These data are essentially global in coverage and monitor the Earth everyday. There are three sources, UAH (University of Alabama in Huntsville), RSS (Remote Sensing Systems, San Rafael CA) and NOAA.

The second type of measurement is produced from the ascent of balloons which carry various instruments including thermistors (which monitor the air temperature) as the balloon rises through this layer. From these measurements a value equivalent to the satellite T_{MT} profile is calculated. Balloon stations are not evenly spaced throughout the Earth, but because the upper air is much more horizontally coherent in its features than the surface, a few balloons can represent a very large area in terms of temperature variability. The sources of these balloon datasets are RAOBCORE and RICH (University of Vienna, Austria), NOAA and UNSW (University of New South Wales, Australia).

Finally, major weather centers around the world generate atmospheric conditions every six hours or so of the entire Earth at many vertical levels, called Reanalyses. These products use many sources of data, including satellites and balloons, and merge the observations with a continuously running general circulation model. From the information at the vertical levels the T_{MT} quantity is generated for an apples-to-apples comparison with models, satellites and balloons. The sources of the Reanalyses are ERA-I (European Centre for Medium-Range Weather Forecasts (ECMWF) – ReAnalysis-Interim), NASA-MERRA2 and JRA-55 (Japan ReAnalyses). These three types of systems - satellites, balloons and reanalyses - represent very different means of computing the bulk atmospheric temperature and are provided by independent, international entities giving us confidence in the observational results.

(3) Testing the claim – applying the scientific method

In Figure 2 we show the evolution of the tropical T_{MT} temperature since 1979 for the 102 climate model runs grouped in 32 curves by institution. Some institutions contributed a single simulation, others as many as 18. Multiple runs from a single institution's model category were averaged into a single time series here. The curves show the temperature evolution of the atmosphere in the tropical box shown in Fig. 1.

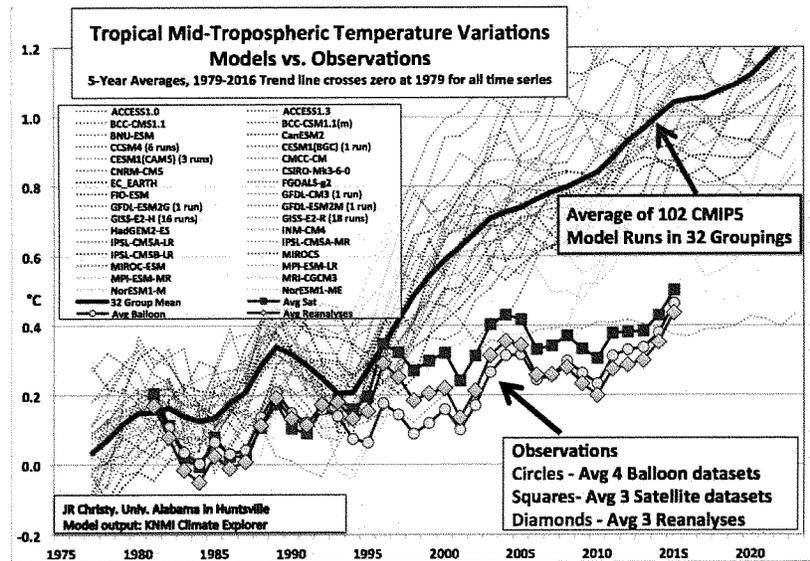


Figure 2: Five-year averaged values of annual mean (1979-2016) tropical bulk T_{MT} as depicted by the average of 102 IPCC CMIP5 climate models (red) in 32 institutional groups (dotted lines). The 1979-2016 linear trend of all time series intersects at zero in 1979. Observations are displayed with symbols: Green circles - average of 4 balloon datasets, blue squares - 3 satellite datasets and purple diamonds - 3 reanalyses. See text for observational datasets utilized. The last observational point at 2015 is the average of 2013-2016 only, while all other points are centered, 5-year averages.

Here we have climate model results (i.e. “claims” or “hypotheses”) to compare with observational datasets in a test to check whether the model average agrees with the observed data (i.e. the “claim” or “hypothesis”). We test the model average because it

represents the consensus of the theoretical models and is used to develop policy which is embodied in policy-related products such as the Social Cost of Carbon, the National Climate Assessment and the EPA Endangerment Finding.

I provided the model and observational information as annual temperature anomalies (both tropical and global) to Dr. Ross McKittrick (University of Guelph) who has published extensively as an applied econometrician on the application of statistical techniques to the testing of climate hypotheses. He applied the Vogelsang-Franzes F-Test method to these data as described in McKittrick, Ross R., S. McIntyre and C. Herman (2010) "Panel and Multivariate Methods for Tests of Trend Equivalence in Climate Data Sets", Atmosph. Sci. Lett., 11. DOI: 10.1002/asl.290. This method is particularly suitable for determining whether the trends of two time series are equivalent or significantly different. [The result found in their 2010 paper indicated model trends were significantly warmer than observations for the earlier datasets available at that time.]

What we are really testing here are the rates of warming depicted by the models and the observations for the period 1979-2016. I have simplified a depiction of the test in Figure 3 so the rate of warming is directly viewed, showing what the test is measuring.

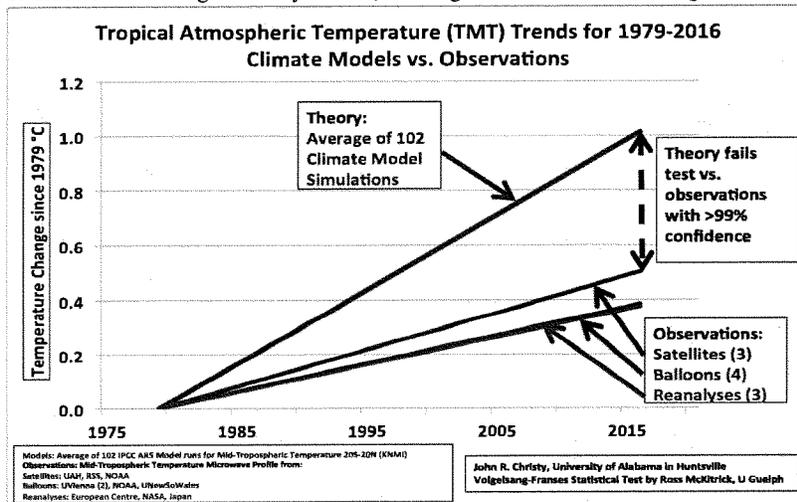


Figure 3. The linear trends of the average of the climate model simulations (red) and the averages of the three types of observational datasets described in the text.

The basic test question is, "Is the red line significantly different from the others?" The results are shown in Table 1 recognizing that there is no equivalence between the model

average trend and the observational datasets whenever the value of the test is greater than 84 at the <1% level. As shown, all test values exceed 84, and thus the mean model trend is highly significantly different from the observations.

Table 1. Test for equivalence between the 1979-2016 trend of the mean of 102 CMIP-5 Climate Model simulations and the trends of various observational datasets. The test is the Vogelsang-Franses F-Test (see McKittrick et al. 2010) that indicates non-equivalence at the 99% confidence level for values greater than 84 and shown in red. All values in the various tests are significant at this level.

	Tropics		Global	
	Trend	Test Value	Trend	Test Value
Balloons	+0.102	259	+0.111	165
Satellites	+0.136	104	+0.117	149
Reanalyses	+0.104	157	+0.123	87
Avg All	+0.113	187	+0.117	158
CMIP-5 Models	+0.274		+0.216	

The scientific conclusion here, if one follows the scientific method, is that the average model trend fails to represent the actual trend of the past 38 years by a highly significant amount. As a result, applying the traditional scientific method, one would accept this failure and not promote the model trends as something truthful about the recent past or the future. Rather, the scientist would return to the project and seek to understand why the failure occurred. The most obvious answer is that the models are simply too sensitive to the extra GHGs that are being added to both the model and the real world.

[We do not use surface temperature as a testable metric because models, to varying degrees, are tuned to agree with the surface temperature observations already – i.e. they’ve been given the answer ahead of time - thus a comparison of the surface would not be a valid scientific test (Hourdin, F.T. et al., “The art and science of climate model tuning”, 2016, doi:10.1175/BAMS-D-00135.1. and Voosen, P., “Climate scientists open up their black boxes to scrutiny”, 2016, Science, 354, pp 401-402. DOI:10.1126/Science.354.6311.401).]

(4) The IPCC AR5 (2013) displayed a similar result – the models failed

Oddly enough, such an important result (i.e. that models fail the test of representing the real-world bulk temperature trend) was available to see in the most recent IPCC AR5.

Unfortunately, it was buried in the Supplementary Material of Chapter 10 without comment. In Fig. 4, I present the figure that appeared in this IPCC section. I was a reviewer (a relatively minor position in that report) in the AR5 and had insisted that such a figure be shown in the main text because of its profound importance, but the government-appointed lead authors decided against it. They opted to place it in the Supplementary Material where little attention would be paid, and to fashion the chart in such a way as to make it difficult to understand and interpret.

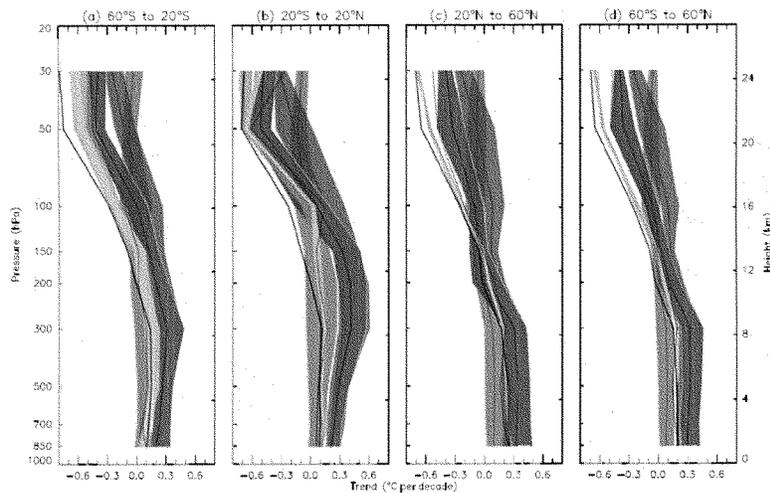


Figure 10.SM.1 | Observed and simulated zonal mean temperatures trends from 1979 to 2010 for CMIP5 simulations containing both anthropogenic and natural forcings (red), natural forcings only (blue) and greenhouse gas forcing only (green) where the 5th to 95th percentile ranges of the ensembles are shown. Three radiosonde observations are shown (thick black line: Hadley Centre Atmospheric Temperature data set 2 (HadAT2), thin black line: Radiosonde Observation Correction using REanalyses (RAOBCORE) 1.5, dark grey band: Radiosonde Innovation Composite Homogenization (RICH)-obs 1.5 ensemble and light grey: RICH- r 1.5 ensemble. (Adapted from Lott et al. (2013) but for the more recent period from 1979 to 2010.)

Figure 4. This is Fig. 10.SM.1 of the IPCC AR5 Supplementary Material for Chapter 10. These are trends (1979-2010) for various vertical levels of the atmosphere from (a) observations (gray band – difficult to see), from (b) models without extra GHGs (blue band) and (c) models with extra GHGs and other forcings (red band). The lower portion of the tropical chart (second panel from left) is simplified in Fig. 5 and used for the following discussion.

I have taken the same information in Fig. 4 (IPCC AR5 Fig. 10.SM.1) and simplified the presentation so as to be clearer in Fig. 5 below. The trends here represent trends at different levels of the tropical atmosphere from the surface up to 50,000 ft. The gray lines are the bounds for the range of observations, the blue for the range of IPCC model results *without* extra GHGs and the red for IPCC model results *with* extra GHGs.

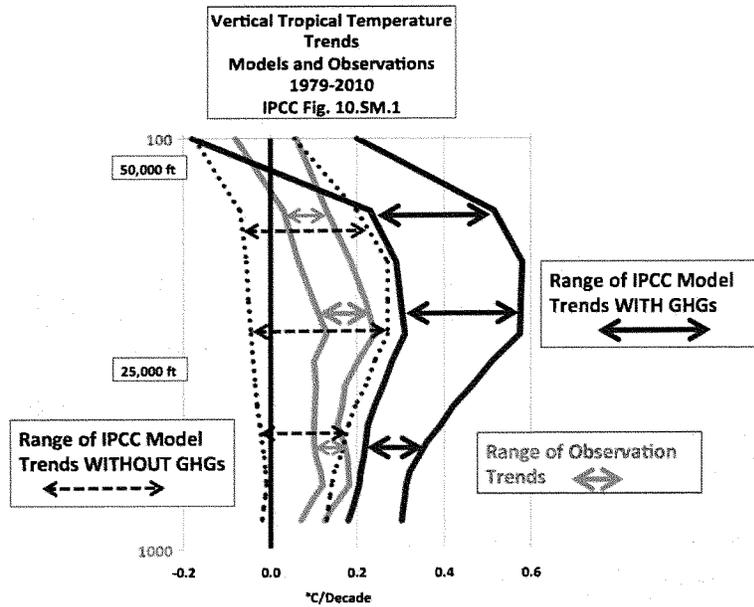


Figure 5. Simplification of IPCC AR5 shown above in Fig. 4. The colored lines represent the range of results for the models and observations. The key point displayed is the lack of overlap between the GHG model results (red) and the observations (gray). The non-GHG model runs (blue) overlap the observations almost completely.

What is immediately evident is that the model trends in which extra GHGs are included lie completely outside of the range of the observational trends, indicating again that the models, as hypotheses, failed a simple “scientific-method” test applied to this fundamental, climate-change variable. That this information was not clearly and openly presented in the IPCC is evidence of a political process that was not representative of the dispassionate examination of evidence as required by the scientific method. Further, (and this took guts) the IPCC then claimed high confidence in knowing *why* the climate evolved as it did over the past few decades (humans as the main cause) ignoring the fact the models on which that claim was based had failed an obvious and rather easy-to-perform validation test. Incredibly, what Fig. 5 shows is that the bulk tropical atmospheric temperature change is modeled best when *no extra* GHGs are included – a direct contradiction to the IPCC conclusion that observed changes could only be modeled *if extra* GHGs were included.

(5) A simple statistical model that passed the same “scientific-method” test

The IPCC climate models performed best versus observations when they did *not* include extra GHGs and this result can be demonstrated with a statistical model as well. I was co-author of a report which produced such an analysis (Wallace, J., J. Christy, and J. D’Aleo, “On the existence of a ‘Tropical Hot Spot’ & the validity of the EPA’s CO2 Endangerment Finding – Abridged Research Report”, August 2016 (Available here <https://thsresearch.files.wordpress.com/2016/09/ef-cpp-sc-2016-data-ths-paper-ex-sum-090516v2.pdf>).

In this report we examine annual estimates from many sources of global and tropical deep-layer temperatures since 1959 and since 1979 utilizing explanatory variables that did not include rising CO2 concentrations. We applied the model to estimates of global and tropical temperature from the satellite and balloon sources, individually, shown in Fig. 2 above. The explanatory variables are those that have been known for decades such as indices of El Nino-Southern Oscillation (ENSO), volcanic activity, and a solar activity (e.g. see Christy and McNider, 1994, “Satellite greenhouse signal”, *Nature*, 367, 27Jan). [One of the ENSO explanatory variables was the accumulated MEI (Multivariate ENSO Index, see <https://www.esrl.noaa.gov/psd/ens/mci/>) in which the index was summed through time to provide an indication of its accumulated impact. This “accumulated-MEI” was shown to be a potential factor in global temperatures by Spencer and Braswell, 2014 (“The role of ENSO in global ocean temperature changes during 1955-2011 simulated with a 1D climate model”, *APJ.Atmos.Sci.* 50(2), 229-237, DOI:10.1007/s13143-014-001-z.) Interestingly, later work has shown that this “accumulated-MEI” has virtually the same impact as the accumulated solar index, both of which generally paralleled the rise in temperatures through the 1980s and 1990s and the slowdown in the 21st century. Thus our report would have the same conclusion with or without the “accumulated-MEI.”]

The basic result of this report is that the temperature trend of several datasets since 1979 can be explained by variations in the components that naturally affect the climate, just as the IPCC inadvertently indicated in Fig. 5 above. The advantage of the simple statistical treatment is that the complicated processes such as clouds, ocean-atmosphere interaction, aerosols, etc., are implicitly incorporated by the statistical relationships discovered from the actual data. Climate models attempt to calculate these highly non-linear processes from imperfect parameterizations (estimates) whereas the statistical model directly accounts for them since the bulk atmospheric temperature is the response-variable these processes impact. It is true that the statistical model does not know what each sub-process is or how each might interact with other processes. But it also must be made clear: it is an understatement to say that no IPCC climate model accurately incorporates all of the non-

linear processes that affect the system. I simply point out that because the model is constrained by the ultimate response variable (bulk temperature), these highly complex processes are included.

The fact that this statistical model explains 75-90 percent of the real annual temperature variability, depending on dataset, using these influences (ENSO, volcanoes, solar) is an indication the statistical model is useful. In addition, the trends produced from this statistical model are not statistically different from the actual data (i.e. passing the “scientific-method” trend test which assumes the natural factors are not influenced by increasing GHGs). This result promotes the conclusion that this approach achieves greater scientific (and policy) utility than results from elaborate climate models which on average fail to reproduce the real world’s global average bulk temperature trend since 1979.

The over-warming of the atmosphere by the IPCC models relates to a problem the IPCC AR5 encountered elsewhere. In trying to determine the climate sensitivity, which is how sensitive the global temperature is relative to increases in GHGs, the IPCC authors chose *not* to give a best estimate. [A high climate sensitivity is a foundational component of the last Administration’s Social Cost of Carbon.] The reason? ... climate models were showing about twice the sensitivity to GHGs than calculations based on real, empirical data. I would encourage this committee, and our government in general, to consider empirical data, not climate model output, when dealing with environmental regulations.

(6) Red Teams needed because Consensus Science is not Science

One way for congress to receive better (less biased) information about claims of climate science is to organize “Red Teams” as is done in other parts of government and industry when critical systems, programs or infrastructure are under consideration. I have discussed this idea in several previous congressional hearings. I will include here the section describing Red Teams from my testimony on 20 Sep 2012 before the Subcommittee on Energy and Power of the House Committee on Energy and Commerce.

The term “consensus science” will often be appealed to regarding arguments about climate change to bolster an assertion. This is a form of “argument from authority.” Consensus, however, is a political notion, not a scientific notion. As I testified to the Inter-Academy Council in June 2010, wrote in Nature that same year (Christy 2010), and documented in my written House Testimony last year (House Space, Science and Technology, 31 Mar 2011) the IPCC and other similar Assessments do not represent for me a consensus of much more than the consensus of those selected to agree with a particular consensus. The content of these climate reports is actually under the control

of a relatively small number of individuals - I often refer to them as the "climate establishment" - who through the years, in my opinion, came to act as gatekeepers of scientific opinion and information, rather than brokers. The voices of those of us who object to various statements and emphases in these assessments are by-in-large dismissed rather than accommodated. This establishment includes the same individuals who become the "experts" called on to promote IPCC claims in government reports such as the Endangerment Finding by the Environmental Protection Agency. As outlined in my [31 Mar 2011] House Testimony, these "experts" become the authors and evaluators of their own research relative to research which challenges their work. But with the luxury of having the "last word" as "expert" authors of the reports, alternative views vanish.

I've often stated that climate science is a "murky" science. We do not have laboratory methods of testing our hypotheses as many other sciences do. As a result what passes for science includes, opinion, arguments-from-authority, dramatic press releases, and fuzzy notions of consensus generated by preselected groups. This is not science.

*I noticed the House passed an amendment last year to de-fund the U.N.'s Intergovernmental Panel on Climate Change (IPCC.) We know from Climategate emails and many other sources that the IPCC has had problems with those who take different positions on climate change than what the IPCC promotes. There is another way to deal with this however. Since the IPCC activity is funded by US taxpayers, then I propose that five to ten percent of the funds be allocated to a group of well-credentialed scientists to produce an assessment that expresses legitimate, alternative hypotheses that have been (in their view) marginalized, misrepresented or ignored in previous IPCC reports (and thus EPA and National Climate Assessments). Such activities are often called "Red Team" reports and are widely used in government and industry. Decisions regarding funding for "Red Teams" should not be placed in the hands of the current "establishment" but in panels populated by credentialed scientists who have experience in examining these issues. Some efforts along this line have arisen from the private sector (i.e. The Non-governmental International Panel on Climate Change at <http://nipccreport.org/> and Michaels (2012) *ADDENDUM: Global Climate Change Impacts in the United States*). I believe policymakers, with the public's purse, should actively support the assembling all of the information that is vital to addressing this murky and wicked science, since the public will ultimately pay the cost of any legislation alleged to deal with climate.*

Topics to be addressed in this "Red Team" assessment, for example, would include (a) evidence for a low climate sensitivity to increasing greenhouse gases, (b) the role and importance of natural, unforced variability, (c) a rigorous and independent evaluation of climate model output, (d) a thorough discussion of uncertainty, (e) a focus on metrics that most directly relate to the rate of accumulation of heat in the climate system, (f) analysis of the many consequences, including benefits, that result from CO2 increases, and (g) the importance that affordable and accessible energy has to human health and welfare.

What this proposal seeks is to provide to the Congress and other policymakers a parallel, scientifically-based assessment regarding the state of climate science which addresses issues which here-to-for have been un- or under-represented by previous tax-payer funded, government-directed climate reports. In other words, our policymakers need to see the entire range of findings regarding climate change.

(7) In Summary

“Science” is not a set of facts but a process or method that sets out a way for us to discover information and which attempts to determine the level of confidence we might have in that information. In the method, a “claim” or “hypothesis” is stated such that rigorous tests might be employed to test the claim to determine its credibility. If the claim fails a test, the claim is rejected or modified then tested again. When the “scientific method” is applied to the output from climate models of the IPCC AR5, specifically the bulk atmospheric temperature trends since 1979 (a key variable with a strong and obvious theoretical response to increasing GHGs in this period), I demonstrate that the consensus of the models fails the test to match the real-world observations by a significant margin. As such, the average of the models is considered to be untruthful in representing the recent decades of climate variation and change, and thus would be inappropriate for use in predicting future changes in the climate or for related policy decisions.

The IPCC inadvertently provided information that supports this conclusion by (a) showing that the tropical trends of climate models *with* extra greenhouse gases failed to match actual trends and (b) showing that climate models *without* extra greenhouse gases agreed with actual trends. A report of which I was a co-author demonstrates that a statistical model that uses only natural influences on the climate also explains the variations and trends since 1979 without the need of extra greenhouse gases. While such a model (or any climate model) cannot “prove” the causes of variations, the fact that its result is not rejected by the scientific method indicates it should be considered when trying to understand why the climate does what it does. Deliberate consideration of the major influences by natural variability on the climate has been conspicuously absent in the current explanations of climate change by the well-funded climate science industry.

One way to aid congress in understanding more of the climate issue than what is produced by biased “official” panels of the climate establishment is to organize and fund credible “Red Teams” that look at issues such as natural variability, the failure of climate models and the huge benefits to society from affordable energy, carbon-based and otherwise. I would expect such a team would offer to congress some very different conclusions regarding the human impacts on climate.

John R. Christy

The University of Alabama in Huntsville

Dr. John R. Christy is the Distinguished Professor of Atmospheric Science and Director of the Earth System Science Center at the University of Alabama in Huntsville where he began studying global climate issues in 1987. Since 2000 he has been Alabama's State Climatologist. In 1989 Dr. Roy Spencer (then a NASA scientist and now a Principle Research Scientist at UAH) and Christy developed a global temperature data set from satellite microwave data beginning in 1979. For this achievement, the Spencer-Christy team was awarded NASA's Medal for Exceptional Scientific Achievement in 1991. In 1996, they were selected to receive a Special Award by the American Meteorological Society "for developing a global, precise record of earth's temperature from operational polar-orbiting satellites, fundamentally advancing our ability to monitor climate." In January 2002 Christy was inducted as a Fellow of the American Meteorological Society.

Dr. Christy has served as Lead Author (2001) and Contributor/Reviewer (1992, 1994, 1996, 2007, 2013) for the U.N. reports by the Intergovernmental Panel on Climate Change in which the satellite temperatures were included for studying global climate change. He has served on five NRC and NAS panels and has performed research funded by NASA, NOAA, DOE, DOT and the State of Alabama, publishing many studies appearing in, for example, *Science*, *Nature*, *Journal of Climate* and *The Journal of Geophysical Research*.

Dr. Christy received the M.S. and Ph.D. degrees in Atmospheric Sciences from the University of Illinois (1984, 1987). Prior to this career path he had graduated from the California State University in Fresno (B.A. Mathematics, 1973) and taught Physics and Chemistry as a missionary teacher in Nyeri, Kenya for two years. After earning a Master of Divinity degree from Golden Gate Baptist Seminary (1978) he served four years as a bivocational mission-pastor in Vermillion, South Dakota where he also taught college math. He has been profiled in the February 2001 issue of *Discover magazine*, by National Public Radio in 2004 and in the *NY Times* in 2014 where his diverse background was highlighted.

Dr. Christy was married to the former Babs Joslin for almost 39 years until her death in 2014 of cancer. She was a fellow missionary whom he met in Kenya. Their two children are now married; Alison has three children and Brian has two. Recently, Dr. Christy and Ms. Sherry Upshaw were joined in marriage. Dr. Christy's favorite hobby is gold panning which he developed as a teenager in California, and he also runs, completing races from 2 miles to ultra-marathons over rugged terrain.

Chairman SMITH. Thank you, Dr. Christy.
And Dr. Mann.

**TESTIMONY OF DR. MICHAEL MANN,
DISTINGUISHED PROFESSOR OF
ATMOSPHERIC SCIENCE AND DIRECTOR,
EARTH SYSTEM SCIENCE CENTER (ESSC),
THE PENNSYLVANIA STATE UNIVERSITY**

Dr. MANN. Thank you, Mr. Chairman and Members of the Committee. My name is Michael Mann. I am Distinguished Professor of Atmospheric Science at Penn State University, where I also direct the Earth System Science Center at Penn State. My research interests are in understanding the behavior of the Earth's climate system. I have served on several National Academy panels and committees. I'm a Fellow of the American Geophysical Union, the American Meteorological Science, and the Association—American Association for the Advancement of Science. I received numerous prestigious awards. I have authored more than 200 publications and several books.

It is important to make clear at the outset that there is extremely broad agreement among the world's scientists on the basic facts of human-caused climate change. The U.S. National Academy of Sciences, all of the scientific societies of all the industrial nations, more than 30 scientific societies around the United States, at least 97 percent of scientists publishing in the field, all of these have concluded based on the evidence that climate change is real, is human caused, and is having adverse impacts on us, our economy, and our planet.

Yet we find ourselves at this hearing today with three individuals who represent that tiny minority that reject this consensus or downplay its significance, and only one, myself, who is in the mainstream. That's 25 percent. That's a far cry from 97 percent, an inauspicious start for an honest discussion about science.

I have devoted my life to understanding the natural world. In the case of climate science, it turns out that this lifelong journal of scientific discovery has also enormous societal implications. Earlier this week, for example, my colleagues and I published a study demonstrating that climate change is altering the jet stream in a way that is making extreme weather events—droughts, floods, heat waves—more likely, events like the 2011 Texas and Oklahoma heat wave and drought, the 2015 California wildfires that affected the lives so many Americans. Other recent studies have shown the fingerprints of human-caused climate change on extreme events like the fires that devastated America's heartland earlier this month, burning cattle alive. One local called these wildfires "Our Hurricane Katrina." February's record warmth was made three times more likely by human-caused climate change, and that record warmth fueled the drought that set up these fires.

Continuing to pose important questions and seeking to answer them using scientific tools and observations, as a scientist, that's what I love doing, but I'm here today because I'm also passionate about communicating what we know to the public and to policy-makers. In my view, nothing could be more noble.

Anti-science forces have launched a series of bad-faith assaults on climate science and climate scientists. I should know. I found myself at the center of these episodes more than once.

We've recently seen the latest in this perpetual series of attacks, and the story is eerily familiar. As always, they focused on a particular individual, in this case, Tom Karl, who in 2015 led a study published in the premier journal *Science* that put the final nail in the coffin of the contrarian myth du jour that global warming had supposedly stopped. Never mind that we've now broken all-time records for three consecutive years and various published studies have convincingly demonstrated that human-caused global warming continues unabated, this Committee's Chairman, Chairman Smith, attacked Karl, aided by contrarian bloggers and the tabloid press. Smith even misrepresented an article I was co-author on, claiming it supported his attacks on Karl and NOAA. While we disagreed over some details, precisely the sort of healthy debate that many in this room would like to pretend doesn't exist in the scientific community, both papers agree that human-caused global warming continues unabated while natural variations continue as well.

While such political theater plays out in Congress, the process of real science plays out in the peer-reviewed literature and at scientific meetings where scientists continuously challenge each other's findings. But just as our critics have intentionally ignored the many independent studies reaffirming the hockey stick curve for which I was attacked, so too have Karl's critics ignored the fact that his findings have been confirmed by the Berkeley Earth Project, a project funded by the Koch Brothers.

When I was attacked by Joe Barton a decade ago over the hockey stick, I found support from moderate pro-science Republicans like John McCain and Sherwood Boehlert, the former Chair of this Committee, I would add. I am deeply appreciative of the efforts today by Republicans like Bob Inglis of South Carolina and former Reagan Administration officials James Baker and George Schultz to promote conservative climate solutions. It is time for other Republicans to put aside the anti-science and engage instead in the worthy debate to be had about how we solve this great challenge to all of humanity.

Thank you.

[The prepared statement of Dr. Mann follows:]

TESTIMONY OF DR. MICHAEL E. MANN
DISTINGUISHED PROFESSOR, OF
ATMOSPHERIC SCIENCE
PENN STATE UNIVERSITY AND
DIRECTOR, PENN STATE EARTH SYSTEM SCIENCE
CENTER

BEFORE THE
COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY.

MARCH 29, 2017

Mr. Chairman, and members of the Committee. My name is Michael Mann. I am Distinguished Professor of Atmospheric Science at Penn State University, and Director of the Penn State Earth System Science Center. My research involves the use of climate models, the analysis of empirical climate data, and developing methods for comparing observations and model predictions. The primary focus of my research is understanding the long-term behavior of the climate system, and determining the roles of various potential agents of climate change, both natural and human.

I have served as organizing committee chair for the National Academy of Sciences *Frontiers of Science*, and as the co-author or advisor for several National Academy of Sciences reports related to climate change. I have served as editor for the *Journal of Climate* of the American Meteorological Society and have served as a member of numerous other international and U.S. scientific working groups, panels and steering committees. I was awarded the Hans Oeschger Medal of the European Geophysical Union in 2012 and received the Friend of the Planet Award from the National Center for Science Education in 2014. I am a Fellow of the American Geophysical Union, the American Meteorological Society, and the American Association for the Advancement of Science. I have authored more than 200 publications, and several books including *Direct Predictions: Understanding Climate Change*, *The Hockey Stick and the Climate Wars* and *The Madhouse Effect: How Climate Change Denial Is Threatening Our Planet*, *Destroying Our Politics*, and *Driving Us Crazy* with Tom Toles, the Pulitzer Prize-winning editorial cartoonist for the *Washington Post*.

Let me first comment about *why* I went into science. I was fascinated by the natural world as a child and wanted to devote my life to understanding it. This led me on a lifelong journey of scientific discovery that is every bit as thrilling to me today as it was

as a child. When the science has broader societal importance, that's icing on the cake. Earlier this week, for example, my colleagues and I published a study in the journal *Scientific Reports* using a combination of observations and climate model simulations to demonstrate a linkage between climate change and jet stream behavior linked to extreme, persistent weather events like the 2011 Texas & Oklahoma Drought and the 2015 California wildfires. Continuing to pose questions and to seek to answer them using scientific tools and observations—that's what I truly love doing.

But I'm here today because I'm also passionate about communicating what we know to the public and to policymakers. I have become convinced that no pursuit could be more noble. So about this hearing: It is important to make clear at the outset that there is extremely broad agreement among the world's scientists on the basic facts of human-caused climate change. The U.S. National Academy of Sciences, the Royal Society of the U.K., and all of the scientific societies¹ of all of the industrial nations—the more than 30 scientific societies² in the U.S. that have weighed in on the matter, and at least 97%³ of scientist publishing in the field have all concluded, based on the evidence, that climate change is real, is human-caused, and is already having adverse impacts on us, our economy, and our planet.

Yet we find ourselves at this hearing today, with three individuals who represent that tiny minority that reject this consensus or downplay its significance, and only one—myself—who is in the mainstream. That's 25%, a far cry from the 97-99% figure that actually characterizes where the world's scientists stand on this issue. This creates the

¹ Joint science academies' statement: Global response to climate change, 2005

² "Scientific Consensus on Global Warming", Union of Concerned Scientists: http://www.ucsusa.org/global_warming/science_and_impacts/science/scientific-consensus-on.html#.WNfu6161v_Q

³ John Cook *et al* 2016 *Environ. Res. Lett.* 11 048002

illusion of a debate that does not exist. This is not an auspicious start for a hearing that purports to be examining science rather than antiscience, fact rather than fiction.

I coined the term “Serengeti Strategy” back in 2012 in “*The Hockey Stick and the Climate Wars*”⁴ to describe how industry special interests who feel threatened by scientific findings—be it tobacco and lung cancer, or fossil fuel burning and climate change—single out individual scientists to attack in much the same way lions of the Serengeti single out an individual zebra from the herd. In numbers there is strength, but individuals are far more vulnerable. Science critics will therefore often select a single scientist to ridicule, hector, and intimidate. The presumed purpose is to set an example for other scientists who might consider sticking their neck out by participating in the public discourse over certain matters of policy-relevant science.

I should know. I’ve found myself at the center of such episodes more than once, as a result of the iconic “hockey stick” that my co-authors and I published in the late 1990s that demonstrates the unprecedented nature of recent warming. While the hockey stick is hardly the basis of the case for human-caused climate change, the visually compelling character of the graphic has made it—and indeed, me—a target of climate change deniers for years.

In October 2003 just days before a critical U.S. Senate resolution to acknowledge the threat of human-caused climate change, an “article” was published by climate change-denial friendly “journal” that engaged in dubious attacks on the hockey stick. A fossil fuel industry front group published an op-ed trumpeting the specious criticisms in *USA Today* on the morning of the Senate vote. Senator James Inhofe of “climate change

⁴ Mann, M.E., *The Hockey Stick and the Climate Wars*, Columbia University Press (2012)

⁵ *Ibid* 4

⁶ What If ... the “Hockey Stick” Were Wrong? By Stefan Rahmstorf, RealClimate.org, Jan 27, 2005.

is the greatest hoax⁷ ever perpetrated on the American people” infamy happily trumpeted the article during the senate floor debate. While the critique on the hockey stick would soon be summarily dismissed⁸, it served the short-term purpose of hijacking the discussion. The bill did not pass.

In 2005, as the House of Representatives was considering energy and climate legislation, Joe Barton (R-TX), Chair of the House Energy and Commerce Committee and a leading recipient of fossil fuel money engaged in what was widely condemned as a “witch-hunt”⁹ against me and my hockey stick co-authors. Barton demanded all of my personal emails and correspondence with other scientists, and numerous other materials, in an apparent effort to find something, anything, he could use to try to discredit the iconic Hockey Stick. In the cynical minds of our critics, discrediting our work would somehow undermine the entire case for concern over human-caused climate change.

On the eve of the Copenhagen U.N. climate summit of December 2009—seen as the greatest opportunity yet for an international agreement to limit greenhouse gas emissions, a trove of emails, including many of my own—had been stolen, and combed through for words and phrases (like “trick”—a completely appropriate term in science for a clever approach) that might seem embarrassing or even damning. The out-of-context snippets were posted on climate change deniers’ websites and then spread through right-wing blogs and news sites. Soon even mainstream news organizations were credulously parroting the denialist narrative that a few stolen emails somehow called into question the fundamental evidence behind human-caused climate change, a result of nearly two

⁷ Inhofe: Calling Climate Change “The Greatest Hoax Ever” Is “Doing The Lord’s Work” by Joe Romm, Climate Progress, Dec 5, 2011.

⁸ “Global warming debate heats up Capitol Hill” by Dan Vergano, USA Today, Nov 18, 2003.

⁹ “Republicans accused of witch-hunt against climate change scientists” by Paul Brown, The Guardian, Aug 30, 2005.

centuries¹⁰ of scientific research. I and a small number of other leading climate scientists found ourselves at the very center of the smear campaign.

At least 10 investigations and reviews have established¹¹ that there was no wrongdoing on the part of the scientists (indeed, the only wrongdoing was the criminal theft of the emails in the first place). The vindications, however, occurred long after fossil fuel interests and those doing their bidding had the opportunity to sabotage efforts to reach an international agreement limiting carbon emissions (Oil-rich Saudi Arabia, for example, insisted¹² in Copenhagen that the stolen emails justified opposition to any agreement to limit carbon emissions; Russia also appears to have played some role in the hacking and/or dissemination of the emails).

We now have the latest in this perpetual series of bad-faith assaults on climate science, and the story is eerily familiar. The attacks, as always, have focused on a particular individual—in this case, Tom Karl¹³, the recently retired Director of NOAA's National Climatic Data Center and a scientist for whom I have the deepest respect.

For proper context, we must consider the climate denial myth *du jour* that global warming has “stopped”. Like most climate denial talking points, the reality is pretty much the opposite of what is being claimed by the contrarians. All surface temperature products, including the controversial UAB satellite temperature record, show a clear long-term warming trend over the past several decades (Exhibit A). We have now broken

¹⁰ “Two Centuries of Climate Science: part one – Fourier to Arrhenius, 1820- 1930 by John Mason, *Skeptical Science*, Apr 26, 2012.

¹¹ “Debunking Misinformation About Stolen Climate Emails in the “Climategate” Manufactured Controversy”, Union of Concerned Scientists: http://www.ucsusa.org/global_warming/solutions/fight-misinformation/debunking-misinformation-stolen-emails-climategate.html

¹² “Climategate”: Hacked e-mails show climate scientists in a bad light but don't change scientific consensus on global warming. By Jess Henig, FactCheck.org, Dec 10, 2009.

¹³ “Tom Karl Retires After Nearly 41 Years of Service”, NOAA Press Release, Aug 4, 2016.

the all-time global temperature record for three consecutive years¹⁴ and a number of published articles have convincingly demonstrated that global warming has continued unabated despite when one properly accounts for the vagaries of natural short-term climate fluctuations. A prominent such study¹⁵ was published by Tom Karl and colleagues in 2015 in the leading journal *Science*. The article was widely viewed as the final nail in the “globe has stopped warming” talking point’s coffin.

Last month, opinion writer David Rose of the British tabloid the *Daily Mail*—known for¹⁶ his serial misrepresentations of climate change and his serial attacks on climate scientists, published a commentary¹⁷ online attacking Tom Karl, accusing him of having “manipulated global warming data” in the 2015 Karl et al article. This fake news story was built entirely on an interview with a single disgruntled former NOAA employee, John Bates, who had been demoted from a supervisory position at NOAA for his inability to work well with others.

Bates’ allegations were also published on the blog of climate science denier Judith Curry (I use the term carefully—reserving it for those who deny the most basic findings of the scientific community, which includes the fact that human activity is substantially or entirely responsible for the large-scale warming we have seen over the past century—something Judith Curry¹⁸ disputes¹⁹). That blog post and the *Daily Mail* story have now

¹⁴ “How 2016 Became Earth’s Hottest Year on Record” by Jugal K. Patel, *New York Times*, Jan 18, 2017.

¹⁵ Karl et al, “Possible artifacts of data biases in the recent global surface warming hiatus”, *Science*, 348, pp. 1469-1472 (2015).

¹⁶ See the DeSmogBlog entry for David Rose: <https://www.desmogblog.com/david-rose>

¹⁷ “Exposed: How world leaders were duped into investing billions over manipulated global warming data” by David Rose, *The Daily Mail* (UK), Feb 4, 2017.

¹⁸ “Scott Pruitt’s office deluged with angry callers after he questions the science of global warming” by Juliet Eilperin and Brady Dennis, *Washington Post*, March 11, 2017.

¹⁹ “IPCC attribution statements redux: A response to Judith Curry” by Gavin Schmidt, *RealClimate.org*, Aug 27, 2014.

been thoroughly debunked by the actual scientific community²⁰. The *Daily Mail* claim that data in the Karl et al. *Science* article had been manipulated was not supported by Bates. When the scientific community pushed back on the untenable “data manipulation” claim, noting that other groups of scientists had independently confirmed²¹ Karl et al’s findings, Bates clarified that the real problem was that data had not been properly archived and that the paper was rushed to publication. These claims too quickly fell apart.

Though Bates claimed that the data from the Karl et al study was “not in machine-readable form”, independent scientist Zeke Hausfather, lead author of a study²² that accessed the data and confirmed its validity, wrote in a commentary²³ “...for the life of me I can't figure out what that means. My computer can read it fine, and it's the same format that other groups use to present their data.” As for the claim that the paper was rushed to publication, Editor-in-chief of *Science* Jeremy Berg says, “With regard to the ‘rush’ to publish, as of 2013, the median time from submission to online publication by *Science* was 109 days, or less than four months. The article by Karl *et al.* underwent handling and review for almost six months. Any suggestion that the review of this paper was ‘rushed’ is baseless and without merit. *Science* stands behind its handling of this paper, which underwent particularly rigorous peer review.”

Shortly after the *Daily Mail* article went live, a video attacking Karl (and NOAA and even NASA for good measure) was posted by the *Wall Street Journal*. Within hours,

²⁰ “Climate Change, Science, NOAA Falsely Maligned by Tabloid Spin”, *Climate Nexus*, <http://climatenexus.org/messaging-communication/current-events/climate-change-science-noaa-falsely-maligned-tabloid-spin>

²¹ Hausfather et al, “Assessing recent warming using instrumentally homogeneous sea surface temperature records”, *Science Advances*, 3, e1601207 (2017).

²² Ibid 21

²³ “Factcheck: Mail on Sunday’s ‘astonishing evidence’ about global temperature rise” by Zeke Hausfather, *Carbon Brief*, Feb 5, 2017: <https://www.carbonbrief.org/factcheck-mail-sundays-astonishing-evidence-global-temperature-rise>

the *Daily Mail* story spread like a virus through the right-wing blogosphere, appearing on numerous right-wing websites and conservative news sites. It didn't take long for the entire Murdoch media empire in the U.S, U.K. and elsewhere to join in, with the execrable *Fox New* for example alleging²⁴ Tom Karl had "cooked" climate data and, with no sense of irony, for *political reasons*.

Rep. Lamar Smith (R-TX), chair of this committee has a history²⁵ of launching attacks on climate science and climate scientists. He quickly posted a press release praising the *Daily Mail* article, placing it on the science committee website, and falsely alleging that government scientists had "falsified data". Smith, it turns out, had been planning a congressional hearing timed to happen just days after this latest dustup, intended to call into question²⁶ the basis for the EPA regulating carbon emissions. His accusations against Karl and NOAA of tampering with climate data was used in that hearing to claim that the entire case for concern over climate change was now undermined.

Of course, even if the Karl study was completely wrong, it wouldn't in any way alter what we know about climate change. Just as our critics have intentionally ignored the many independent studies reaffirming²⁷ the "Hockey Stick" curve in the peer-reviewed scientific literature (see Exhibit B), so too have Karl's critics ignored that his findings have been replicated and confirmed by other research groups publishing in the

²⁴ "Federal scientist cooked climate change books ahead of Obama presentation, whistle blower charges", *Fox News* (Feb 17, 2017).

²⁵ "The Assault on Climate Science" by Michael E. Mann, *New York Times*, Dec 8, 2015.

²⁶ "Global warming skeptic Lamar Smith sets "Make EPA Great Again" hearing" by Kiah Collier, *Texas Tribune*, Feb. 2, 2017

²⁷ "Most Comprehensive Paleoclimate Reconstruction Confirms Hockey Stick" by Stefan Rahmstorf, *Climate Progress*, Jul 8, 2013: <https://thinkprogress.org/most-comprehensive-paleoclimate-reconstruction-confirms-hockey-stick-e7ce8c3a2384#.p1bm8mmfd>

peer-reviewed literature. That includes the study²⁸ led by Zeke Hausfather of the “Berkeley Earth” project—a project funded in part by the Koch Brothers and including²⁹ as one of its original team members, climate change contrarian Judith Curry. The authors showed that the Karl et al estimates agree with the best available independent estimates of ocean warming (see Exhibit C). Lead author Hausfather has stated³⁰ that “The fact that the new NOAA record is effectively identical with records constructed only from higher quality instruments (buoys, satellite radiometers, and Argo floats) strongly suggests that NOAA got it right and that we have been underestimating ocean warming in recent years.”

Let me make some additional observations with regard to this latest episode. Climate contrarians like to accuse scientists of understating uncertainty. Anyone who knows scientists and is familiar with scientific research understands how absurd that accusation is. Scientists embrace the concept of uncertainty, because it guides us—it informs our choices of what additional measurements to make and hypotheses to pursue. I would note that our 1999 “hockey stick” article that is so much maligned by climate change deniers, contained the words “uncertainties” and “limitations” in the title. Let me also remind you that the implications of scientific “uncertainty” are rather different from what your contrarian witnesses would like you to believe. Leading economists like Harvard’s Marty Weitzman have shown that³¹ uncertainty is most likely a reason for even more concerted action to mitigate climate change because of what is known as the “heavy tail” of the distribution of risk, namely the huge potential costs if the impacts turn out to

²⁸ Ibid 21

²⁹ Sourcwatch page on Judith Curry: http://www.sourcewatch.org/index.php/Judith_Curry

³⁰ Ibid 23

³¹ “Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change” by Martin L. Weitzman, Symposium on Fat Tails and the Economics of Climate Change, Oxford University Press, 2011.

be even greater than predicted, something that appears to be the case now with the potential rapid collapse³² of the West Antarctic Ice Sheet and the increased sea level rise that will come with it.

Contrarians also falsely accuse scientists of conspiring to enforce “dogma”. But the way scientists get articles in leading journals like *Science* or *Nature* is by demonstrating something novel—something we didn’t already know, not by simply reiterating what is known. And herein lies a conundrum for those attacking the Karl et al study. One of the articles seized upon in a previous hearing by Chairman Smith as a supposed indictment of Karl et al is a *Nature Climate Change* article³³ (Fyfe *et al* 2016) on which I was a co-author. As a co-author of this article, I can assure you that it in no way calls into question the integrity of NOAA’s data, or the honesty of Tom Karl and his colleagues, whom I hold in the highest esteem. We simply differed with them on the best interpretation of the temperature record, demonstrating that the interpretation of whether or not there was a temporary slowdown in warming during the first decade of the 21st century depends on precisely how the baseline warming trend is defined.

Chairman Smith can’t have it both ways. This study can’t both be an indictment of Tom Karl and colleagues and at the same time support the Chairman’s conspiracy theories about climate scientists colluding with each other and being compromised by “groupthink”. What our *Nature Climate Change* piece actually demonstrates is that there is indeed a robust, healthy, and respectful debate among scientists when it comes to interpreting data and testing hypotheses. True scientists are skeptics—real skeptics,

³² “Climate Model Predicts West Antarctic Ice Sheet Could Melt Rapidly” by Justin Gillis, *New York Times*, Mar 30, 2016.

³³ Fyfe J. et al, “Making sense of the early-2000s warming slowdown” *Nature Climate Change*, 6, 224–228 (2016)

contesting prevailing paradigms and challenging each other, in the peer-reviewed literature, at scientific meetings, and in seminars—the proper channels for good faith scientific debate. That, of course, is inconvenient to the caricature that Congressman Smith and his contrarians witnesses have sought to paint when it comes to climate science and climate scientists.

While we're at it, let me address another favorite talking point of the critics, the claim that climate models we use to project future climate change are unreliable and untested. The reality is that the models have been tested vigorously and rigorously in numerous ways, and have passed a number of impressive tests in the past, such as James Hansen's famous successful predictions³⁴ from the 1980s and 1990s. Let me take the opportunity to bring your attention to one particular analysis³⁵ that appears in the latest issue of *Nature Climate Change*. Back in 1989, legendary climate scientists Ron Stouffer (a graduate of our program at Penn State I'm proud to say) and Suki Manabe made a prediction not just of the average warming of the globe, but of the precise global pattern of that warming. That pattern matches the observed pattern of warming that has ensued remarkably well (see Exhibit D).

When I was attacked by Joe Barton³⁶ a little more than decade ago over the “hockey stick”, at a time when both houses of congress and the presidency were in the hands of Republicans, I found support in the hands of both the Bush Administration's Office of Science and Technology Policy, and moderate, pro-science, pro-environment Republicans in the Senate and House such as John McCain (R-AZ) and Sherwood Boehlert (R-NY). Mr. Boehlert was the Republican Chairman of this Committee, the

³⁴ “Hansen's 1988 projections” by Gavin Schmidt, *RealClimate.org*, May 15, 2007:
<http://www.realclimate.org/index.php/archives/2007/05/hansens-1988-projections/>

³⁵ Stouffer, R.J. and Manabe, S., Assessing temperature pattern projections made in 1989, *Nature Climate Change*, 7, 163-166 (2017).

Science Committee, at the time. Where are these good faith conservatives today? Why are they not speaking out against this latest abuse against science and reason? If they fail to force their concerns, we must worry just how far down the antiscience rabbit hole we'll be going this time.

There is a worthy debate to be had about climate policy. And I am deeply appreciative of the efforts of conservatives like Bob Inglis³⁷ of South Carolina, former Reagan administration officials Jakes Baker and George Schultz³⁸, and Republican-led groups like RepublicEN³⁹ and the Niskanen Center⁴⁰, to promote conservative solutions to solving the climate problem. It is time for other Republicans to put aside the antiscience and engage instead in the worthy debate to be had about how we solve this great challenge to all of humanity.

³⁶ *Ibid* 4

³⁷ JFK "Profile In Courage" Award Announcement (2015): <https://www.jfklibrary.org/Events-and-Awards/Profile-in-Courage-Award/Award-Recipients/Congressman-Bob-Inglis-2015.aspx>

³⁸ "Senior Republican statesmen propose replacing Obama's climate policies with a carbon tax" by Chris Mooney and Juliet Eilperin, *Washington Post*, Feb 8, 2017.

³⁹ RepublicEN.org: <http://www.republicen.org/>

⁴⁰ Niskanen Center: <https://niskanencenter.org/>

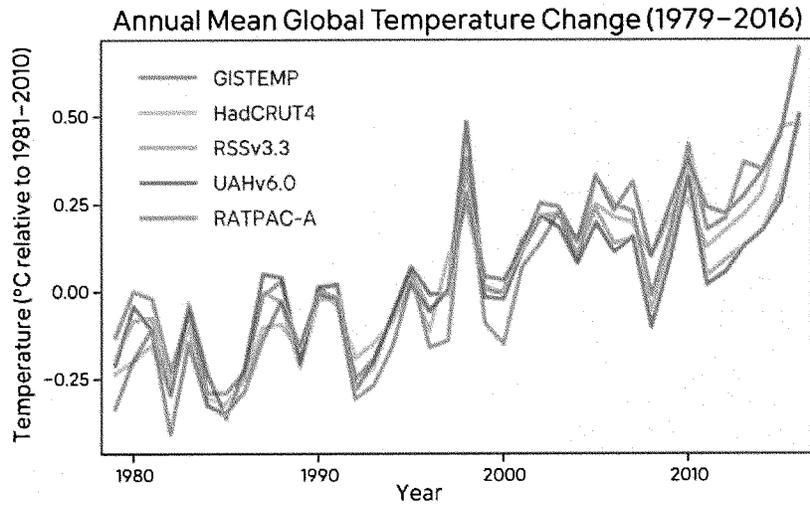


Exhibit A. Comparison of the various surface or lower atmospheric temperature records (during past few decades (Graph by Peter Jacobs of George Mason University).

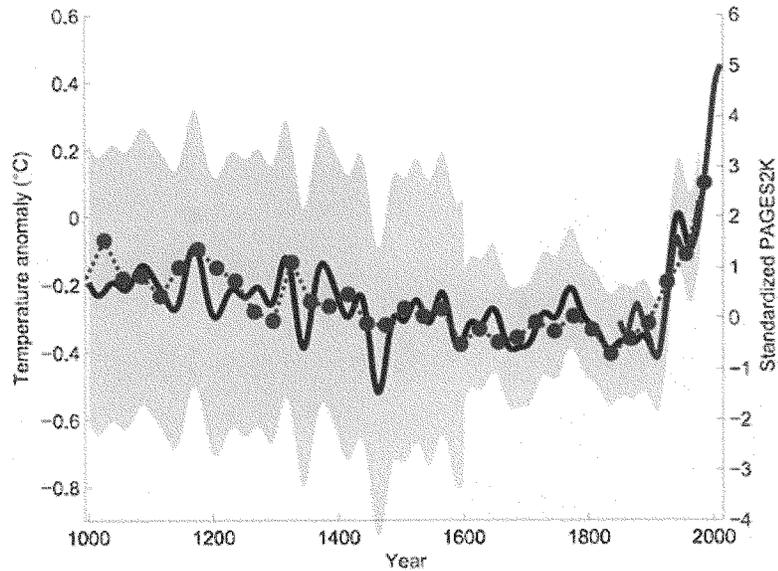


Exhibit B. PAGES 2k temperature reconstruction published by team of 78 scientists around the world using the most widespread paleoclimate database to date (Ahmed *et al*, *Nature Geoscience*, 2014) shown (green) along with the original Mann et al 1999 “Hockey Stick” reconstruction (blue), and instrumental (HadCRUT4) temperature record (red). Blue shading indicates uncertainty in the Mann et al temperature reconstruction (Graph by Klaus Bitterman of Potsdam Institute for Climate Studies).

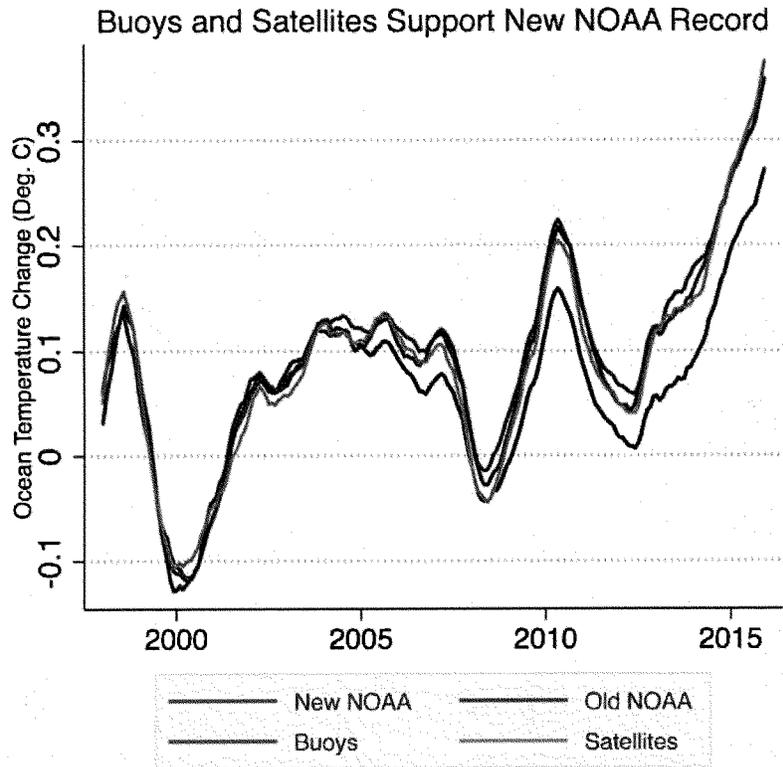


Exhibit C. Global sea surface temperatures from the old NOAA record (ERSSTv3b), the new NOAA record (ERSSTv4), and instrumentally homogenous records from buoys and satellites. See Hausfather et al (2017) for details, as well as comparisons with shorter Argo-based records.

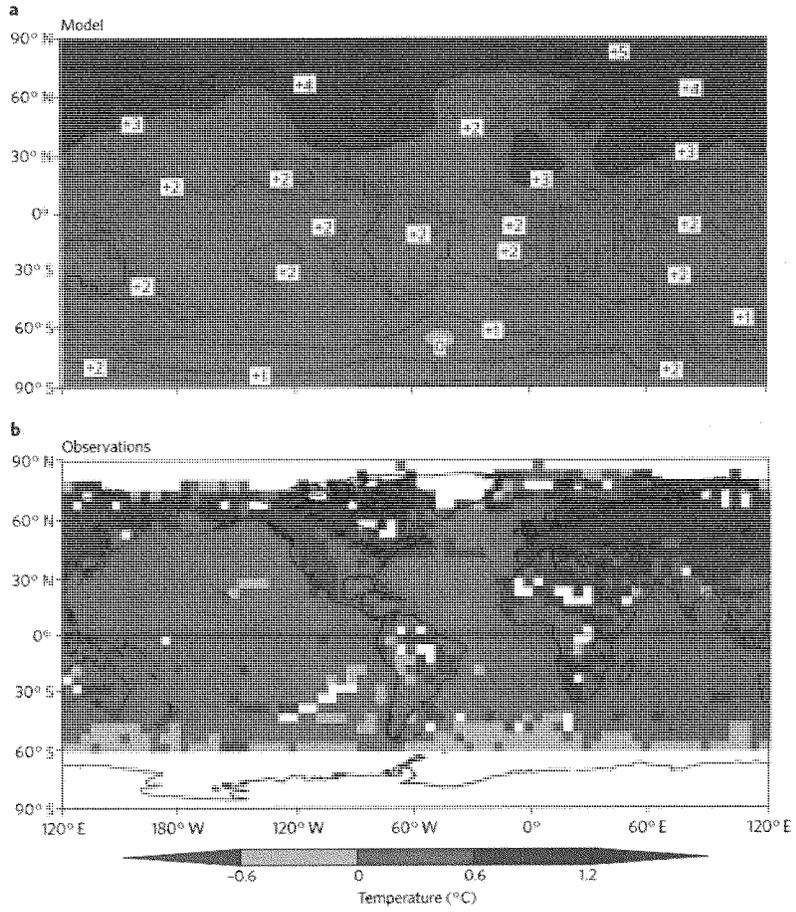


Exhibit D. Pattern of warming predicted by climate model simulations performed in 1989 (top) compared with observed pattern (bottom) of warming (from Stouffer and Manabe, *Nature Climate Change*, 2017)



Michael E. Mann

Biographical Sketch

Dr. Michael E. Mann is Distinguished Professor of Atmospheric Science at Penn State University, with joint appointments in the Department of Geosciences and the Earth and Environmental Systems Institute (EESI). He is also director of the Penn State Earth System Science Center (ESSC). Dr. Mann received his undergraduate degrees in Physics and Applied Math from the University of California at Berkeley, an M.S. degree in Physics from Yale University, and a Ph.D. in Geology & Geophysics from Yale University. His research involves the use of theoretical models and observational data to better understand Earth's climate system.

Dr. Mann was a Lead Author on the *Observed Climate Variability and Change* chapter of the Intergovernmental Panel on Climate Change (IPCC) Third Scientific Assessment Report in 2001 and was organizing committee chair for the National Academy of Sciences *Frontiers of Science* in 2003. He has received a number of honors and awards including NOAA's outstanding publication award in 2002 and selection by *Scientific American* as one of the fifty leading visionaries in science and technology in 2002. He contributed, with other IPCC authors, to the award of the 2007 Nobel Peace Prize. He was awarded the Hans Oeschger Medal of the European Geosciences Union in 2012 and was awarded the National Conservation Achievement Award for science by the National Wildlife Federation in 2013. He made Bloomberg News' list of fifty most influential people in 2013. In 2014, he was named Highly Cited Researcher by the Institute for Scientific Information (ISI) and received the Friend of the Planet Award from the National Center for Science Education. He is a Fellow of the American Geophysical Union, the American Meteorological Society, and the American Association for the Advancement of Science. He is also a co-founder of the award-winning science website RealClimate.org.

Dr. Mann is author of more than 200 peer-reviewed and edited publications, and has published three books including *Dire Predictions: Understanding Climate Change*, *The Hockey Stick and the Climate Wars* and most recently, *The Madhouse Effect* with Washington Post editorial cartoonist Tom Toles.

Chairman SMITH. Thank you, Dr. Mann.
And Dr. Pielke.

**TESTIMONY OF DR. ROGER PIELKE JR., PROFESSOR,
ENVIRONMENTAL STUDIES DEPARTMENT,
UNIVERSITY OF COLORADO**

Dr. PIELKE. Thank you.

I started my career in science and policy working for Chairman George Brown, who's in the red sweater to my left looking down on us, at this Committee 26 years ago. It's always a privilege to come back, and I know how hard the members and the staff work on all our behalf.

My testimony focuses on how Members of Congress can better support scientific integrity and climate research. Let me tell you a story.

Several months after I testified before this Committee in December of 2013, the White House posted on its website a six-page essay by the President's Science Advisor, which claimed falsely that my testimony before this Committee was not representative of mainstream views and was seriously misleading. Now, we've all come to learn that no good happens when the White House releases false information, and my case was no different.

One year later, Congressman Raul Grijalva opened a formal investigation of me and six other professors, three of whom are testifying here today. In his letter to my university's president, Mr. Grijalva justified the investigation of me by relying on the Science Advisor's false claims. In his letter, he introduced another false implication, that I and the other academics had potential conflicts of interest in failures to disclose corporate funding sources. He cited ExxonMobil and the Koch Foundations as possible sources of undisclosed funding that I might have received. My university conducted the investigation, and no surprise to me found I've never received any fossil fuel or Koch Foundation funding.

In 2016, the University of Colorado's elected Board of Regents issued a unanimous bipartisan statement in support of me and academic freedom more generally.

Despite being ultimately vindicated about the integrity of my research and my funding sources, as well as receiving the strong support of my university leadership, the investigation proved extremely harmful to my ability to work in the field of climate, yet scientific evidence in support of the conclusions I presented to this Committee in 2013 is stronger today. There is little scientific basis in support of claims that extreme weather events and specifically hurricanes, floods, drought and tornados and their economic damage has increased in recent decades due to the emissions of greenhouse gases. In fact, since 2013, when I last appeared here, the world and the United States have had a remarkable stretch of good fortune with respect to extreme weather as compared to the past.

The lack of evidence to support claims of increasing frequency or intensity of hurricanes, floods, drought or tornados on climate time scales is also supported by the most recent assessments of the IPCC and the broader peer-reviewed literature on which the IPCC is based.

My experience as an inconvenient academic is not unique. Politicians, including elected officials in Congress, and enthusiastic advocates from both sides of the aisle have targeted climate researchers whose peer-reviewed research they do not like including all four witnesses testifying here today.

Such dynamics of delegitimatization are not unique to the climate issue. Drawing on my experiences, my research and that of the broader community focused on science advice, I offer several recommendations focused on how Members of Congress can improve the state of science integrity and climate science.

Policymakers and scientists have developed well-established processes for assessing the state of scientific knowledge on subjects of relevance. Such process include federal advisory committees, those of the National Academies, the assessments of the IPCC, and many other nationally and internationally. Such processes work best when they are populated by a diversity of experts including those who may hold minority or even unpopular perspectives. Members of Congress have the standing and authority to call for such assessments to ensure through oversight that they are conducted with integrity and responsive to their information requests.

In contrast, while the legislative process can be extremely effective in highlighting partisan differences on policy, it is not well-suited to provide an accurate characterization of the state of scientific understandings.

Sometimes debates over science serve as a proxy for debates about policy preferences or political orientation. When Members of Congress and scientists participate in such proxy debates, it contributes to the pathological politicization of science.

Oversight of the integrity of scientific assessments is an important and appropriate role for Congressional committees. However, the investigation of individual researchers is not an appropriate role for Congress and is unlikely to contribute positively to the upholding of scientific integrity. A bipartisan truce ending such investigations of individual researchers should start immediately.

Congress should support the role of scientific assessments in providing an accurate perspective on questions asked by policymakers. We have plenty of knowledge and experience about how to arrive at accurate represents of the state of scientific understandings on any topic. It's a choice whether or not to use that knowledge and experience.

Thanks again for the opportunity to share these views.

[The prepared statement of Dr. Pielke follows:]

STATEMENT OF
DR. ROGER PIELKE, JR.
to the COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
of the UNITED STATES HOUSE OF REPRESENTATIVES

HEARING on
Climate Science: Assumptions, Policy Implications, and the Scientific Method
2318 Rayburn House Office Building
29 March 2017

My testimony focuses on how members of Congress can better support scientific integrity in climate research and the steps that members can take to avoid contributing to the pathological politicization of science.

Take-Home Points

- Science offers a powerful set of methods, evidence and an orientation to knowledge that can be essential to effective decision making.
- The science and policy communities have together over many decades developed highly credible, legitimate and relevant mechanisms for the assessment of the state of knowledge in any area of relevance to decision making.
- The legislative process is essential to a well-functioning democracy, but it is not well suited to the reliable characterization of the overall state of knowledge on a particular topic.
- How elected officials chose to utilize assessment and legislative processes for characterizing knowledge has great influence over the degree to which science becomes pathologically politicized.
- Ultimately, on complex, political issues like climate policy, reaching agreement on matters of science is neither necessary nor sufficient for policy action to occur.

My Recent Experiences Where Science Meets Politics

Despite publishing many peer reviewed papers on a wide range of climate-related topics with colleagues around the world and having my research included in the reports of the Intergovernmental Panel for Climate Change (IPCC),¹ I experienced an organized effort of delegitimization by members of Congress and the White House, supported by their political allies in the media and in well-funded advocacy groups. These efforts were successful in that they resulted in me re-orienting my academic career away from climate-related research.

Here are some specifics of my experiences over the past few years:

- Several months after I testified before this committee in December, 2013, the White House posted on its website a 6-page essay by the President's Science Advisor,

¹ See: <https://scholar.google.com/citations?user=WtqpmDIAAA&hl=en&oi=ao>

John Holdren, which claimed falsely that my testimony before this committee was “not representative of mainstream views on this topic in the climate-science community” and was “seriously misleading.”²

- Science advisor Holdren’s false claims were put forward even though my testimony was drawn from and consistent with the most recent reports of the IPCC. I have for decades supported the scientific assessment process of the IPCC and did so explicitly in my 2013 Congressional testimony.
- One year later, Congressman Raul Grijalva (D-AZ) opened a formal investigation of me and six other professors (three of us are testifying here today). In his letter to my university’s president, Mr. Grijalva justified the investigation of me by relying on the science advisor’s false claims: “John Holdren, director of the White House Office of Science and Technology Policy, has highlighted what he believes were serious misstatements by Prof. Pielke of the scientific consensus on climate change,” and cited Dr. Holdren’s essay on the White House website.³
- In his letter, Mr. Grijalva introduced another false implication -- that I, and the other academics, had “potential conflicts of interest and failure to disclose corporate funding sources.”⁴ Mr. Grijalva’s letter cited Exxon Mobil and the Koch Foundation as possible sources of undisclosed funding that I may have received.
- The communications director for the House Natural Resources Committee explained how we seven academics were chosen to be investigated by Mr. Grijalva: “The way we chose the list of recipients [of Mr. Grijalva’s letter] is who has published widely, who has testified in Congress before, who seems to have the most impact on policy in the scientific community.”⁵
- Publishing widely, testifying before Congress when asked and doing work with policy impact are usually held up as virtues among academics who are supported with public funds, but not in this circumstance.
- My university conducted the investigation as requested by Mr. Grijalva, and (no surprise to me) found that I have never received any fossil fuel or Koch Foundation funding. In 2016, the University of Colorado’s elected Board of Regents issued a statement of support for me and academic freedom more generally.⁶
- Despite being ultimately vindicated about the integrity my research and my funding sources, as well as receiving the strong support of my University’s leadership, the investigation proved extremely harmful to my ability to work in the field of climate.
- I have academic tenure (thankfully) and have chosen to shift the focus of my research to other interesting subjects at the intersection of science, policy and politics.

² J. P. Holdren, Drought and Global Climate Change: An Analysis of Statements by Roger Pielke Jr., 28 February 2014. (Available at: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/critique_of_pielke_jr_statements_on_drought.pdf)

³ Letter from Congressman Raul Grijalva (D-AZ) to Bruce Benson, President, University of Colorado, 24 February 2015.

⁴ Ibid.

⁵ Quoted in: http://www.al.com/news/huntsville/index.ssf/2015/02/arizona_congressman_asking_que.html

⁶ I am very proud to be associated with the University of Colorado, whose leadership offered unwavering support throughout my experiences, see: http://www.dailycamera.com/cu-news/ci_30558681/cu-board-shows-support-faculty-students-academic-freedom

- Further details of my experiences can be found in an op-ed included as Appendix A to this testimony.

Lessons of My Experience

- Scientific evidence in support of the conclusions I presented to this committee in 2013 is even stronger today. There is little scientific basis in support of claims that extreme weather events – specifically, hurricanes, floods, drought, tornadoes – and their economic damage have increased in recent decades due to the emission of greenhouse gases. In fact, since 2013 the world and the United States have had a remarkable stretch of good fortune with respect to extreme weather, as compared to the past.
- The lack of evidence to support claims of increasing frequency or intensity of hurricanes, floods, drought or tornadoes on climate timescales is also supported by the most recent assessments of the IPCC and the broader peer reviewed literature on which the IPCC is based.
- I have included an update of relevant data and summary conclusions of the IPCC related to trends in extreme weather as an Appendix B to this testimony.
- My experience as an inconvenient academic is not unique. Politicians, including elected officials in Congress, and enthusiastic advocates from both sides of the aisle have targeted climate researchers whose peer-reviewed research they do not like – including all four witnesses testifying here today. Such dynamics of delegitimization are not unique to the climate issue.
- Academics -- no matter how solid their research may be -- are no match for well-funded advocacy groups, activists in the media, the White House or Congress.
- Members of Congress have great power to delegitimize inconvenient experts, even derail their careers, and in the process, contribute to the pathological politicization of science.
- Members of Congress also have the power to defuse the pathological politicization of science, to uphold scientific integrity and put both science and politics in their proper places.
- This is a bipartisan challenge which can only be addressed with a bipartisan commitment to scientific integrity.

Recommendations to improve the state of scientific integrity in climate science

I have studied and written about science in policy and politics for several decades. I am a part of an international community of scholars and practitioners who focus on the challenges of science advice to governments.⁷ There is consequently a deep body of knowledge and evidence on scientific advice – what works, and what does not.

⁷ See <http://www.ingsa.org/>

My most well-known contribution to this area of scholarship and practice is **The Honest Broker: Making Sense of Science in Policy and Politics** (Cambridge University Press, 2007).

Drawing on my experiences, my research and that of the broader community focused on scientific advice I offer the following recommendations focused on how members of Congress can help to improve the state of scientific integrity in climate science.

- Policy makers and scientists have developed well-established established processes for assessing the state of scientific knowledge on subjects of relevance to policy makers.
- Such processes include federal advisory committees, those of the National Academies, the assessments of the IPCC and many others nationally and internationally.
- There is also an enormous academic literature on the role of scientific assessments in policy and politics. Google Scholar lists almost a million articles under the key words “scientific assessments policy politics.”⁸
- Assessments of scientific knowledge are most effective when they address questions that policy makers have judged to be relevant to decision making and do so in a way that is viewed to be authoritative, unbiased and inclusive.⁹
- Such processes work best when they accurately characterize areas of uncertainty and ignorance, in addition to what is known with greater certainty. Such accurate characterization is facilitated when assessment processes are populated by a diversity of experts, including those who may hold minority or unpopular perspectives.
- Members of Congress have the standing and authority to call for such assessments, to ensure through oversight that they are conducted with integrity and are responsive to their information requests.
- In contrast, while the legislative process can be extremely effective in highlighting partisan differences on policy, it is not well suited to provide an accurate characterization of the state of scientific understandings.
- Sometimes debates over science serves as a proxy for debates about policy preferences or political orientation. When members of Congress participate in such proxy debates, it contributes to the pathological politicization of science.
- Assessments are best conducted outside the spotlight of high stakes political conflict.
- There is of course a risk that such assessments might be captured by interests, fall prey to groupthink or gatekeeping, or fail to accurately represent scientific understandings. In such instances the assessment process may become viewed as partisan, illegitimate or simply not useful. In my area of expertise this occurred in the Fourth Assessment Report of the IPCC.¹⁰
- Climate science is a particularly politicized research area, meaning that careful attention should be paid to how assessments are organized and who leads and participates in them.
- Consequently, oversight of the integrity of these assessments is an important and appropriate role for Congressional committees, among others.

⁸ https://scholar.google.com/scholar?q=scientific+assessments+policy+politics&btnG=&hl=en&as_sdt=0%2C6

⁹ Sarewitz, D., & Pielke, R. A. (2007). The neglected heart of science policy: reconciling supply of and demand for science. *Environmental Science & Policy*, 10:5-16.

¹⁰ See Chapter 6 of *The Climate Fix* for details.

- However, the investigation of individual researchers (whether governmental or non-governmental) is not an appropriate role for Congress and is unlikely to contribute positively to the upholding of scientific integrity.
- A bipartisan truce ending such investigations of individual researchers should start immediately.
- Congress should support the role of scientific assessments in providing an accurate perspective on questions asked by policy makers. In climate, the IPCC, if it did not exist, would have to be invented. If members of Congress wish to secure robust answers to questions of climate science, impacts or economics, they might look to the IPCC.
- However, if the IPCC is not viewed to be legitimate, then Congress could easily request the US National Academy of Sciences (or other authoritative body) to empanel a high level, unimpeachable assessment process. Such assessments related to climate have of course been done for decades and the overarching scientific conclusions have remained consistent.
- We have plenty of knowledge and experience about how to arrive at accurate assessments of the state of scientific understandings on any topic. It is a choice whether or not to utilize that knowledge and experience.
- Irrespective of the state of scientific understandings, policy action related to energy policies and improving adaptation to climate variability and change does not require that everyone believe the same things about climate science or that all uncertainties be eliminated.¹¹

To avoid any confusion – My views on climate science and policy

Because the climate issue is so deeply politicized, it is necessary to include several statements to clearly present my views. The following conclusions are taken from my book *The Climate Fix* in a section titled “Guidelines for a Common Sense Approach to Climate Policy” (Chapter 1, pp. 32-34). In that book I call for a low but rising carbon tax to fund energy innovation, focused on cleaner, cheaper and more broadly accessible energy technologies. If the world’s economy is to decarbonize, it will be because of advances in energy technology, and not because everyone comes to hold the same views of climate science.¹²

Increasing Carbon Dioxide Influences the Climate System, Perhaps Dramatically and Irreversibly

That human activities have led to changes in the earth system is broadly accepted. So too is the possibility that such changes could lead to undesirable outcomes in the future. For those wanting to know more—much more—about aspects of climate science, the report of Working Group I of the IPCC is an excellent place to start further investigations, even as aspects of that report continue to be contested.

¹¹ See: **The Climate Fix: What Scientists and Politicians Won't Tell you About Global Warming** (2011, Basic Books)

¹² More broadly see: Rayner, S., & Caine, M., **The Hartwell Approach to Climate Policy**. (Routledge, 2014).

The Climate System Is Subject to Multiple Human Influences

Carbon dioxide ... is not the only important human influence. The climate system is complex and is still not fully characterized. Even so, many scientists and policy makers have concluded that dealing with carbon dioxide should be a top policy priority.

Our Ability to See the Future Is Limited

There are debates about how the future will play out that simply cannot be resolved on the timescales of decision making. Efforts to gain clarity about the future may in fact have the paradoxical consequence of making that future even cloudier. Decisions about climate change will occur in the context of contestation, uncertainties and ignorance.

Certainty Is Not Forthcoming

As decisions are made about decarbonizing economies and improving adaptation to climate in the coming years, certainties about the long-term climate future are not forthcoming. UK science adviser John Beddington explains, "There is a fundamental uncertainty about climate change prediction that can't be changed." As Andy Revkin summarizes his years of covering the climate debate: "What the debate comes down to is not whether changes are coming but when they'll occur—and how severe they'll be. There is serious scientific disagreement about such vital questions as how fast and far temperatures, seas, and storm strength could rise." Such disagreements will persist for the foreseeable future. Uncertainties are a reality to be lived with and managed. They are not going away.

Stabilizing Atmospheric Concentrations of Carbon Dioxide Does Not Stop Climate Change

Carbon policy is not a comprehensive climate policy. It is possible that the world could successfully address accumulating concentrations of carbon dioxide in the atmosphere and still have to deal with a significant issue of human influences on the climate system. For this reason, among others, Mike Hulme has written that climate change is a problem to be managed, not solved.¹³ Our debates about climate change would benefit by distinguishing carbon policies from greenhouse gas policies and broader conceptions of climate policy.

¹³ Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge University Press.

Biography of Roger Pielke Jr.

Roger Pielke, Jr. has been on the faculty of the University of Colorado since 2001. Currently, he serves as the director of the Sports Governance Center, a new initiative on campus, and faculty affiliate of the Center for Science and Technology Policy Research. He is a Professor in the Environmental Studies Program and from 2001-2016 was a Fellow of the Cooperative Institute for Research in Environmental Sciences (CIRES). Roger served several terms as the founding director of the university's Center for Science and Technology Policy Research. Roger's research focuses on science, innovation and politics, which he has explored in many topical areas over recent decades, including: space policy, natural disasters, energy policy, climate policy and more recently, in sports governance.

Roger holds degrees in mathematics, public policy and political science, all from the University of Colorado. In 2012 Roger was awarded an honorary doctorate from Linköping University in Sweden and he was also awarded the Public Service Award of the Geological Society of America. Roger also received the Eduard Brückner Prize in Munich, Germany in 2006 for outstanding achievement in interdisciplinary climate research. Before joining the faculty of the University of Colorado, from 1993-2001 Roger was a Scientist at the National Center for Atmospheric Research. Roger is a Senior Fellow of the Breakthrough Institute, and has held academic appointments at Macquarie University in Sydney, Australia, Oxford University and the London School of Economics.

Roger has hundreds of peer-reviewed publications and, for those who consider such things, he has an H-Index of 51 (Google). He is also author, co-author or co-editor of eight books, including **The Honest Broker: Making Sense of Science in Policy and Politics** published by Cambridge University Press (2007), **The Climate Fix: What Scientists and Politicians Won't Tell you About Global Warming** (2011, Basic Books), and **The Rightful Place of Science: Disasters and Climate Change** (CSPO: ASU, 2014). His most recent book is **The Edge: The War Against Cheating and Corruption in the Cutthroat World of Elite Sports** (Roaring Forties Press, 2016).

Appendix 1

December 2016 op-ed on my experiences in climate research

My Unhappy Life as a Climate Heretic¹⁴

My research was attacked by thought police in journalism, activist groups funded by billionaires and even the White House.

Much to my surprise, I showed up in the WikiLeaks releases before the election. In a 2014 email, a staffer at the Center for American Progress, founded by John Podesta in 2003, took credit for a campaign to have me eliminated as a writer for Nate Silver's FiveThirtyEight website. In the email, the editor of the think tank's climate blog bragged to one of its billionaire donors, Tom Steyer: "I think it's fair [to] say that, without Climate Progress, Pielke would still be writing on climate change for 538."

WikiLeaks provides a window into a world I've seen up close for decades: the debate over what to do about climate change, and the role of science in that argument. Although it is too soon to tell how the Trump administration will engage the scientific community, my long experience shows what can happen when politicians and media turn against inconvenient research—which we've seen under Republican and Democratic presidents.

I understand why Mr. Podesta—most recently Hillary Clinton's campaign chairman—wanted to drive me out of the climate-change discussion. When substantively countering an academic's research proves difficult, other techniques are needed to banish it. That is how politics sometimes works, and professors need to understand this if we want to participate in that arena.

More troubling is the degree to which journalists and other academics joined the campaign against me. What sort of responsibility do scientists and the media have to defend the ability to share research, on any subject, that might be inconvenient to political interests—even our own?

I believe climate change is real and that human emissions of greenhouse gases risk justifying action, including a carbon tax. But my research led me to a conclusion that many climate campaigners find unacceptable: There is scant evidence to indicate that hurricanes, floods, tornadoes or drought have become more frequent or intense in the U.S. or globally. In fact we are in an era of good fortune when it comes to extreme weather. This is a topic I've studied and published on as much as anyone over two decades. My conclusion might be wrong, but I think I've earned the right to share this research without risk to my career.

Instead, my research was under constant attack for years by activists, journalists and politicians. In 2011 writers in the journal *Foreign Policy* signaled that some accused me of being a "climate-change denier." I earned the title, the authors explained, by "questioning certain graphs presented in IPCC reports." That an academic who raised questions about

¹⁴ <https://www.wsj.com/articles/my-unhappy-life-as-a-climate-heretic-1480723518>

the Intergovernmental Panel on Climate Change in an area of his expertise was tarred as a denier reveals the groupthink at work.

Yet I was right to question the IPCC's 2007 report, which included a graph purporting to show that disaster costs were rising due to global temperature increases. The graph was later revealed to have been based on invented and inaccurate information, as I documented in my book "The Climate Fix." The insurance industry scientist Robert-Muir Wood of Risk Management Solutions had smuggled the graph into the IPCC report. He explained in a public debate with me in London in 2010 that he had included the graph and misreferenced it because he expected future research to show a relationship between increasing disaster costs and rising temperatures.

When his research was eventually published in 2008, well after the IPCC report, it concluded the opposite: "We find insufficient evidence to claim a statistical relationship between global temperature increase and normalized catastrophe losses." Whoops.

The IPCC never acknowledged the snafu, but subsequent reports got the science right: There is not a strong basis for connecting weather disasters with human-caused climate change.

Yes, storms and other extremes still occur, with devastating human consequences, but history shows they could be far worse. No Category 3, 4 or 5 hurricane has made landfall in the U.S. since Hurricane Wilma in 2005, by far the longest such period on record. This means that cumulative economic damage from hurricanes over the past decade is some \$70 billion less than the long-term average would lead us to expect, based on my research with colleagues. This is good news, and it should be OK to say so. Yet in today's hyper-partisan climate debate, every instance of extreme weather becomes a political talking point.

For a time I called out politicians and reporters who went beyond what science can support, but some journalists won't hear of this. In 2011 and 2012, I pointed out on my blog and social media that the lead climate reporter at the New York Times, Justin Gillis, had mischaracterized the relationship of climate change and food shortages, and the relationship of climate change and disasters. His reporting wasn't consistent with most expert views, or the evidence. In response he promptly blocked me from his Twitter feed. Other reporters did the same.

In August this year on Twitter, I criticized poor reporting on the website Mashable about a supposed coming hurricane apocalypse—including a bad misquote of me in the cartoon role of climate skeptic. (The misquote was later removed.) The publication's lead science editor, Andrew Freedman, helpfully explained via Twitter that this sort of behavior "is why you're on many reporters' 'do not call' lists despite your expertise."

I didn't know reporters had such lists. But I get it. No one likes being told that he misreported scientific research, especially on climate change. Some believe that connecting extreme weather with greenhouse gases helps to advance the cause of climate policy. Plus, bad news gets clicks.

Yet more is going on here than thin-skinned reporters responding petulantly to a vocal professor. In 2015 I was quoted in the Los Angeles Times, by Pulitzer Prize-winning reporter Paige St. John, making the rather obvious point that politicians use the weather-of-the-moment to make the case for action on climate change, even if the scientific basis is thin or contested.

Ms. St. John was pilloried by her peers in the media. Shortly thereafter, she emailed me what she had learned: “You should come with a warning label: Quoting Roger Pielke will bring a hailstorm down on your work from the London Guardian, Mother Jones, and Media Matters.”

Or look at the journalists who helped push me out of FiveThirtyEight. My first article there, in 2014, was based on the consensus of the IPCC and peer-reviewed research. I pointed out that the global cost of disasters was increasing at a rate slower than GDP growth, which is very good news. Disasters still occur, but their economic and human effect is smaller than in the past. It’s not terribly complicated.

That article prompted an intense media campaign to have me fired. Writers at Slate, Salon, the New Republic, the New York Times, the Guardian and others piled on.

In March of 2014, FiveThirtyEight editor Mike Wilson demoted me from staff writer to freelancer. A few months later I chose to leave the site after it became clear it wouldn’t publish me. The mob celebrated. ClimateTruth.org, founded by former Center for American Progress staffer Brad Johnson, and advised by Penn State’s Michael Mann, called my departure a “victory for climate truth.” The Center for American Progress promised its donor Mr. Steyer more of the same.

Yet the climate thought police still weren’t done. In 2013 committees in the House and Senate invited me to a several hearings to summarize the science on disasters and climate change. As a professor at a public university, I was happy to do so. My testimony was strong, and it was well aligned with the conclusions of the IPCC and the U.S. government’s climate-science program. Those conclusions indicate no overall increasing trend in hurricanes, floods, tornadoes or droughts—in the U.S. or globally.

In early 2014, not long after I appeared before Congress, President Obama’s science adviser John Holdren testified before the same Senate Environment and Public Works Committee. He was asked about his public statements that appeared to contradict the scientific consensus on extreme weather events that I had earlier presented. Mr. Holdren responded with the all-too-common approach of attacking the messenger, telling the senators incorrectly that my views were “not representative of the mainstream scientific opinion.” Mr. Holdren followed up by posting a strange essay, of nearly 3,000 words, on the White House website under the heading, “An Analysis of Statements by Roger Pielke Jr.,” where it remains today.

I suppose it is a distinction of a sort to be singled out in this manner by the president’s science adviser. Yet Mr. Holdren’s screed reads more like a dashed-off blog post from the nutty wings of the online climate debate, chock-full of errors and misstatements.

But when the White House puts a target on your back on its website, people notice. Almost a year later Mr. Holdren's missive was the basis for an investigation of me by Arizona Rep. Raul Grijalva, the ranking Democrat on the House Natural Resources Committee. Rep. Grijalva explained in a letter to my university's president that I was being investigated because Mr. Holdren had "highlighted what he believes were serious misstatements by Prof. Pielke of the scientific consensus on climate change." He made the letter public.

The "investigation" turned out to be a farce. In the letter, Rep. Grijalva suggested that I—and six other academics with apparently heretical views—might be on the payroll of Exxon Mobil (or perhaps the Illuminati, I forget). He asked for records detailing my research funding, emails and so on. After some well-deserved criticism from the American Meteorological Society and the American Geophysical Union, Rep. Grijalva deleted the letter from his website. The University of Colorado complied with Rep. Grijalva's request and responded that I have never received funding from fossil-fuel companies. My heretical views can be traced to research support from the U.S. government.

But the damage to my reputation had been done, and perhaps that was the point. Studying and engaging on climate change had become decidedly less fun. So I started researching and teaching other topics and have found the change in direction refreshing. Don't worry about me: I have tenure and supportive campus leaders and regents. No one is trying to get me fired for my new scholarly pursuits.

But the lesson is that a lone academic is no match for billionaires, well-funded advocacy groups, the media, Congress and the White House. If academics—in any subject—are to play a meaningful role in public debate, the country will have to do a better job supporting good-faith researchers, even when their results are unwelcome. This goes for Republicans and Democrats alike, and to the administration of President-elect Trump.

Academics and the media in particular should support viewpoint diversity instead of serving as the handmaidens of political expediency by trying to exclude voices or damage reputations and careers. If academics and the media won't support open debate, who will?

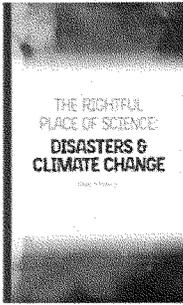
Mr. Pielke is a professor and director of the Sports Governance Center at the University of Colorado, Boulder. His most recent book is "The Edge: The Wars Against Cheating and Corruption in the Cutthroat World of Elite Sports" (Roaring Forties Press, 2016). Appeared in the Dec. 03, 2016, print edition, Wall Street Journal.

Appendix B

An Update on Trends in Extreme Events in the US and Globally

An update to my 2013 House & Senate Testimony

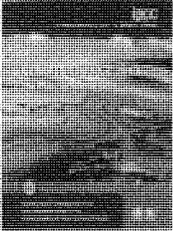
- **The latest science on trends in extreme events**
 - Hurricanes (tropical cyclones)
 - Tornadoes
 - Floods
 - Drought
 - Other (temps, extreme precip)
- **These data are updated from the summary of data and the IPCC found in my short 2014 book →**



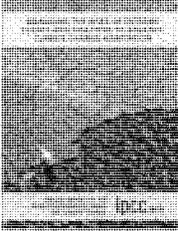
slide 1

A note on references

- **IPCC = Intergovernmental Panel on Climate Change**
- **IPCC AR5 = 5th assessment report in 2013/14**
- **IPCC SREX = Special Report on Extreme Events in 2012**

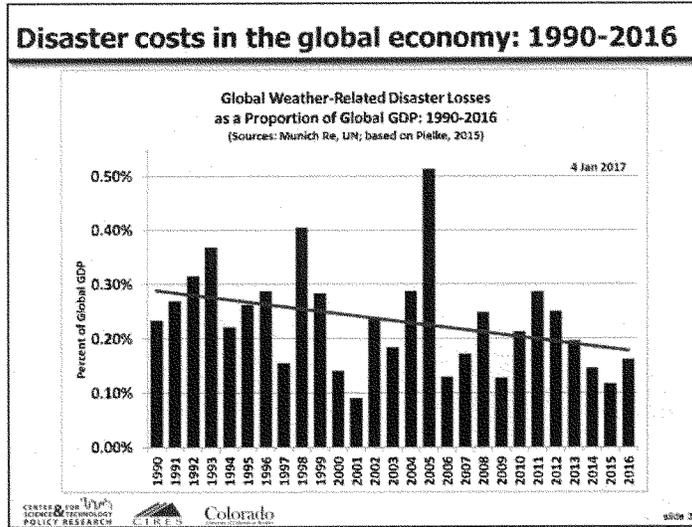


IPCC AR5



IPCC SREX

slide 2



IPCC AR5 – Extreme temperatures

"[T]here is medium confidence that globally the length and frequency of warm spells, including heat waves, has increased since the middle of the 20th century although it is likely that heatwave frequency has increased during this period in large parts of Europe, Asia and Australia."

"Medium confidence: increases in more regions than decreases but 1930s dominates longer term trends in the USA."

CENTRE FOR SCIENCE & TECHNOLOGY POLICY RESEARCH Colorado slide 4

IPCC AR5 – Extreme precipitation



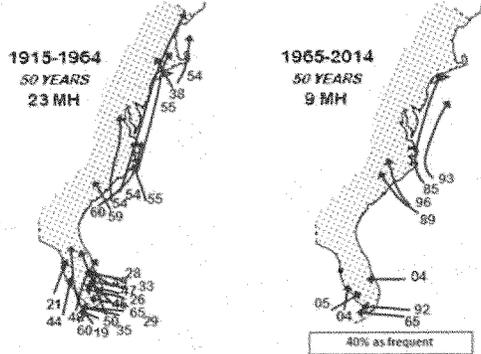
"[I]t is likely that since 1951 there have been statistically significant increases in the number of heavy precipitation events (e.g., above the 95th percentile) in more regions than there have been statistically significant decreases, but there are strong regional and subregional variations in the trends."

"[T]here is medium confidence that anthropogenic forcing has contributed to a global scale intensification of heavy precipitation over the second half of the 20th century in land regions where observational coverage is sufficient for assessment."

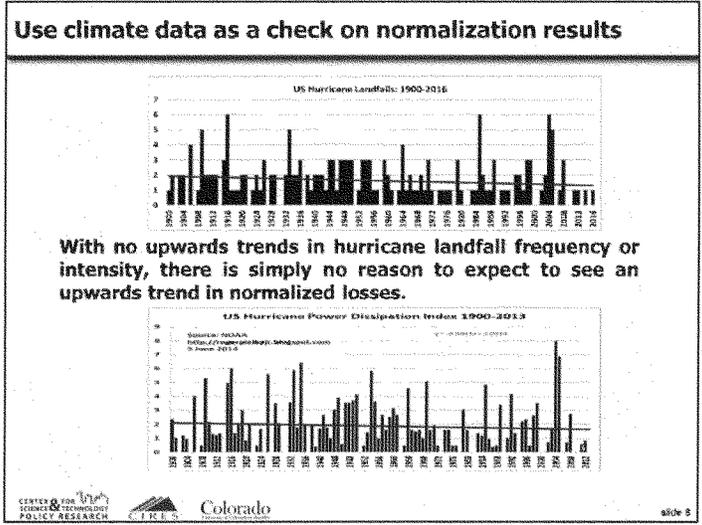
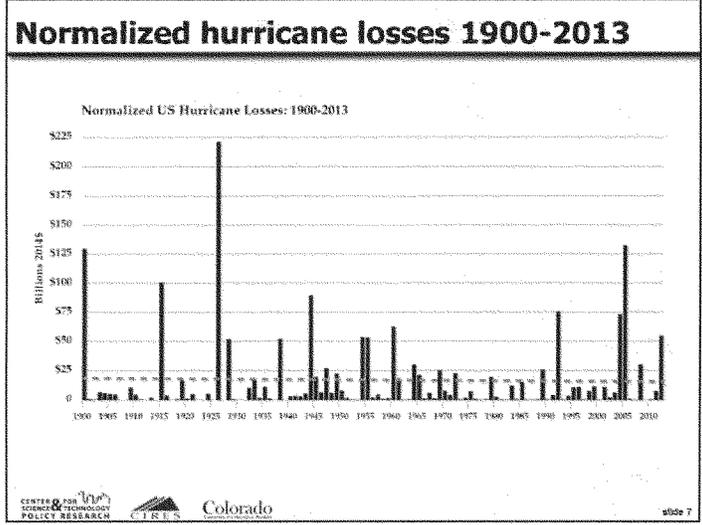
Note: "Likely" = >66%

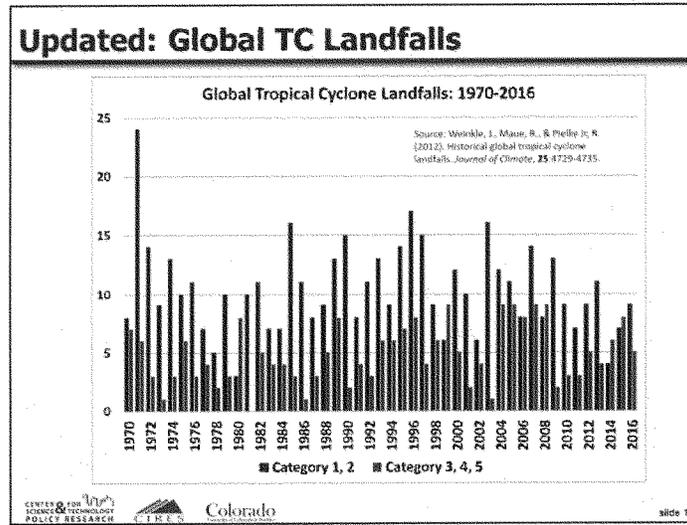
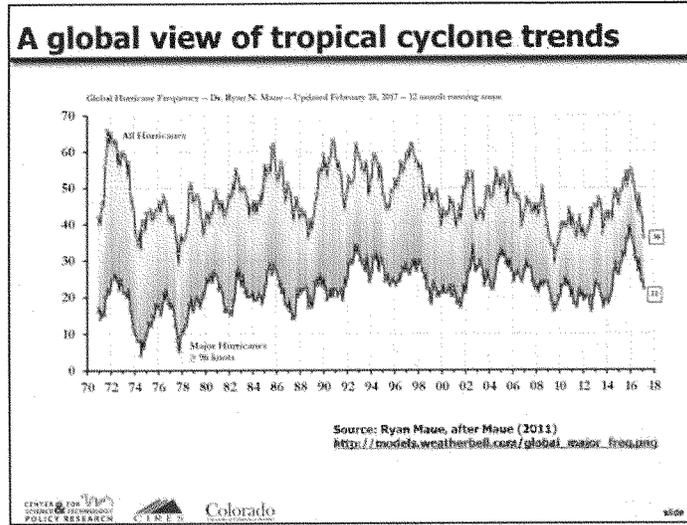
Where did they go?

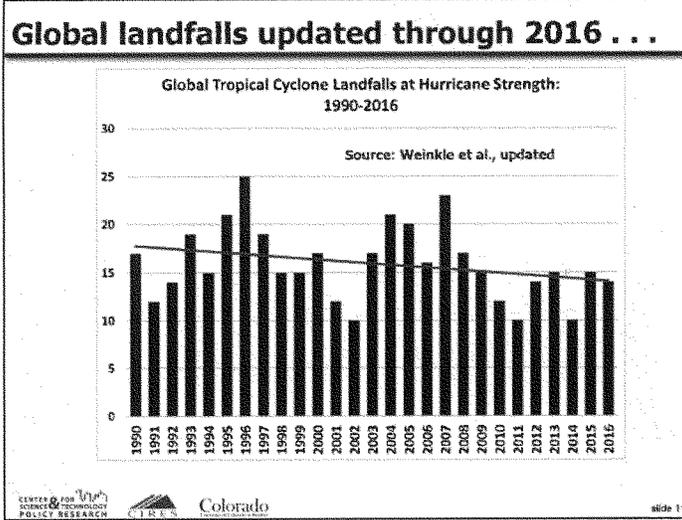
U.S. MAJOR HURRICANE IMPACTS



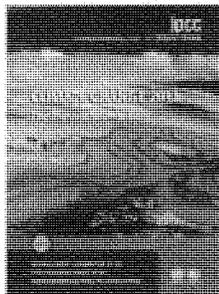
Source: P. Klotzbach







IPCC AR5 – Tropical cyclones

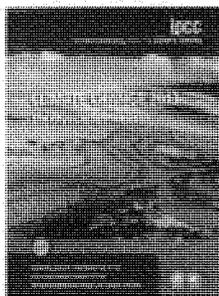


"Current datasets indicate no significant observed trends in global tropical cyclone frequency over the past century."

"No robust trends in annual numbers of tropical storms, hurricanes and major hurricanes counts have been identified over the past 100 years in the North Atlantic basin."

CENTERS FOR ENVIRONMENTAL SCIENCE & TECHNOLOGY POLICY RESEARCH C.E.S.T. Colorado slide 12

IPCC AR5 – Floods



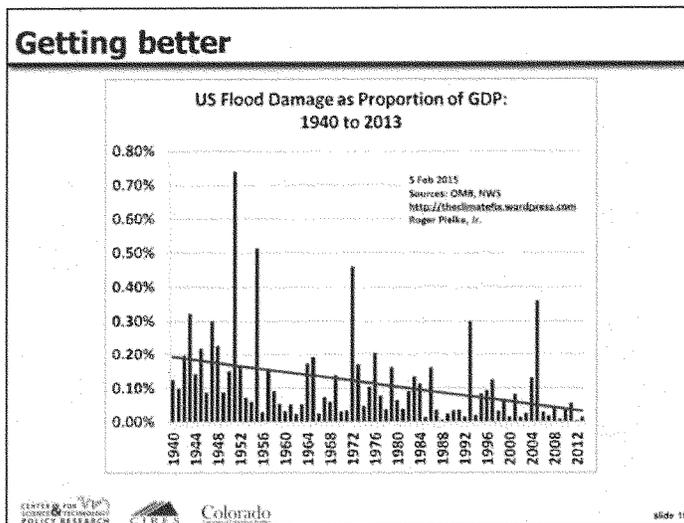
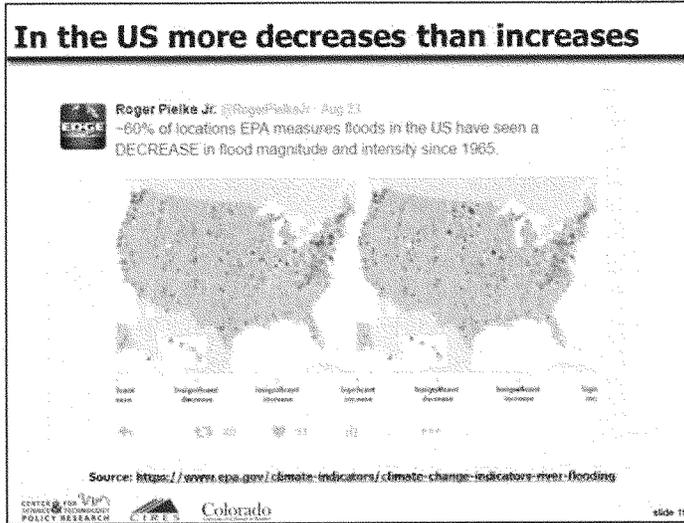
"In summary, there continues to be a lack of evidence and thus low confidence regarding the sign of trend in the magnitude and/or frequency of floods on a global scale."

IPCC SREX co-authors – Floods

"a direct statistical link between anthropogenic climate change and trends in the magnitude/frequency of floods has not been established..."

There is such a furore of concern about the linkage between greenhouse forcing and floods that it causes society to lose focus on the things we already know for certain about floods and how to mitigate and adapt to them."

**Zbigniew et al. 2014
*Hydrological Sciences Journal***



FEMA agrees ...

- Major U.S flood events continue to be a major loss focus.
- 2016 had 4 major flooding events.
 - Late Winter Severe Storms - March
 - Torrential Rains - Texas - April
 - Louisiana Flooding - Aug
 - Hurricane Matthew - Oct (Pending Official Data)
- However, no real trend in flood event since 1972

*Major Flood Event = Flooding events with 1,500 FEMA claims.

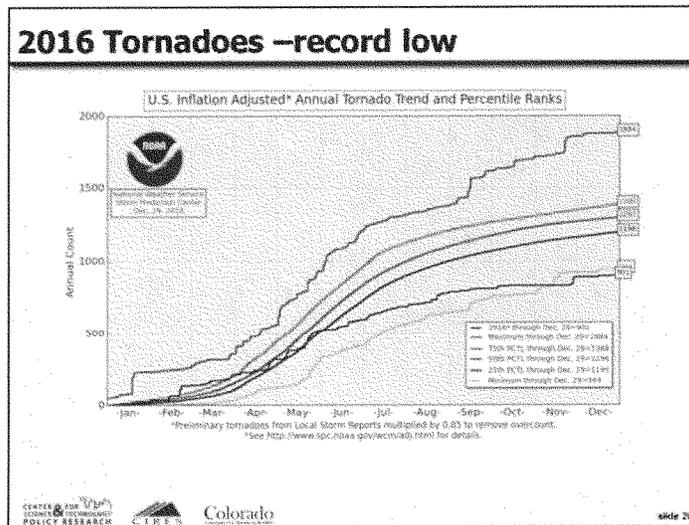
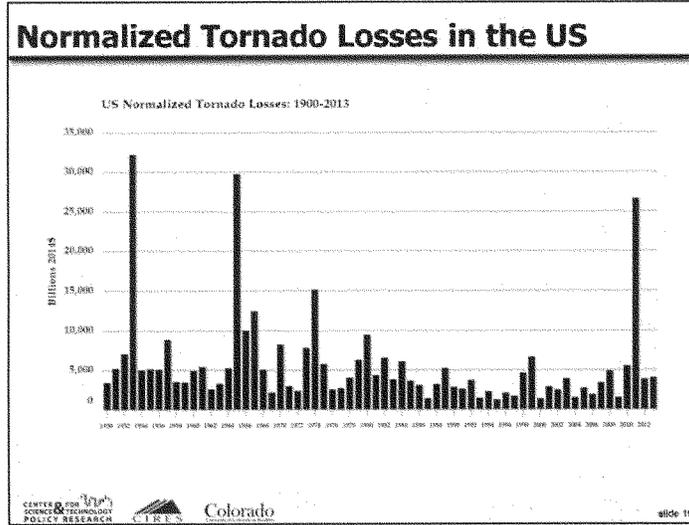
Year	Number of Major Flood Events (FEMA)
1972	3
1973	2
1974	1
1975	2
1976	1
1977	2
1978	1
1979	2
1980	1
1981	2
1982	1
1983	2
1984	1
1985	2
1986	1
1987	2
1988	1
1989	2
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2002	1
2003	2
2004	1
2005	2
2006	1
2007	2
2008	1
2009	2
2010	1
2011	2
2012	1
2013	2
2014	1
2015	2
2016	8

CENTERS FOR POLICY RESEARCH I R E S Colorado slide 17

IPCC SREX – Tornadoes

"There is low confidence in observed trends in small spatial-scale phenomena such as tornadoes and hail."

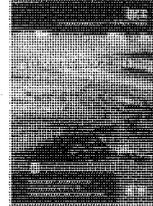
CENTERS FOR POLICY RESEARCH I R E S Colorado slide 18



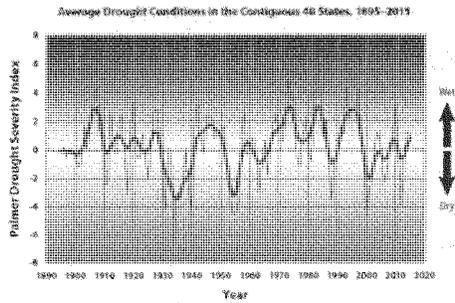
IPCC AR5 – Drought

“There is not enough evidence to support medium or high confidence of attribution of increasing trends to anthropogenic forcings as a result of observational uncertainties and variable results from region to region. . we conclude consistent with SREX that there is low confidence in detection and attribution of changes in drought over global land areas since the mid-20th century.”

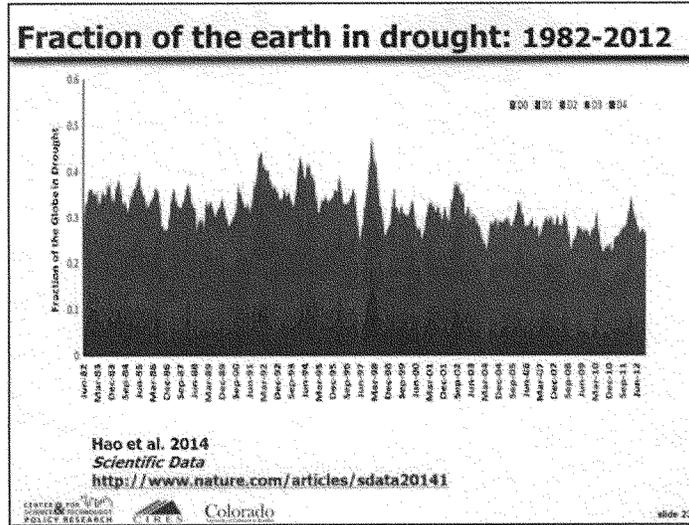
“Recent long-term droughts in western North America cannot definitively be shown to lie outside the very large envelope of natural precipitation variability in this region”



Via EPA 2016 (US drought trends) ...



Data from NOAA National Oceanic and Atmospheric Administration, 2016 National Centers for Environmental Information. Accessed January 2016, www.ncep.noaa.gov/CDO/CDO.DroughtWebIndex. For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.



Summary

Have disasters in the US or globally become more costly because of human-caused climate change?

Only one answer to this question is strongly supported by the available data, the broad scientific literature and the assessments of the IPCC:

No.

There is exceedingly little evidence to support claims that disasters have become more costly because of human caused climate change.

slide 24

Biography of Roger Pielke Jr.

Roger Pielke, Jr. has been on the faculty of the University of Colorado since 2001. Currently, he serves as the director of the Sports Governance Center, a new initiative on campus, and faculty affiliate of the Center for Science and Technology Policy Research. He is a Professor in the Environmental Studies Program and from 2001-2016 was a Fellow of the Cooperative Institute for Research in Environmental Sciences (CIRES). Roger served several terms as the founding director of the university's Center for Science and Technology Policy Research. Roger's research focuses on science, innovation and politics, which he has explored in many topical areas over recent decades, including: space policy, natural disasters, energy policy, climate policy and more recently, in sports governance.

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Chairman SMITH. Thank you, Dr. Pielke, and I'll recognize myself for questions, and let me address my first question to Dr. Curry.

Dr. Curry, let me say at the outset, I know you could take an hour to answer this question. Unfortunately, you'll have to give me a summary, and the question is this: what are the uncertainties, complexities, biases involved with climate science or the study of climate science that need to be considered before we can actually make informed decisions about what to do about climate science?

Dr. CURRY. Well, the greatest uncertainties in both our understanding and our ability to model the climate system relate to these items. The first is what I call the thermodynamic feedbacks related to clouds and water vapor. Climate models have a large amplifying effect from clouds and water vapor. The magnitude of this amplifying effect and even the sign are in dispute. A lot about the oceans that we don't understand, how the ocean transports heat and carbon in the vertical is not well represented in the climate models. We also have these very large-scale long-term ocean oscillations, which play a huge role in determining our climate. These are not well simulated, and we don't have good documentation of the really long time period oscillations. The effects of the sun on climate, particularly the indirect solar effects, and I could go on and on, but I think those are the key issues.

Chairman SMITH. And you didn't even get into the biases and other uncertainties, but that's a good start, and that gives us an idea. Thank you, Dr. Curry.

Dr. Christy, the PowerPoints you put up on the flat screens a while ago I thought were absolutely riveting, and at least to me very persuasive. My question is, why are both the satellite and surface temperature measurements so far below the climate model predictions? In other words, there's a conflict between the data and the predictions. Why is that?

Dr. CHRISTY. Well, there are a lot of answers, I suppose. I can speculate about some. What we've seen is that the models tend to be too sensitive to greenhouse gases, likely related to the fact the models tend to shrink clouds more than in reality so that more sunlight gets in and heats up the Earth more, so that's one idea that may be the reason. But overall, the basic answer is that models are too sensitive to extra greenhouse gases. The Earth has a way to release the heat that greenhouse gases try to build up.

Chairman SMITH. I think most constructive was the line that showed the actual observations as opposed to the modeling and how big of a discrepancy there was between the two. Thank you for pointing that out.

Dr. Pielke, you in your testimony today mentioned that extreme weather events are not necessarily caused by climate change. In fact, the IPCC has said there's low confidence that there's any connection between climate change and extreme weather events. Why are some climate scientists claiming that there's a connection when you and other scientists and the IPCC all says there's likely not a connection?

Dr. PIELKE. Yeah, when you talk about trends and extreme events, it's really important to focus on the phenomena you're talking about—hurricanes, floods, drought—and look at those individ-

ually. It's long been a puzzle to me why there would be any controversy over this topic since something like a hurricane is pretty big. It's easy to see when it occurs. We have very good data on it. In the United States, the number of hurricanes and the intensity of hurricanes is down by 20 percent since 1900. I don't put a lot of stock into that because you can start at different dates and get different trends, but the point is, there's no evidence to suggest that hurricanes either in the United States or globally are increasing, and the same goes for floods, drought and tornado. And don't believe me, you can look at the appendix that I provided with data from the IPCC. So why people would hang their hat on long-term trends in extreme weather is a puzzle.

Chairman SMITH. Thank you, Dr. Pielke.

That concludes my questions, and the gentlewoman from Texas, the Ranking Member, is recognized for hers.

Ms. JOHNSON. Thank you, Mr. Smith.

We have seen some Congressional Republicans be critical of individuals scientists because the scientist's research does not align with their personal and political beliefs.

Dr. Mann, what kind of effect does criticism of this type have on individual scientists, research institutions or even the entire fields of research?

Dr. MANN. I think the attacks against scientists by individuals, groups, many of them allied with fossil fuel interests and fossil fuel front groups, are aimed at several goals. One of them is to silence climate scientists. If you get attacked every time you publish an article that demonstrates the reality and threat of human-caused climate change, if that causes you to become subject to Congressional inquiries and Freedom of Information Act requests, obviously that's very stifling, and I think the intention is to cause scientists to retreat. I also think that the intention of these very public attacks on climate scientists like Tom Karl is meant to send a chilling signal to the entire research community that if you too publish and speak about the threat of human-caused climate change, we're going to come after you too.

Science and the progress of science that we have relied upon as a nation for our prosperity, science relies on the ability of researchers to carry out unfettered investigations into the natural world, and any time you start trying to game that system, it becomes very problematic.

I would like to speak to one example from history. This is the example. Trofim Lysenko was a Russian agronomist, and it became Leninist doctrine to impose his views about heredity, which were crackpot theories completely at odds with the world's scientists. Under Stalin, scientists were being jailed if they disagreed with his theories about agriculture, and Russian agriculture actually suffered. Scientists were jailed. They died in their jail cells. And potentially millions of people suffered from the disastrous agricultural policies that followed from that. So that's what happens when fringe scientific views that might support a particular ideology are allowed to trump actual mainstream science.

Ms. JOHNSON. Thank you.

How do we make sure that political influence does not negatively influence the scientific process?

Dr. MANN. Say that again, please.

Ms. JOHNSON. How can we make sure that political influence does not negatively influence the scientific process?

Dr. MANN. Well, you know, I agree with Roger Pielke, Jr., that we have to discourage investigations that are aimed at discrediting and threatening individual climate scientists about their research. Now, asking for a scientist's source of funding to me is fair game, and I'm more than—always more than happy to provide details about where my funding comes from. I think any scientist should be willing to do that, and Congress has a right to know that information as well.

But going after scientists simply because you don't like the implications of their research, not because their science is bad but because you find the implications of their research inconvenient to the special interests who fund your campaigns, I would hope we could all agree that that is completely inappropriate. It's a threat to science, it's a threat to our prosperity as a nation, which relies on scientific research—unfettered, honest, scientific research.

Ms. JOHNSON. Thank you.

Very quickly, Dr. Pielke has accused you and other climate researchers of being bullies toward individuals who don't agree with you. Have you been a target of personal attacks based on your research?

Dr. MANN. Well, I have. As I just mentioned the hockey stick graph became a focus of attacks by Congressional Republicans like Congressman Joe Barton, Ken Kucinelli, the Attorney General of Virginia. Of course, our research ultimately has been validated time and again and yet the attacks continue because it was an iconic research result. But I would like—and it spoke to the obvious fact that our globe is warming and it's due to human activity.

But I would like to speak to this other point you raised about Dr. Pielke and others accusing climate scientists like myself of being bullies. I do think that's rather rich coming from Roger. He does have a history of bullying other scientists who criticize him and then sort of points to himself as the victim. Three years ago, he wrote a piece for Nate Silver's new FiveThirtyEight website that rejected the connection between climate change and extreme weather. Keep in mind, Roger isn't an actual climate scientist. A number of actual climate scientists including Kevin Trenberth, who is a distinguished researcher at the National Center for Atmospheric Research, challenged, publically challenged his statements in his article, and was the subject along with me of threatening emails from Roger. In fact, Kevin Trenberth's boss received a threatening email that implied potential legal action if he didn't apologize and retract his criticisms. Well, the emails were reviewed by FiveThirtyEight, by Nate Silver, and he decided that they were not in keeping with the values of the organization. He terminated Roger's involvement with FiveThirtyEight. Roger then presented himself as the victim. And so in this case, clearly Roger was the bully, sending these bullying emails to me and Kevin Trenberth and our bosses, and then trying to paint himself as the victim, and that just doesn't serve the discourse.

Ms. JOHNSON. Thank you very much.

Chairman SMITH. The gentlewoman's time is expired.

The gentleman from Alabama, Mr. Brooks, is recognized.

Mr. BROOKS. Thank you, Mr. Chairman. As an overview, so many questions, so little time. I'm going to direct my question to Dr. Christy from my hometown at University of Alabama in Huntsville, but if anyone else wants to add any comments, please feel free.

When I say "so many questions," first we've got the issue of whether global warming exists, and if so, to what degree, and if so, is it cyclical or manmade. But we've also got the question about if it is noncyclical, if it is manmade, what are the effects, and in that vein, I'd like to get your insight on some information that I received while I was in Antarctica about 15 or 16 months ago. The question focuses on sea-level rise or fall. What we generally see in the news media is if there's global warming and it makes sense at first blush, well, you're going to see ice melt and you're going to see the sea levels rise and we're going to have all sorts of damage done to our coastal areas as a consequence. But while I was in Antarctica, I met with a number of national science foundations who all contended that there was some degree of global warming but they added that if there was a slight or a modest global warming, that the sea levels will fall, not rise. Let me emphasize that: that the sea levels if there is slight or modest global warming will fall, not rise. And of course, that was somewhat perplexing because that's the exact opposite of what we hear in the news media on a regular basis, and this is what they said, and Dr. Christy, if you'd please share your insight as to whether you think their argument is legitimate or not, first, that the principal amount of ice on the planet is in Antarctica, roughly 85 percent, more or less, of the total amount of ice on the planet; second, that if the temperatures rise a little bit, then that air is going to carry more moisture, which in Antarctica is going to be deposited on a huge land mass that is larger than the size of the United States of America, by way of example, some levels of ice, I think the mean is around 6,000 feet deep, at the South Pole it's more than that, and some places in Antarctica as much as 3 miles thick, and that it takes hundreds of years for that ice that has fallen in Antarctica to actually reach the coastline, which means that if the temperature goes up a little bit because of this effect, you're actually looking at more snow and ice being deposited on Antarctica and water being taken from the oceans, more than offsetting whatever melt there may be in Greenland or the Arctic.

So what are your thoughts on that theory or argument that they were raising to us in Antarctica?

Dr. CHRISTY. Well, thank you for the question, Congressman. I will yield to our polar expert here, Dr. Curry, for the answer.

Mr. BROOKS. Well, dadgummit, I wanted to do something with a local boy, but go ahead, Dr. Curry.

Dr. CHRISTY. It's pretty hot in Alabama.

Dr. CURRY. Thank you, John.

Well, the math balance of glaciers is a complicated topic, and we have, you know, new satellite technologies that are trying to measure this from laser altimetry and so on and so forth. But you see glacier accumulation in some regions due to increased snowfall and then there's a few regions where you see it melting, and this is true

both for Greenland and Antarctica. The idea of warmer oceans translating into more snowfall seems to be a real one but then there's glacier dynamics. It's a very complex situation so there is something to what you heard, you know, that is a real mechanism, but how all this plays out for the glacier mass balance remains, you know, a topic of research, and it's really only, you know, the last decade or so that we have had really, really good measurements of glacier topography, and we can really track the mass balance. So we do need the observations from satellite and also field experiments to sort out this issue.

Mr. BROOKS. Well, moving to a NASA study from 1992 to 2008, they concluded that in Antarctica, you were seeing, while there's this global warming going on, a net addition of about 100 billion tons of ice per year, and you talk about over the last decade. Is that 1992 to 2008 data accurate in your judgment or inaccurate?

Dr. CURRY. There's uncertainty but you've seen the accumulation over east Antarctic where on the west Antarctic ice shelves you're seeing net melting. So there's some spatial variability, and there is significant uncertainties in our estimates of all this, particularly the further back you go.

Mr. BROOKS. Anybody else want to add any comments to that issue? Dr. Mann?

Dr. MANN. Yes. So we have widespread measurements now from satellites, direct measurements of the total ice mass contained in the ice sheets, and there is no question that the two main potential contributors to global sea-level rise, the Greenland ice sheet and the west Antarctic ice sheet, are losing ice, and we know that that loss of ice means that the ice sheets are contributing to sea-level rise already. Now, we hear so much about uncertainty as if uncertainty is a reason for inaction, but in this case, the uncertainties are breaking against us because we are actually seeing more rapid loss of ice from those ice sheets than the climate models that many here criticize had predicted in the past. That means that we are going to see more sea-level rise in the near term than the models had predicted. In this case, uncertainty is not our friend. It's breaking against us.

Mr. BROOKS. Dr. Mann, Dr. Curry, thank you.

Dr. Christy, next time.

Thank you, Mr. Chairman.

Chairman SMITH. Thank you, Mr. Brooks.

The gentlewoman from Oregon, Ms. Bonamici, is recognized.

Ms. BONAMICI. Thank you very much, Mr. Chairman.

There have been many studies that have confirmed that of the thousands of peer-reviewed papers that have taken a position on the cause of global warming, 97 percent recognize the influence humans have on global warming, and only three percent reject or minimize the connection between humans and climate change. So the witness panel does not really represent the vast majority of climate scientists who have concluded that there is a connection between human activity and climate change. So sort of visualize 96 more climate scientists who agree that climate change is driven by human activity. I know we don't have that many seats at the dais but I just want to put that out there. For a balanced panel, we'd need 96 more Dr. Manns.

So we know that human contributions to climate change have vast and alarming effects including rising sea levels, ocean acidification, melting glaciers. We just got the alarming report recently about the Great Barrier Reef. Climate change is damaging our environment, our economy, our food sources, and fossil fuel emissions also contribute to higher rates of asthma, lung and heart disease, threatening the lives of our children and grandchildren.

So I'm proud to say that my home State of Oregon is taking action. In January of 2016, the Nature Conservancy convened the Oregon Business Leaders Greenhouse Gas Emission Task Force, and it's a coalition of business leaders who recently produced a report with strategies to reduce greenhouse gas emissions and at the same time maintain our business competitiveness. The action items include calling for Oregon building codes to promote energy efficiency, increasing federal investment in low-carbon technologies, addressing congestion in the metropolitan areas, and I applaud the Nature Conservancy and our business leaders in Oregon for rising to the challenge and coming up with commonsense solutions that benefit the environment and also help our businesses succeed in a changing world. We understand that it is not mutually exclusive that we can protect the environment and grow our economy.

So Mr. Chairman, I request unanimous consent to enter the Nature Conservancy report into the record.

Chairman SMITH. Without objection.

[The information appears in Appendix II]

Ms. BONAMICI. Dr. Mann, science continues to prove the connection between human activity and our changing climate, so instead of holding this unproductive hearing, what would be better for this Committee to do? How could we further scientific inquiry and investigate actions that we could take to respond to the current and future risks of climate change?

Dr. MANN. Well, thanks very much for the question, and as I often like to say, actually scientists—science doesn't prove anything. Proof is for mathematical theorems and alcoholic beverages. But what science does do is establish at high levels of confidence, just like the theory of gravity. We haven't proved it but we don't jump off a cliff. We understand that it's real. And the same thing is true with climate change. In fact, by some measures, there is as deep a consensus about human-caused climate change as there is about gravity. It literally goes back two centuries to Joseph Fourier in the early 1880s.

So as I've said before, what I would like to see, what I would hope we would see in Congress is a good-faith debate between politicians on both sides of the aisle advocating for solutions to this problem that are consistent with their ideologies, and I think it's great that they're Republicans and conservatives today who are out there saying to their fellow Republicans, let's put aside the anti-science. This is about U.S. competitiveness. The rest of the world is moving ahead. They're transitioning to renewable energy. They're actually tackling this problem, and we stand to get left behind.

Ms. BONAMICI. Thank you. I'm going to get another question. I did want to note that Mr. Pielke's testimony indicates he might support a carbon tax. I wish we were having a hearing about that.

So we've also heard in the Committee and elsewhere in Congress criticisms of the climate models used by the National Oceanic and Atmospheric Administration, the IPCC and other bodies that understand and discuss responses to climate change. So there have been some like Dr. Christy who claim that the satellite data somehow disproves our understanding of climate change. So would you respond to that claim, and how should we consider the value of satellite and in situ observations as we work to better understanding our Earth's climate?

Dr. MANN. Well, thanks for the question, and I would say, you know, that statement that the satellite data somehow disprove human-caused climate change, it's what I can an RUS. It's a ridiculously untrue statement. And the surface and near-surface temperature records—in fact, if we can show Exhibit A from my written statement here, it shows that all of the surface and near-surface temperature records agree that there's a steady long-term pattern of warming. That's true for the temperatures measured by thermometers at the surface, the balloon measurements in the lower atmosphere, and both John's satellite data set and other estimates from the same satellite data.

Now, I should point out that that's John's satellite data set after it's been corrected for numerous errors that he had made over the years and which came to light because of other attempts by other researchers to reproduce his results, and ultimately now with those corrections, his satellite record is basically consistent with these other records. They all show long-term warming, and I would add, by the way, that if he is right, that the mid and upper troposphere are not warming as fast as the models say, and there's a paper just out a week ago by Ben Santer, Susan Solomon, Presidential Medal of Science winner, a very austere team of climate scientists that has shown that his claim of the observations not showing the model predicted warming in the mid and upper troposphere is largely an artifact, an artifact of the fact that he's mixing in stratospheric temperatures. The stratosphere actually cools. In global warming, the lower part of the atmosphere including where we live, the troposphere warms, the stratosphere cools. His satellite estimates actually smear some of that cooling stratosphere into what he's calling the upper troposphere, and that's the reason for the discrepancy, and if he was right that it was warming less quickly than the models predict, it would actually imply the opposite of what he claimed earlier. It would imply a higher climate sensitivity because it turns out that one of the negative feedback, one of the ameliorating effects, so-called lapse rate feedback, would not be as strong as we think it is, so it would actually mean that the climate is even more sensitive to increasing greenhouse gas concentrations.

Chairman SMITH. The gentlewoman's time has expired.

Ms. BONAMICI. I'm out of time. Yield back. Thank you, Mr. Chairman.

Chairman SMITH. The gentleman from Arizona, Mr. Biggs, is recognized for his questions.

Mr. BIGGS. Thanks, Mr. Chairman, and I guess I'll go back to you and this ping pong ball discussion, Dr. Christy. You know, it was very interesting. Would you like to respond to Dr. Mann's explanation of your—

Dr. CHRISTY. Absolutely. What he said was incorrect. The satellites, balloons and reanalyses, 12—10 different measuring systems, show the same thing. All include the stratospheric portion, which is very tiny in the tropics. The models included it as well. And so it was an apples-apples comparison. What I showed was a legitimate scientific test.

And I would just like to say one other thing. Science is not done by polling, it's done by numbers, and I showed numbers that can stand up, you know, under cross-examination. Those are the numbers that are out there and that we see the climate models do fail when compared against real data.

Mr. BIGGS. And Dr. Christy, continuing with you, we've heard referred to any basically if you don't toe to the consensus view on climate here that you're practicing anti-science, and I was wondering what your comment would be on that.

Dr. CHRISTY. I would just say I don't practice anti-science. People can say what—something you should understand. Scientists are people and they say crazy things all the time. They are people and human.

Mr. BIGGS. Sounds like Congress is really what it sounds like.

Well, this hearing is really focusing on scientific method and some of our recent discourse might have gotten a little bit away from strictly scientific method but a lot of research on climate change receives significant funding from governments, and by extension, that means the American taxpayer.

So my next question is focusing on us really trying to get at funding and how it might impact outcomes in research and potential biases. So the Congressional Research Service has estimated that between 2008 and 2013, the United States government spent \$77 billion on climate change, and it's my understanding that the Government Accountability Office is also working on a similar in-depth report.

So I'll go with you, Dr. Curry. Are there concerns that climate change funding across many federal agencies may be duplicative or even sometimes wasteful?

Dr. CURRY. Well, I think that the funding for observing systems, particularly satellite observing systems, is money very, very well spent, also for our ocean observing systems. I mean, this is critical information that we need, and I urge you to support continued funding of these.

My concern is that too many announcements of opportunity from funding agents, you know, implicitly assume that climate change is caused by humans and that it's dangerous, and as a result, what we get is what a lot of research that I would call climate model taxonomy where scientists just analyze the output of the IPCC production runs and, you know, make claims that, you know, climate change causes syphilis or will stop growing grapes in California, or whatever. You've seen all these claims. And these are not useful studies. What we need is more fundamental climate dynamics research to understand how the climate system works on decadal to century time scales and uses understanding to develop new structural forms for our climate models. That's what I think we need to do to move all this forward.

Mr. BIGGS. And Dr. Pielke, is there any way to determine how much of the funding that we see going to support this, what has been called the consensus of science or those who question the consensus or perhaps may be skeptical? Is there any way to track that?

Dr. PIELKE. Let me say at the outset that the findings related to climate science have been largely consistent since the 1980s. Yeah, there's a lot of details but there is fundamental risk, it's not going away, and there are fundamental legitimate disagreements as you heard here.

What has happened in climate science is that this idea of a 97 percent consensus went from characterizing what the research looked like to characterizing what views were legitimately allowed to be aired. The fact that a scientist as distinguished as John Christy is excoriated in the media by politicians on social media on a daily basis for doing legitimate science tells us something about the pressures to conform to a particular point of view.

But let me say, you can fund billions and billions of dollars more of climate research and the findings will be very much the same. There's fundamental risks, the future's uncertain, and we have choices about whether and how we might want to mitigate those risks.

Mr. BIGGS. Thank you. I'll yield back.

Chairman SMITH. Thank you, Mr. Biggs.

The gentleman from California, Dr. Bera, is recognized.

Mr. BERA. Thank you, Mr. Chairman.

So a lot of people talked about the scientific method, and I am a scientist. I'm a doctor. I've spent a lot of time in the lab, a lot of time doing research, and as a physician, how I interpret the scientific method is to discover cause-and-effect relationships by asking questions, gathering and examining the evidence, and seeing if all available information can bring me to a logical conclusion. So let's do that. Let's actually go through the scientific method here and gather information.

The temperature is rising. You know, Dr. Mann, what was the hottest year on record? Twenty sixteen, second, 2015; third, 2014; fourth, 2010. So we see this trend. Even Dr. Christy's graphs show, you know, while there's variation show a trend line of warming temperature.

Dr. Mann, is the polar ice melting?

Dr. MANN. Yes.

Mr. BERA. Does ice melt when it gets colder or hotter? I'm a simple person—

Dr. MANN. I'm pretty sure about that one.

Mr. BERA. Exactly. So—and is ocean temperature rising?

Dr. MANN. Equally sure about that one.

Mr. BERA. Okay. So we've gathered the facts. Now let's start to think about okay, what's—you know, those are the—what's causing this. So we can agree that we ought to move the conversation towards what's causing it, and even Dr. Pielke, you said we can talk about how we mitigate those causes. Yes, no one's going to disagree there's variation in weather patterns. In my home State of California, we've gone through dramatic droughts in the past few years, not this year, though. We're having if not the wettest year on

record, one of the wettest years on record. So there is variation. But that doesn't mean we ought not to be thinking about what's causing this and move the conversation.

And we ought not to—whether you deny the climate change or deny that the Earth is getting hotter or you agree with that, as the vast majority of scientists do, we ought not to be persecuting our scientists. We ought to be having an open dialogue, and there's no problem with varying opinions but we ought to have an honest conversation about it.

You know, do any of you think the—do any of you disagree with the fact that the Earth rotates around the sun? Pretty given science. But in 1633, Galileo was persecuted for putting forth that theory. Again, let's not go back to that time. Let's actually move this conversation forward. This is the Science and Technology Committee. Let's have an honest conversation about what's happening. We all agree the Earth is warming. We all agree that we're seeing more extremes of climate. Let's start mitigating that.

Again, you could argue whether humans are causing this or if it's natural. I seem to think, you know, there's a human cause of this. So Dr. Mann, where would you proceed if you were to again advise this Committee?

Dr. MANN. Well, let me first say the scientific method—we've heard this term quite a bit. The Chairman keeps using this term. I do not think it means what he thinks it means.

According to an article that came out a few days ago in the Journal of Science, Chairman Smith was on record at the Heartland Institute. This is a climate change-denying Koch Brothers-funded outlet that has a climate change denier conference every year, and Chairman Smith spoke at that conference—

Chairman SMITH. Dr. Mann, don't mischaracterize that.

Dr. MANN. Let me finish my—

Chairman SMITH. No, they do not say that they are deniers, and you should not say that they are either.

Dr. MANN. Well, we can have that discussion. I'd be happy to. Let me finish my statement.

Chairman SMITH. Well, be accurate in your description.

Dr. MANN. I stand by my statements. Can I finish my point?

Mr. BERA. I'd like to reclaim my time.

Dr. MANN. Yes. So he indicated at this conference that he, according to Science, and I'm quoting from them, he sees his role on this Committee as a tool to advance his political agenda rather than a forum to examine important issues facing the U.S. research community. As a scientist, I find that deeply disturbing.

Chairman SMITH. Dr. Mann, who said that?

Dr. MANN. This is according to Science magazine, one of the most respected outlets when it comes to science.

Chairman SMITH. And who are they quoting?

Dr. MANN. This is the author, Jeffrey Mervis, who wrote that article. I'd be happy to send to Committee the article.

Chairman SMITH. That is not known as an objective writer or magazine.

Dr. MANN. Well, it's Science magazine.

Mr. BERA. I'd like to reclaim my time.

Chairman SMITH. And the gentleman from California reclaims his time.

Mr. BERA. Dr. Mann, if you could submit that paper to me, you know—

Dr. MANN. Absolutely.

Mr. BERA. —we'd love to submit that for the record.

Dr. MANN. Yes, it would be my pleasure.

So just to continue, so science involves an objective search for truth, and that's what scientists do, and we challenge each other. It's not the lovefest that some would like to make it sound like. My good friend, who's no longer with us, Steve Schneider, used to characterize climate—or science in general as a contact sport because scientists are constantly contesting in the peer-reviewed literature, at meetings. The way you get ahead in science isn't by saying yes, I agree with everything, I agree with all the others. The way you get an article in the journals Nature and Science is by showing something different, something new, and so that's the self-correcting machinery that keeps—using the language of Carl Sagan, that keeps science on a path towards truth. What we stand to be in danger of here is to have that machinery basically destroyed by the politicization of science.

Mr. BERA. I couldn't agree with you more. So let's not persecute our scientists. We can disagree, we can have robust debate, but let's actually have an honest, robust debate.

Thank you.

Chairman SMITH. Thank you, Dr. Bera.

And without objection, I'd like to enter into the record three articles on the so-called 97 percent consensus, which shows that there was no consensus. The 97 percent was derived from a small sample of a small sample, and the question wasn't whether humans contributed most of the change in climate but whether they contributed any part at all. The surprise is that it's not more than 97 percent.

Anyway, the 97 percent figure has been misused today a number of times, and without objection, those articles are made a part of the record.

[The information appears in Appendix II]

Chairman SMITH. The gentleman from Louisiana, Mr. Higgins, is recognized for his questions.

Mr. HIGGINS. Thank you, Mr. Chairman.

Dr. Mann, are you affiliated or associated with an organization called the Union of Concerned Scientists?

Dr. MANN. No. I—

Mr. HIGGINS. You're not affiliated nor associated with them?

Dr. MANN. Am I associated with them? I know people who are—

Mr. HIGGINS. Are you affiliated or associated with an organization called the Climate Accountability Institute?

Dr. MANN. No. I mean, may—

Mr. HIGGINS. You're not affiliated—

Dr. MANN. —correspond with—

Mr. HIGGINS. —or associated with them?

Dr. MANN. I can provide—I've submitted my CV. You can see who I'm associated with and who I'm not.

Mr. HIGGINS. These two organizations, are they connected directly with organized efforts to prosecute manned influence climate skeptics via RICO statutes?

Dr. MANN. The way you've phrased it, I would find it extremely surprising if what you said was true.

Mr. HIGGINS. Dr. Pielke, I'm going to ask you a series of short questions, please. Are hurricanes increasing?

Dr. PIELKE. It depends on what date you want to start, but on climate time scales in the United States and globally, no.

Mr. HIGGINS. Are tornados increasing?

Dr. PIELKE. There's a lot of uncertainty about tornados but there's no evidence to suggest that they've been increasing.

Mr. HIGGINS. Are floods increasing?

Dr. PIELKE. As the IPCC concluded, there's not really good data worldwide to know if they're going up or down.

Mr. HIGGINS. Are droughts increasing?

Dr. PIELKE. Globally and in the United States, according to the EPA and according to the IPCC, the answer is no.

Mr. HIGGINS. Why would you—can you explain why some would say that with such certainty that extreme weather events will increase given the fact that they have not?

Dr. PIELKE. Well, they may increase yet in the future, and there's a number of projections made by the IPCC that suggest that they might, and that's part of the uncertainty associated with science, but looking from the past to today, we have good evidence to be able to answer the question whether these phenomena have increased on climate time scales.

Mr. HIGGINS. And some scientists have a hypothesis that extreme weather events will increase because of climate change, and how do they—how do those scientists, how would you explain they square that hypothesis with the reality that these extreme weather events have not increased?

Dr. PIELKE. Yeah, most—if you look at the IPCC and mainstream science, we shouldn't expect to see the signal of human-caused climate change and increasing extreme events for decades, and many decades into the future. So there's often a conflation of what's predicted, say, in 2100 with what we're observing today, and if we're seeing an increase in extreme events today, that would actually show that the models are wrong because they suggest we won't see it for many decades.

Mr. HIGGINS. Thank you, sir.

Dr. Mann, would you be able to at some future date provide to this Committee evidence of your lack of association with the organization Union of Concerned Scientists and lack of your association with the organization called Climate Accountability Institute? Can you provide that documentation to this Committee, sir?

Dr. MANN. Yeah, so you haven't defined what "association" even means here, but it's all in my CV, which has already been provided to Committee.

Mr. HIGGINS. Would you provide a statement—

Dr. MANN. I'll send it again.

Mr. HIGGINS. —to this Committee regarding your assertion?

Dr. MANN. I will send it again.

Mr. HIGGINS. Thank you, sir.

Mr. Chairman, I yield back.

Chairman SMITH. Thank you, Mr. Higgins.

The gentleman from New York, Mr. Tonko, is recognized.

Mr. TONKO. Thank you, Mr. Chair.

As an engineer, I know a few things about uncertainty. I know, for example, that everything from a steel beam to a parachute has a certain very small probability of failure. We have to account for uncertainty to be able to build large buildings and great structures that last for generations. We do the math, we check out our work, and we test it. We go back over time and shore up any weak spots. And when everyone does their part to build and maintain and test them, these structures remain strong.

Science works in a similar way: thriving on the uncertainty that lives between evidence and conclusions. So when a few individuals express doubt about climate change, scientists listen, check their theories against the available data, and continue to observe and improve. But like the failure rate of that steel beam, the uncertainty in climate change science is known and negligible.

For every one scientist who disputes the fact that human activity is driving climate change, there are 17,352 who acknowledge human activity is the main driver of climate change. So if we have a handful of scientists here in this room today who are skeptical about the human role in climate change, there are tens of thousands more credible, trained scientists out in the world standing up for the scientific fact that humans are the major driver of climate change.

It is notable that those tens of thousands of scientists are represented here solely by Dr. Mann. I want to thank Dr. Mann for being here today, and representing this overwhelming consensus.

The scientific community thrives on skepticism and uncertainty but denial is something different. Unlike healthy scientific skepticism, climate change denial stands today as one of the great pillars in the pantheon of political manipulation. Decades ago, major players in the fossil fuel industry saw the issue of climate change gaining popular attention. They also realized that any serious effort to reduce carbon pollution and greenhouse gases could be a death blow for their industry. So instead of embracing the clear evidence in front of them that fossil fuels contribute to climate change, they launched one of the most successful misinformation campaigns in our American history, right up there with the tobacco industry lying about cancer risks.

In 1998, the fossil fuel industry laid out its misinformation strategy and tactics in something they called the Global Climate Science Communications Action Plan. Mr. Chair, I ask to enter this document into the record.

Chairman SMITH. Without objection.

[The information appears in Appendix II]

Mr. TONKO. Thank you.

This action plan said, and I quote, "Victory will be achieved when average citizens understand and recognize uncertainties in climate science; media understands, recognizes uncertainties in climate science." The plan also called for identifying, recruiting and training a team of independent scientists to participate in media outreach. Their cause was not to better science or public education; it

was to undermine the ability of science to inform our public and private decisions.

The plan was devised by one dozen people from the oil and gas industry along with communications strategists—PR professionals. One of those individuals was Myron Ebell, whose name has recently surfaced again because he led President Trump’s transition team at the EPA, and it seems certain from EPA Administrator Scott Pruitt’s recent actions that he will be more interested in strategic communications and parlor tricks to distract the public from the reality of climate change than actually attempting to address these serious problems.

So Dr. Mann, a question. Can you talk a little bit about how you see these sort of tactics and distractive techniques being played out in the discussions about climate change, please?

Dr. MANN. Yeah. Thanks for the question. And indeed, we do see these attacks against climate scientists orchestrated in many cases by organizations and individuals tied to fossil fuel interests. You mentioned specifically Scott Pruitt, and of course, Scott Pruitt is on record saying that—this is his quote: “I would not agree that human activity is a primary contributor to the global warming that we see,” which is completely at odds with what the world’s scientists have determined.

Now, what is particularly concerning to me is that one of our witnesses here today, Judith Curry, supported that statement. She said, “I do not find anything to disagree with in what he said,” which means that she’s clearly going against what the U.S. National Academy of Sciences has said, what every academic scientific organization in the U.S. that has weighed in on the matter has said, and I find that distressing.

Now, to have an EPA Administrator who has such a position that’s so at odds with the scientific evidence, there is no precedent, even in past Republican Administrations, under Nixon, under Reagan, under George H.W. Bush, they each had EPA Administrators that embraced science and actually that’s where market-driven solutions to dealing with environmental problems came about. Nixon founded the EPA. George H.W. Bush under his wonderful EPA Administrator, William K. Riley, signed the Montreal—sorry—passed cap-and-trade legislation. Remember cap and trade? That came from Bush Administration as a market-driven mechanism, a market-driven mechanism for dealing with an environmental problem.

So what we have today with an EPA Administrator who rejects the overwhelming opinion of the world’s scientists is completely at odds with what we have ever seen before in both Democratic and Republican Administrations.

Mr. TONKO. Dr. Mann, thank you so much.

And Mr. Chair, I yield back.

Chairman SMITH. Thank you.

The gentleman from California, Mr. Rohrabacher, is recognized.

Mr. ROHRABACHER. Yes. I’d like to thank the Chairman for calling this hearing today because it exposes people to different ideas, and it exposes people and especially at a time when those who disagree with the mainstream are being brutalized into silence, this type of hearing is vital to hear the fundamental arguments.

Unfortunately, from get-go, we have heard personal attack after personal attack after personal attack coming from those who are claiming to represent the mainstream of science, even to the point that our Chairman is attacked with a non-quote with an analysis of somebody else's interpretation of what he said, and we have our Chairman attacked like that. That is ridiculous. People should be ashamed of yourselves for people who continue to attack other people because they disagree. You call people deniers all you want. You can use every kind of name you want. You're not standing up to consensus. When we talk about how Mr. Lysenko was promoted by Stalin, that's the type of thing they did to the scientists in Russia because you don't agree with Mr. Lysenko, and now you can bet nobody except those who agree with Lysenko are going to be able to get a government research contract in Russia, the same as we've heard here in the United States from scientists who have great credentials who aren't able to get their—who haven't been able to get research grants because they're now labeled deniers and attacked personally. This is a disgrace to the scientific community.

And let me just go into some thing here. Now, CO₂, the theory of CO₂ changing the temperature of the climate, that is what basically we're talking about when we talk about manmade climate change. That's the theory. It's not whether or not we've cut down the forest in order to produce farmland, et cetera. It's CO₂ production. That's what they're talking about when they're proposing United Nations restrictions on our activities based on that theory because the globe is going to be affected by it.

Now, was there a pause or wasn't there a pause in the increase of temperature of the climate at a time when there was massive increases in CO₂? That seems to be a fundamental question of whether or not—now, the fact that today the pause is—it should be evident that at one point at least those people who are attacking this side admitted that there was a pause, and you can tell that by the very discussion. That is, we remember when the issue was global warming. We remember over and over again global warming, and now just some evolution, that now we call it climate change. Well, what that is, is a recognition, is there was a pause in the heating of the planet even by those people who are advocating the opposite now. That's why they call it climate change. Every time you call it climate change, you are admitting that yes, there was a pause, a major pause in temperature increase because before that, it was global warming over and over and over again. We heard that global warming.

Let me ask Ms. Curry. You in particular, your testimony today was, I think, perhaps the most important testimony, and that is from someone who felt that she had to go along with the consensus and ignore facts that would lead—that would then lead to an honest conclusion. Could you give me your reaction to what I just said in terms of the way you're getting treated?

Dr. CURRY. Well, the issue—okay. You know, what advocacy groups say, what the media say, what anonymous bloggers say, you know, it's noise, but what I'm concerned about is the behavior of scientists, and you know, I've been called a denier per the Congressional record from Michael Mann's testimony. Judith Curry, the denier is now in the Congressional record. What kind of a behavior

is that? This is not the behavior of scientists who are respectfully disagreeing and open to debate. I mean, I am not out there in the fringes. My main point is that I think there are a lot of uncertainties and that the climate models and the data et cetera are not fit for the purpose for drawing highly confident conclusions about what has been causing the recent warming.

It's been warming for hundreds of years, and we can't explain all of that, you know, due to human causes. So I'm saying we need to think more broadly about this problem, and that's what I'm saying—

Mr. ROHRABACHER. Right.

Dr. CURRY. —and I get called a denier and who knows what else.

Mr. ROHRABACHER. Well, we've seen cycles. There have been cycles throughout the history of the planet of warming and cooling cycles. Whether or not man's use of CO₂ is now creating a warming cycle is what this is all about, and for scientists on either side to try to call names and try to beat somebody into submission, that's a Stalinist tactic. Those using the words "denier" are using a Stalinist tactic—

Chairman SMITH. The gentleman—

Mr. ROHRABACHER. —and it is just incredible for me to hear others trying to claim that the basis of their discussion is what all scientists and the rest of everybody else who disagrees is in some way not worthy of being called a scientist, they're deniers.

Chairman SMITH. Thank you.

Mr. ROHRABACHER. Mr. Chairman, I want to place on the record very quickly 300 names of 300 major scientists given—who signed on to a letter by of course the head of the science, Dr. Linzen from MIT, asking us to get out of the convention for climate change—

Chairman SMITH. Without objection, so ordered.

[The information appears in Appendix II]

Mr. ROHRABACHER. —300 prominent scientists. I'd like to also put for the record an in-depth study by a professor—and I don't know how to pronounce his name—Neals Alex Werner talking about sea level, a man who has spent a massive amount of time studying sea-level rise and shows what we are getting—

Chairman SMITH. Without objection, that'll be made a part of the record.

[The information appears in Appendix II]

Mr. ROHRABACHER. Thank you very much, Mr. Chairman.

Chairman SMITH. Thank you, Mr. Rohrabacher, and the gentleman from Louisiana is recognized for unanimous consent as well.

Mr. HIGGINS. Thank you, Mr. Chairman.

My research has clarified that the organization called the Climate Accountability Institute is the primary—is a primary organization calling for criminal prosecution of climate skeptics under RICO statutes. I'd like to enter it into the record, sir, from their website, from the Climate Accountability website, listed as one of the Climate Accountability Institute council of advisors, Mr. Michael E. Mann. I would like this entered into the record, Mr. Chairman.

Chairman SMITH. Without objection.

[The information appears in Appendix II]

Chairman SMITH. The gentleman from California, Mr. Takano, is recognized for questions.

Mr. TAKANO. Thank you, Mr. Chairman.

Chairman SMITH. I'm sorry. Mr. McNerney has returned, and he was ahead of you. The gentleman from California, Mr. McNerney, is recognized for questions.

Mr. MCNERNEY. I didn't know I was going to be so controversial here, Mr. Chairman.

I want to thank my friend from California for his opinion on this issue. Mr. Rohrabacher, thank you.

Mr. Mann—Dr. Mann, I'm looking at the Exhibit B, and I was hoping that this could be brought to the screen, and it's the so-called hockey curve. Now, what interests me about this is the way the shaded area diminishes over time. Could you explain that a little bit, how the shaded blue area diminishes as we get closer to the current day?

Dr. MANN. Absolutely, and I'm glad you're showing that plot here because one thing it shows, our hockey stick curve, that's the blue curve that was published near two decades ago along with its uncertainties, the blue shading, you'll notice it's near identical to that green curve. That green curve is from a team of 78 scientists who published in the premier journal *Nature Geoscience* a few years ago using the most widespread database of proxy data ever brought to bear on a problem like this, and they got virtually an identical result to the one we had published decades ago. So to those who claim that the hockey stick has been discredited, just the opposite is true. The reason it's accepted is because other scientists using different methods, different data, coming at the problem from different angles have all come up with the same result, and that's how science works.

Mr. MCNERNEY. And that's consistent with the scientific method?

Dr. MANN. Exactly. That's how science works. If your result is wrong, it's going to be discovered pretty quickly, and that's what happened with John's satellite records, which he originally claimed showed cooling. Ultimately it was discovered that there was an algebraic error in their code and a sine error like a minus where there's supposed to be a plus, and now we have a consensus where John's updated estimates are more or less in keeping with the other estimates. That's how science works.

Now, you ask why does the uncertainty become so large back in time? So let me add, by the way, that the word "uncertainties" appeared in the original article. To those who claim that we are trying to hide uncertainty, that we don't want to talk about uncertainty, the words "uncertainties" and "limitations" appeared in the title of this original article, and that's something we focused on. You can see those uncertainties do get quite large as you go back in time because you have less data, you have less paleo data as you go farther back into the past.

Now, with some of these newer efforts like this pages 2K estimate, the green estimate, they have much more widespread data, the uncertainties are now smaller, and that's how science works. You refine a result, you get a better estimate. Other scientists continually challenge each other, and that's Carl Sagan's self-correcting machinery.

Mr. MCNERNEY. Thank you. Why is it so narrow now in the current time, the uncertainty region?

Dr. MANN. Yeah, because we've got widespread thermometer data over the last century and a half, so as we get more data, the uncertainties get smaller, and the red curve shows the instrumental record. We don't need paleo data to tell us what's happened to temperatures over the past century and a half. We've got widespread thermometer measurements for that.

Mr. MCNERNEY. And these are measurements in the ocean and the atmosphere and all over the whole planet?

Dr. MANN. That's right, and to people who say, you know, they don't trust a surface temperature record, well, we've got measurements from the ocean surface, we've got measurements of the land and for all the continents. We've got the southern hemisphere, we've got the northern hemisphere. They all point in the same direction. We've got a lot of independent information from holes in the ground, bore holes, an independent way of estimating surface temperatures back in time, dozens of independent lines of evidence that all come together telling us the same thing. That's how science works. That's why there's a consensus, not because we're standing around holding hands because independent teams of scientists coming at the problem from different angles arriving at the same consistent answer over and over again.

Mr. MCNERNEY. Thank you. In his testimony, Dr. Pielke asserts that since 2013, the world and the United States have had a remarkable stretch of good fortune with respect to extreme weather as compared to the past. Would you respond to that, please?

Dr. MANN. Yes. So Roger is, you know, pointing to outdated reports, outdated data. Three years ago, he actually posted the following on his blog. He said, "I am no longer conducting research or academic writing related to climate. I am not available for talks, and on the climate interest, I have no interest in speaking with reporters or giving testimony before Congress." That's what he said back in 2015. Well, that's, you know, three years ago. There has been a lot of progress over the past three years. We just published an article in the Journal of Scientific Reports a few days ago that reaffirms what scientists are now finding. There are teams of scientists now, whole teams of scientists, when there's an extreme event, they can use what's known as detection and attribution. They can actually compare models and observations and estimate how much more likely that event might have been made by human-caused climate change, and in many of the extreme droughts and flooding events that we've seen in recent years, those groups have positively attributed those events. They've said that those events were sufficiently unlikely to have happened without human-caused global warming that we can say at a relatively high level of certainty that climate change did impact the event, not that it created the event; it made it worse, it made it bigger.

Mr. MCNERNEY. Thank you, Mr. Chairman.

Chairman SMITH. Thank you, Mr. McNerney.

The gentleman from Texas, Mr. Weber, is recognized.

Mr. WEBER. Thank you, Mr. Chairman.

I think it's a sad day when one of our witnesses lectures us about the number of witnesses we have and how many times that they've

been here to testify. It's odd to me that he can remember how many times they've testified but he cannot remember being associated with Climate Accountability Institute. That certainly seems to be a lack of—a convenient lack of memory.

So having said that, I'm going to go ahead and get to my questions. This will be for you, Dr. Curry, and I'm sorry that you've been demonized and it's been written in the Congressional record that you are a climate denier. You shouldn't have to endure that, you know, just because you might have a differing opinion, what we would call a minority report. I don't think that you should have to endure that.

I also remember, by the way, that if I remember correctly, Mark Twain said that sometimes a majority means all the fools are on one side. So there is that.

Dr. Curry, would you characterize any of the climate policies discussed in the United States such as major industrial CO₂ restrictions as flexible and adaptive?

Dr. CURRY. No. I'm concerned about—you know, we're facing a problem with—characterized by deep uncertainty and trying to fit this into a command-and-control kind of solution with climate models I think is a mismatch to this extremely complex and wicked problem.

Mr. WEBER. So they're not—in your opinion, they're not flexible and adaptive, but scientists—science is supposed to be about the ongoing investigational study and adapting when necessary. Is that correct?

Dr. CURRY. That would certainly be one approach that I think is consistent with the kinds of deep uncertainty we're facing with this problem.

Mr. WEBER. Sure. Okay.

How about you, Dr. Christy? Would you describe those major industrial CO₂ restrictions being discussed as flexible and adaptive?

Dr. CHRISTY. Well, what I understand is that those regulations are based upon knowing how the system operates, how the climate system operates. One of the fundamental things about science is that when you understand a system, you can predict its behavior. I've demonstrated that the climate models we have now cannot predict even predict from the past a major climate metric, the bulk temperature of the atmosphere.

Mr. WEBER. So they're not flexible and adaptive?

Dr. CHRISTY. Well, we don't know what's going to happen in the future so how can you then say well, this regulation is going to have this consequence. We don't have confidence there.

Mr. WEBER. Dr. Mann, I'll give you a shot at that. Are they flexible and adaptive, those restrictions that we're discussing on CO₂?

Dr. MANN. I'm not sure why you're asking me that question. Obviously—

Mr. WEBER. Because you're a learned scientist and you're here to participate in the discussion.

Dr. MANN. Yeah, that's a matter of policy that you're asking about, and I've tried to be quite clear in my view that there is a worthy debate to be had about what policies we invoke to deal with the problem—

Mr. WEBER. So now it's worthy and it's not climate deniers. You—

Dr. MANN. No, you misunderstood what I'm saying. There's a worthy debate to be had about the solutions to this problem. There is no longer a worthy debate to be had about whether the problem exists.

Mr. WEBER. That is your opinion.

Dr. MANN. That's the opinion of the overwhelming community of scientists around the world.

Mr. WEBER. And yet the EPA won't release that data.

I'm going to move on to you, Doctor. Is it Pielke? Is that how you say it?

Dr. PIELKE. Yes.

Mr. WEBER. In your opinion—you're watching this. This is important to you, I'm sure. You all are watching this. Are the restrictions being discussed flexible and adaptive in your opinion? Do you have an opinion?

Dr. PIELKE. Yes, I do. I've written a book on climate policy. And regulation has a very important role to play in bringing mature or near-mature technologies into deployment. Regulation itself is not a very good tool in stimulating R&D or fundamental innovation to create new technologies and so if in the absence of energy system innovation regulations will have marginal effects but they won't have transformative effects like are being called for with the—

Mr. WEBER. So I'll continue with you then and go back the other way. So in your opinion, before we make these kinds of major, major restrictive regulations, wouldn't we want to be absolutely sure about the data, have the EPA release it, and why in the world would we demonize people who want that? Wouldn't we want transparency from our own government?

Dr. PIELKE. Well, my view, which may not be popular among anyone here, is that scientific uncertainty is not going to be eliminated on this topic before we have to act. If we want to improve energy technology, energy innovation for reasons of competitiveness, for air pollution benefits, for energy access around the world, we have plenty of justification for the U.S. to be a leader. Regulation plays a part in that but so too does investment in new technologies. To fund that, you guys might think about a low-carbon tax, one that's maybe 2 or 3 pennies on a gallon of gas, raises hundreds of billions of dollars to bring those new technologies, and if the technologies exist, it'll be a lot easier for you guys to regulate it because it won't have costs that will affect people.

Mr. WEBER. Well, now that he's uttered blasphemy, Mr. Chairman, my time is expired and I'll yield back.

Chairman SMITH. Thank you, Mr. Weber.

Back to the gentleman from California, Mr. Takano.

Mr. TAKANO. Thank you, Mr. Chairman.

Dr. Mann, last year Chairman Smith cited one of your papers in an attempt to contradict the findings of a NOAA study that disproved the theory of a global warming hiatus. In questioning then-Administrator Kathy Sullivan, he asked "Do you still stand by the Karl study's conclusions or do you now recognize that these conclusions might have been weak and agree with the Nature scientists?" Well, Dr. Mann, you are one of those Nature scientists, correct?

Dr. MANN. That's absolutely correct.

Mr. TAKANO. By Nature, I mean the Nature magazine. How do you respond?

Dr. MANN. Yeah, well, I find it unfortunate that our work was misrepresented in that way. Our work in no way challenged the integrity of Tom Karl's work. I have the utmost respect for Tom Karl as a scientist and as a human being, and he has the utmost integrity as a scientist. Our paper expressed an honest scientific difference of opinion. Yes, that's what scientists do. We fight over interpretations and details, precisely the sort of challenges again that the critics like to pretend doesn't take place, and in this case, it was a good-faith disagreement over how to characterize long-term warming trend. We weren't disagreeing about whether there's a long-term human-caused warming trend; we were simply contesting the interpretation, is it sort of a step-like trend like that or is it a more wavy trend like that, and what we weren't disagreeing about was that there's a long-term trend and that it's caused by increasing greenhouse gas concentrations.

Finally, let me say that other independent scientists including scientists, I'll say it again, funded by the Koch Brothers have come up with precisely the same result that Tom Karl came up with and they said that they were able to download online all of the required raw data that was necessary to reproduce his findings, so the claim that he hadn't archived and provided the data necessary for other scientists is just false.

Mr. TAKANO. Well, in fact here, I have a letter, actually two letters signed by all 11 of those Nature scientists including one from my own home State of California rejecting the Chairman's interpretation of their work. I would like to have these letters included into the record.

Chairman SMITH. Without objection.

[The information appears in Appendix II]

Mr. TAKANO. Dr. Mann, I think it's important to take a moment and address those who suggest that those of us who believe and know that climate change is occurring are somehow asking others simply to trust us. Science is not about trust or belief. It is the pursuit of knowledge and understanding. Sweeping statements and allegations about climate change and other issues that are not supported by any accepted scientific knowledge or often facts may be the calling card of this new Administration. But it is imperative that we not let such irrational rhetoric distract people from understanding how science works. The American people know that our climate is changing and they understand that we need policies to protect our health and environment.

Dr. Mann, is this distinction between trust and understanding important?

Dr. MANN. It absolutely is, and you know, when it comes to trust, I trust the U.S. National Academy of Sciences, which I might add was founded by a Republican President, Abraham Lincoln, in the 19th century to inform Congress about matters of policy-relevant science, and they have weighed in. The world's scientists have weighed in. And you know what? It doesn't matter if individual scientists are bad persons. We all have faults as human beings. If our understanding depended on one or a small number of individuals,

their opinions, then of course we would not accept these findings as valid. It's the fact that the entire community of climate scientists around the world arguing back and forth in the peer-reviewed literature contesting each other at meetings have all from different directions come to the same conclusion and all of the scientific assessments that have been done including the U.S. National Academy of Sciences back in the Bush Administration—George W. Bush in his first term—when the IPCC had just published their finding that climate change is real and human-caused, the Bush Administration was skeptical about that finding so they wanted an independent assessment. They asked the U.S. National Academy of Sciences to assess what the IPCC had said. The U.S. National Academy of Science after independently reviewing the literature and soliciting independent reviewers with a variety of perspectives came back and said well, you know, the IPCC, what they said was basically right.

That's—those are the facts, and we can't dispute the facts, and it doesn't matter—you know, the individual personalities of scientists, each of whom are human beings and have their own personal flaws, if that mattered, it would be a problem. The scientific process works because that doesn't matter. Regardless of how good or bad a person you are, your claims will be independently tested by other scientists.

Mr. TAKANO. Its reproducibility—

Chairman SMITH. The gentleman's time has expired.

Mr. TAKANO. —reproduction and corroboration by peers.

Dr. MANN. Absolutely.

Mr. TAKANO. Thank you.

Chairman SMITH. Thank you, Mr. Takano.

Before recognizing the gentleman from Florida, Mr. Webster, without objection, I'll put into the record an op-ed from the Wall Street Journal called Keeping Cool about Hot Temperatures, which points out that even though it is claimed that 2016 was the hottest year in record and 2015 the hottest year on record before that, 2014 the hottest year before that, all three instances, the temperatures were within the margin of error and that in fact in 2014, NASA admitted that they were only 38 percent confident of that temperature. That's less than half.

[The information appears in Appendix II]

Chairman SMITH. The gentleman from Florida, Mr. Webster, is recognized.

Mr. WEBSTER. Thank you, Mr. Chair, and thank you for holding this hearing. It's been very informative.

Dr. Curry, I'll ask you. You were a professor at my alma mater so I did talk to Dr. Peterson here on Monday about some things, not about climate change, but anyway, I'd like to ask you what caused the Ice Age?

Dr. CURRY. Well, the Ice— I mean, the big Ice Ages, the very big Ice Ages?

Mr. WEBSTER. Yes.

Dr. CURRY. Well, it has to do with—

Mr. WEBSTER. I know you weren't there but—

Dr. CURRY. —yeah. The prevailing theory, the so-called Milankovitch theory, that it has—it's related to the orbital vari-

ations, changes in the tilt of the Earth's axis, and then there's complex feedbacks with ocean circulations and the carbon cycle. So do we—are we at a point where we have complete predictive understanding of the Ice Ages? The answer is no, but that—you know, our current understanding relates to Earth-sun geometry, long-term deep circulations in the ocean and the Earth's carbon cycle. All these things are—

Mr. WEBSTER. So number one, all of those were natural causes.

Dr. CURRY. Yes.

Mr. WEBSTER. Number two, it just proves the point that there is a lot we don't know about what goes on in years whether it be 40 years or thousands of years or whatever.

So when I first ran for office, which is many years ago, long before this issue was an issue, there was another issue, and it was called the coming Ice Age. There was a big article in one of the magazines, I think it was Time magazine, when I was running for office. I read everything. I just wanted to know as much as I could in case some question came up, so I read and read and read. Well, anyway, this article was by the—this was the standard belief of most scientists at the time in the late 1970s, and it talked about the coming Ice Age. So you kind of wonder, we had some charts up there that started in late 1979. I don't know, maybe those before that were the other way, and so the only growth in the temperature was a re-energizing what the temperature used to be before it was cooling.

And so it just seems like there is such a short period of time. We're looking at this data. It's calculated within, you know, down to maybe four-tenths of a degree, and if we look back thousands of years, there might be a better pattern to see, and granted, we may not have that data but it seems like we're basing a lot of things on current data, not on necessarily what's happened in the world in general, and we're blaming it on one set of circumstances, which may or may not have been the case for other things that occurred and in some cases there weren't any humans.

Dr. CURRY. Well, if you look at the climate of the 20th century, you saw a pretty steep warming trend in the early part of the century up until about 1940, 1945, and this is at a time when there was very little human input of carbon dioxide, and then we saw a cooling trend from the mid-1940s to the mid-1970s, and this is what I guess triggered concerns about the Ice Age. And then there was a massive reorganization of ocean circulations in the Pacific in the mid-1970s, the so-called, you know, great climate shift, and then we saw increasing temperatures following that. And so trying to sort out what caused the early warming period and then the mid-century cooling period, I've argued that we end to understand this before we have highly confident attribution arguments about the warming since the mid-1970s. So there's a lot of natural variability, largely associated with the multidecadal and longer ocean oscillations that are not well represented in the climate models, and this is why I've argued for fundamental climate dynamics research to try to better understand this.

Mr. WEBSTER. So if the scientists of that day just not too long ago believed that there was a possibility of a coming Ice Age and then all of a sudden it changes, is that—

Dr. CURRY. Well, that—

Mr. WEBSTER. It seems like some of the data's being left out.

Dr. CURRY. Well, that was before we had, you know, climate, you know, climate modeling. Global climate modeling was in its infancy, you know, in the 1970s, so we really didn't have that as a tool to help us understand but, you know, we understand a lot more now than we did in the 1970s.

Mr. WEBSTER. But the point is—

Chairman SMITH. The gentleman's time—

Mr. WEBSTER. —if there was—

Chairman SMITH. The gentleman's time has expired.

Mr. WEBSTER. —if the scientists of that day with the amount of information that they had at that time believed this for a certainty and now today we believe something for a certainty, we don't know what kind of technology is going to be available 40 years from now.

Dr. CURRY. That's the unknown unknowns.

Mr. WEBSTER. So all I can say is, it seems to me like the more I hear, the more I believe that there—this is an embezzlement and flow, not necessarily a constant among even those if they are the majority of scientists, it's going back and forth, not necessarily stagnant.

Dr. CURRY. There's definitely oscillations.

Mr. WEBSTER. I yield back.

Chairman SMITH. Thank you, Mr. Webster.

The gentleman from Virginia, Mr. Beyer, is recognized.

Mr. BEYER. Yeah, thank you, Mr. Chairman, very much. I'd like to begin just by welcoming a constituent who is shadowing me today, Jairo Medrano, who is a history buff and attending George Washington Middle School in Alexandria. Jairo, thank you for being with us.

Thank you very much for being—testifying. I have this great sense of a food fight among scientists, and I guess each one of you in different ways has talked about what Dr. Curry called was gutter politics. And I apologize for that, and I was trying to think why can't we all just get along, and realized it's because the stakes are so high. You know, if the vast majority of scientists are correct about the human impact from global warming, you have 55 million people in Bangladesh that will be displaced, or many countries, including the Maldives, that disappear from the planet.

I was just in India with Congresswoman Esty, and they talked about how climate change there already is dramatically changing agricultural patterns and their ability to feed 1.3 billion people. Or the demonstrated increased from CDC and lung disease and in tropical diseases here in the United States. Or on a more trivial measure, not for them, the outdoor industries are in a panic about what it's doing to climbing and skiing and hunting and fishing, and many, many other things. So it's—there's a lot at stake, which is why this gets so high.

I'd like to ask that the—Dr. Christy's third slide be put up just a for moment, and just point out that the average of the 102 climate models is 1 degree centigrade increase over those 36 years, and the observations are half a degree. So not wildly different, it's half, but it's still—looks like a straight line up from 1976 to 2015. And then replace it with Exhibit A from Dr. Mann, which is exactly

half a degree from 1979 to 2015. Those two data sets are very, very clear.

And I ask Dr. Mann, so the 102 isn't one degree over that 36-year period of time, it's only half a degree centigrade or 1.8 Fahrenheit. And we also look—two other quick data sets. CO₂ parts per billion in 1979 was 330. They were around 403 in 2016. So we have a 30 or 73 parts per billion increase, and it's now increasing at three parts per billion per year and increasing, according to the EPA. What does Dr. Christy's line look like in 2030, 2040, 2050?

Dr. MANN. Yeah. Well as we see in that comparison, the various surface and lower atmosphere temperature data sets all agree pretty well on the warming over the past few decades, and so we can get into discussions about what's happening in the mid and upper troposphere, but at the surface, there's a pretty clear consistency among the records, and the records are consistent with the models. And that has been demonstrated in numerous publications, and the models allow us to project forward so we can feed the models with different possible scenarios for future fossil fuel burning. And it turns out that given sort of business as usual burning of fossil fuels, if we don't do anything to stem our ongoing burning of fossil fuels and the increased elevation of greenhouse gases in the atmosphere, we will probably cross 2 degrees Celsius warming. That's about 3-1/2 Fahrenheit warming of the planet relative to the pre-industrial time in a matter of a couple of decades. It's an important number because that amount of warming is what most scientists who've studied the impacts of climate change will tell you is when we truly get into dangerous and potentially irreversible changes in climate.

So we'll be there in a couple decades if we don't do something about the problem.

Mr. BEYER. I think that's my larger point too is that Dr. Christy argues that we didn't get close to the 102 average model, but it's still significantly upward direction. And if—back to my India trip, they say when they bring the other 300 million people get electricity, that will be a 40 percent increase in what we expect the greenhouse gases to be.

One more quick—and I only have a minute—but Dr. Mann, when you were at University of Virginia, the American Tradition Institute, used the FOIA stuff to try to get all of your emails. And Chris Horner and David Schnare were two ATI attorneys who sued UVA. David Schnare apparently was doing this on a pro bono basis while he was a full-time EPA employee and according to letters from the EPA, never did get permission. I'd like to submit those for the record, Mr. Chairman, the letters from the EPA.

Chairman SMITH. Without objection.

[The information appears in Appendix II]

Mr. BEYER. One final thought. Dr. Curry, you just said, and I quote, "I'm not out there on the fringes." Would you consider Dr. Christy and Dr. Pielke out there on the fringes?

Dr. CURRY. Absolutely not.

Mr. BEYER. Who is out there on the fringes, or is there a fringe?

Dr. CURRY. There are some fringes. People who are questioning the fundamental thermodynamics of the, you know, of the greenhouse effect and things like that. There are some fringe things. You

do see a few papers published in fringe journals. There are some people out there on the fringe that I would call out there on the fringes. Who knows, you know. Occasionally I read the papers just to try to keep an open mind. They always send them to me. But I would regard that as out there on the fringes. I don't regard myself, John Christy, or Roger Pielke as out there on the fringes. I think there's a lot of scientists who share our perspective and who agree with us and who are not part of the politically active publicly—you know, the Rankin file, the research geeks, who a lot of them out there agree with us. I hear from them all the time, especially from people working from—scientists working at government agencies who are afraid to speak out. I hear from a lot of them.

Chairman SMITH. Gentleman's time is expired.

Mr. BEYER. Chair, I yield back.

Chairman SMITH. Thank you, Mr. Beyer.

The gentleman from Illinois, Mr. LaHood, is recognized.

Mr. LAHOOD. Thank you, Mr. Chairman, and I want to thank the witnesses for your testimony here today. I appreciate it.

Dr. Pielke, I wanted to start with you, and I was glad to hear your history of serving on this committee as a staffer and for George Brown. He was a Democrat, correct, that served here?

Dr. PIELKE. That's right.

Mr. LAHOOD. I wanted to ask you, Dr. Pielke, have you ever felt attacked by a colleague because of your position on climate change science?

Dr. PIELKE. Yes. It just happened. I mean, I was just called fringe or suggested to be fringe, and I've come here representing the science that's in the IPCC report. It's almost a bizarre sort of reaction to be called fringe when you're representing mainstream science.

Mr. LAHOOD. And let me ask you, has Dr. Mann ever directed negative comments to you in your work?

Dr. PIELKE. Yeah, I don't—I'm not interested in the food fight with Dr. Mann. I hope everyone takes a look at the YouTube of this testimony and sees Dr. Mann speaking and listens carefully, but he's a respected scientist. He's the leader of the climate change movement in the United States, and I think everyone deserves to see his behavior at this hearing.

Mr. LAHOOD. And as I understand it in the past—and this is public record, Dr. Mann has referred to you as "a carnival barker" and also "a contrarian pundit." Are you familiar with that?

Dr. PIELKE. Yeah. I can't keep up with all of Dr. Mann's epithets.

Mr. LAHOOD. And Dr. Curry, to you, have you ever felt attacked by a colleague because of your position on climate change science?

Dr. CURRY. The only one who's really attacked me publicly and vociferously is Michael Mann, and you heard, you know, some of that today, including being called a denier in his Congressional testimony.

Most scientists are very respectful of my perspectives and want to engage me in debate.

Mr. LAHOOD. And Dr. Christy, same question for you in terms of being attacked by a colleague because of your position on climate change science?

Dr. CHRISTY. You know, I try to forget all that, and so I'd rather not comment anymore. It's just something that shouldn't happen. I'm sorry it does.

Mr. LAHOOD. Got you. Well thank you for that.

And I guess as I've listened to the testimony here today, and I guess, Dr. Mann, I would ask you, as I understand it, you are involved currently with a defamation lawsuit about comments that were made about you that is currently pending in the DC. circuit, is that correct?

Dr. MANN. I'm not going to speak about that here. It's not appropriate to do so.

Mr. LAHOOD. And I guess what I would question—I've read that defamation suit and I'm familiar with it, and I'm really perplexed in trying to figure out the rationale and the reasoning for engaging in those types of statements that relate to direct threats and bullying. And you mentioned in your opening statement about staying away from that. And yet, we have a suit that's been filed based on those exact same things. And if the real goal is to get away from harassing and silencing critics, that does not seem to be the type of language you'd want to engage in, and there's a real disconnect between a defamation suit that does the exact same thing, but you're engaged in that in this public forum. Do you want to comment on that?

Dr. MANN. So I'm not going to talk about the suit, but I do want to clarify that there are a number of statements that have been attributed to me that are not correct. I don't believe I called anybody here a denier, and yet that's been stated over and over again. So I've been misrepresented quite a bit today by several people—

Dr. CURRY. It's in your written testimony. Go read it again.

Dr. MANN. There—when I talked in the written statement, I described scientists who either deny the science or who reject its impacts, something to that effect. I did not call you a climate change denier, and so that's just a misstatement. It's been repeated here.

But let me state that there's a difference between disagreeing with people, which is not only appropriate but critical in science, to have honest and frank discussions of uncertainty to disagree, to call out those statements that you don't believe to be supportable. That is completely appropriate. That's very different, for example, from an accusation of misconduct or fraud. Those are two completely different things, and it's unfortunate that in your question you are conflating those two groups of things.

Mr. LAHOOD. Well, that's your opinion, Dr. Mann, but are you denying that as it relates to Dr. Pielke's work on climate change science that you didn't call him a carnival barker or a contrarian pundit?

Dr. MANN. You would have to provide me the context. I don't remember everything I've ever said or done. But what I can tell you is that Dr. Pielke has made the following statement. This is a quote.

Mr. LAHOOD. Well let me—

Dr. MANN. In the Wall Street Journal, he said "There is scamp evidence to indicate that hurricanes, floods, tornadoes, or drought have become more frequent or intense in the U.S. or globally." That is simply not true. The best available science is now attributing in-

dividual droughts and floods at a fairly high level of confidence to climate change. So do I challenge him publicly when he says things like that? Of course I do. Is that appropriate? Of course it is.

Mr. LAHOOD. So are—again, are you denying—let me ask you this. Is it fair to say you could have said that and you don't remember that here today?

Dr. MANN. I don't remember everything that I've ever said, and you would have to provide me the context. I'm not sure that your characterization is correct. You would have to show me the context. You haven't done that.

Mr. LAHOOD. I would be happy to show you that.

I guess my point is you seem overly sensitive to criticism as it relates to the defamation suit that engages in the same activity that you're engaged here today with these three witnesses, and I think there's some hypocrisy in that.

Thank you.

Chairman SMITH. Thank you, Mr. LaHood, and without objection, I now put into the record, if it's not already a part of the record, page 6 of Dr. Mann's written testimony today where, Dr. Curry, he says "Climate science denier Judith Curry."

[The information appears in Appendix II]

Chairman SMITH. I assume that is you he is wrongfully referring to.

Dr. MANN. Climate science. It wasn't climate change. That's different, but—

Chairman SMITH. Climate science denier.

Dr. CURRY. Climate science denier Judith Curry.

Chairman SMITH. I think that—

Dr. MANN. And I've described the science that she's denying.

Chairman SMITH. That clearly contradicts what Dr. Mann so well—

Dr. MANN. I've described the science that she's denying.

Chairman SMITH. The gentleman from Illinois, Mr. Foster, is recognized.

Mr. FOSTER. Well thank you. As a Ph.D. physicist, I would just—very interested in how this is sort of—a very strange mixture of science and not.

And so maybe I'd like to try to understand what the range of agreement is here. Is there anyone on the panel here that believes, for example, on the policy side that the cutbacks in climate science, space-based measurements of things like temperature ice sheet thickness and so on at NOAA, NASA, EPA and the other places of the magnitude contemplated in the skinny budget of the Trump Administration are, in fact, a good idea? Is there anyone who believes that those cutbacks are a good idea?

Dr. CHRISTY. Well, you know, as a scientist, we live on observations and data, and that's how we learn and discover things that will help us. So I'm all for—

Mr. FOSTER. So there—

Dr. CHRISTY. —the observing systems being made—

Mr. FOSTER. Well-funded and so there is a consensus actually that that's not a good idea.

Let's see. Under the physics point of view, if we go to the other end, Dr. Curry, you indicate that your criteria for what represented

fringe were just rejection of fundamental thermodynamics and so on. Does everyone on this panel agree, for example, that you know, the temperature of the Earth is set in general terms by radiative balance, and that the infrared absorption spectra of carbon dioxide is a very relevant driving term, and that the uncertainty really is in the other positive and negative feedback terms that may or may not be present, changes in the convection, things—many of which simply redistribute where the excess heat goes when you put carbon dioxide in the atmosphere. The other ones, you know, potentially increase or decrease the albedo of the Earth, things like that, where there is—you know, you can imagine mechanisms that either make things better or worse. For example, you know, if we melt the methane release that could come from Siberia, if we melt all of the swamps in Siberia, basically. There are very possibly a very strong positive as well as negative feedback loops. Is that sort of the range of disagreement that we're seeing here? Anyone feel themselves outside of that?

And so that—and is there anyone that feels that that range of uncertainty makes it likely that this is never going to be a problem if we continue business as usual? So you all think—would agree that it's more likely than not that this will be a big problem?

Dr. CURRY. I would say that we don't know.

Mr. FOSTER. No, do you think it is more likely than not that this would be a big problem?

Dr. CURRY. I would say as likely as not.

Mr. FOSTER. All right. Dr. Mann, do you—

Dr. MANN. I just want to say that's what I'm talking about. I didn't call Judith Curry a climate change denier here today. There is a statement in the written statement that she's a science—climate science denier, and this is precisely what I'm talking about. She has argued that we might be responsible for less than 50 percent of the warming that we have seen. The IPCC has assessed that. They've actually estimated the likelihood that that could be true. It is one in 10,000. One in 10,000 is the likelihood of something that she claims to be true. That is a rejection of basic accepted science.

Mr. FOSTER. Based on climate—

Dr. MANN. That is a rejection of science.

Dr. CURRY. Based on climate models—

Dr. MANN. That's a rejection of science.

Dr. CURRY. —I have argued that the climate models are not fit for that purpose.

Dr. MANN. It's a rejection of accepted science.

Dr. CURRY. No, it's a rejection of a manufactured consensus. That's what I rejected.

Dr. MANN. Well just one last statement.

Mr. FOSTER. If we could separate from temperatures. The question of ocean acidification, is there an agreement that as you raise CO₂ levels in the atmosphere that this will lead to ocean acidification, or is that also sort of thought of as a fringe point of view? So that one, there is agreement on, because that has very severe environmental consequences, obviously, that are not—it's interesting that they're not really under debate.

Dr. CURRY. The environmental consequences—our understanding of the ecological impacts of ocean acidification is in its infancy, and how this relates to ecosystems. I mean, we don't know very much about how slow rates, highly variable ocean acidification impacts ecosystems. It's something under investigation.

Mr. FOSTER. It could be either better or worse than our current best estimate?

Dr. CURRY. Yes.

Mr. FOSTER. Okay. The other sort of general question is what is the proper response to fringe? How do you set what is defined as a fringe opinion? You know, in physics conferences, there's always a poster session where you have people that say Einstein was wrong, you know, and they are very sweet people with a variety of science credentials. And it's always a delicate thing trying to understand. You know, I've often gone and had conversation with people, listen to their very interesting theories, and yet they're not given plenary talks at this thing. And so how do you—what is the right way to handle that? How many standard deviations do you have to be out of the mainstream before it is acceptable to do that? Yeah, Dr. Curry, how would you—

Dr. CURRY. Well, the point is is you ignore these things if you don't find them interesting or convincing. Okay, you ignore it. And most of these things don't have any particular consequence to our engineering, our technologies, or to the most consequential, you know, science issues of the day. So you just ignore it. There's no reason to squash it, okay? You just—if somebody catches somebody's attention and you look at it and you consider it, maybe it tweaked something in your brain about oh, you know, there is some sort of line suggested by this that maybe we should explore, or you ignore it. There's no reason to squash it or even particularly define it.

Chairman SMITH. The gentleman's time—

Dr. CURRY. Just don't pay attention to it.

Chairman SMITH. The gentleman's time has expired. Thank you, Mr. Foster.

The gentleman from Georgia, Mr. Loudermilk, is recognized.

Mr. LOUDERMILK. Thank you, Mr. Chairman, and thank all the witnesses for being here. This is—there for a while, I thought you guys were in the Republican conference debating Obamacare repeal.

Dr. Curry, being from Georgia, I appreciate you being here again. If I recall last year when you were here, in part of your testimony you—let me just ask you the question this way. Do you believe that the climate is changing?

Dr. CURRY. Absolutely. Climate is always changing.

Mr. LOUDERMILK. Do you believe that human activity could be a cause?

Dr. CURRY. Oh, it is a cause. It does contribute.

Mr. LOUDERMILK. Okay. So you actually do believe that it does—

Dr. CURRY. Oh yeah, sure. The question is whether it's the dominant cause.

Mr. LOUDERMILK. Right.

Dr. CURRY. Okay, and even the IPCC says more than half, okay? And that's from 51 percent to 99 percent. That's a big—

Mr. LOUDERMILK. So you don't deny that human activity is—

Dr. CURRY. No, absolutely not.

Mr. LOUDERMILK. Okay.

Dr. CURRY. I just don't know how much is human versus how much is natural, and I think there's a great deal of uncertainty, and it's very difficult to entangle it.

Mr. LOUDERMILK. Is that uncertainty possibly because we don't really fully understand what causes this climate machine?

Dr. CURRY. Absolutely. Our understanding of climate dynamics on decades to century to millennial time scale is far from complete.

Mr. LOUDERMILK. Okay. Dr. Christy, same question. Do you believe that there's change in the climate?

Dr. CHRISTY. Yes.

Mr. LOUDERMILK. Okay, that—do you believe that it's possible that human activity could contribute to it?

Dr. CHRISTY. I actually have a couple papers showing how humans have affected the temperature, mainly through the surface thermometers, urbanization—

Mr. LOUDERMILK. It doesn't sound like either one of you are deniers of—

Dr. CHRISTY. And that carbon dioxide is a greenhouse gas. It can't not absorb infrared energy.

Mr. LOUDERMILK. Okay. Dr. Mann, obviously you think, you know, climate is changing. Do you think that it's possible that human activity is not the dominant factor?

Dr. MANN. So I already spoke to that. Judith Curry is on record, and we just heard it—

Mr. LOUDERMILK. No, I'm asking you. What do you think?

Dr. MANN. Well saying less than 50 percent. It might be less than 50 percent. The IPCC actually has a very nice—

Mr. LOUDERMILK. I'm asking what do you think?

Dr. MANN. I believe what the IPCC has said about this, that the—less than—the proposition that we are responsible for less than 50 percent of the warming can be dismissed as a 1 in 10,000 proposition—

Mr. LOUDERMILK. Okay. Well what do you think, or are you just—

Dr. MANN. I accept the consensus.

Mr. LOUDERMILK. I don't want you to parrot what IPCC says.

Dr. MANN. I accept the world's scientists opinion. I accept the consensus.

Mr. LOUDERMILK. So in your opinion, there could not be no chance that human activity does not—is not the major contributor?

Dr. MANN. Well it's a double negative, but there is a possibility we'll wake up tomorrow and gravity no longer exists. Those are possibilities, but extremely unlikely.

Mr. LOUDERMILK. Okay. It doesn't sound like anybody or any amount of data could convince you otherwise at this point.

Dr. MANN. I go with the physics.

Mr. LOUDERMILK. Okay, so—

Dr. MANN. You can go with opinions if you want. I go with physics.

Mr. LOUDERMILK. We could say you're a denier of natural change.

Dr. MANN. No, I actually—my career in large part was built on my studies of natural variability. The Atlantic multi-decadal oscillation that Judith Curry loves to talk about, that was coined by me. My early studies—

Mr. LOUDERMILK. Let me ask you this question.

Dr. MANN. —established the importance of internal oscillations in the climate.

Mr. LOUDERMILK. I'm not trying to be—

Dr. MANN. I just want to inform—

Mr. LOUDERMILK. —confrontative—

Dr. MANN. No, I just want to make sure you know that.

Mr. LOUDERMILK. Okay. Do you believe that we truly understand what creates the weather? What is—do we understand the climate machine?

Dr. MANN. So the weather is caused by what we call baroclinic instability. I'd be happy to talk to you for hours offline about—

Mr. LOUDERMILK. But I mean, do you disagree with Dr. Curry that—you sound like we have grasps on science that we know what creates this weather patterns and we know what creates—

Dr. MANN. I'm not sure how to—

Mr. LOUDERMILK. —the weather machine?

Dr. MANN. —parse that question. We understand at a great level of detail the workings of the atmosphere, the workings of the ocean and the ice sheets and the way they interact. Thousands of scientists have been studying these things for decades. We understand—

Mr. LOUDERMILK. Let me ask you this.

Dr. MANN. —the science of climate as well as the science of just about any other field.

Mr. LOUDERMILK. I don't want to filibuster. I'm running out of time here.

So why do we ban—

Dr. CHRISTY. I would just like to add that when we understand other fields of science, we can predict the behavior.

Mr. LOUDERMILK. Right.

Dr. CHRISTY. I have demonstrated we cannot predict—

Mr. LOUDERMILK. Okay. The National Academy of Science agrees with you, at least they did in the 1970s, when they said we do not have a good quantitative understanding of our climate machine and what determines its course. Without the fundamental understanding, it does not seem possible to predict the climate.

Why did we have a ban on sulfuric dioxide in the 1970s, Dr. Mann?

Dr. MANN. Yeah, so you're right that, you know, more than 40 years ago we didn't have nearly the understanding we have today. In 1975, the National Academy of Science actually said they didn't know what was going to win out. They didn't say that global warming isn't caused by increase in greenhouse gases. What they were saying in that report was that we don't know what's going to win out, the warming effect of increasing greenhouse gases, or the cooling effect of these particulates that we are producing.

Mr. LOUDERMILK. So there were differences among the scientific community because as was mentioned earlier, there was a cooling trend?

Dr. MANN. Yeah, we understand very well where that came from. The state—

Mr. LOUDERMILK. The policy result was the reaction of lawmakers and banning sulfuric dioxide in response to the cooling trend that a group of scientists said was definitely causing the cooling of the Earth. And I just refer back to Dr. Curry.

Dr. MANN. Can I answer?

Mr. LOUDERMILK. Dr. Curry, does this show evidence of—that we really don't have a full grasp of what causes the climate change?

Dr. CURRY. There are—

Mr. LOUDERMILK. And I think what your thing is, we may overreact in public policy that could actually have a diminishing factor in—

Chairman SMITH. The gentleman's time has expired. Do you want to answer very quickly, Dr. Curry?

Dr. CURRY. That's okay.

Chairman SMITH. Okay. I'm sorry. The gentleman from Florida, Mr. Webster, has a unanimous consent request.

Mr. WEBSTER. Yes, Mr. Chair. I have a report here entitled "What Triggers Ice Ages" and I would like to have that entered into the record.

Chairman SMITH. Without objection.

[The information appears in Appendix II]

Chairman SMITH. And the gentlewoman from Texas has a unanimous consent request, and she is recognized for that purpose.

Ms. JOHNSON. Thank you, Mr. Chairman. I'd like to enter into the record an article published in Scientific American that debunks the claim that there was a pause in global warming, and I'd also like to enter into the record a blog post by the Union of Concerned Scientists that breaks down Dr. Lindzen's letter to President Trump.

Chairman SMITH. Okay, without objection.

[The information appears in Appendix II]

Chairman SMITH. And the gentlewoman from Connecticut, Ms. Esty, is recognized for her questions.

Ms. ESTY. Thank you, Mr. Chairman.

I'd like to return again to the question a little bit about—the topic here is on scientific process. Do we have agreement that scientific process is about proposing hypotheses, testing them, revising, and continuing to do that in the ultimate goal of trying to arrive at some sort of truth? That that's the objective, never attained in its entirety, but that's the objective? If that—if there's agreement? I'm getting nods that that is, in layperson's terms, the understanding of scientific process.

What do people think we should be funding research to do in the area of climate, recognizing that there are bands within which humans will not survive on the Earth if it goes outside those bands? Does anybody think that cutting climate funding for research should happen now, given the robust disagreement on this panel? Because there are proposals on the table that—right now to cut planetary science funding, to stop NOAA from looking at it, to stop

NASA from looking at this, because of a disagreement about how to interpret and prioritize those results. Do I—Dr. Curry, do you believe we should be funding more science or less scientific research in this field?

Dr. CURRY. Different science.

Ms. ESTY. Okay, but the—let's be clear that proposals in the so-called skinny budget from the President would be for cutting that research?

Dr. CURRY. Yeah. It's a matter of priority. Spending more money on climate model taxonomy isn't going to get us anywhere. Spending more money on observing systems will.

Ms. ESTY. Which would be NASA, for example.

Dr. CURRY. Yeah, and spending more money on fundamental understanding, theory regarding climate dynamics on a range of time scales, that would pay dividends.

Ms. ESTY. And those are some—precisely the ones that are being cut in the proposals on the table right now, so I'm glad to see there's agreement, that I think you agree with those of us on this panel that would like to see that funding continue to try to determine this.

Our job will be to take the science and to try to make public policy decisions. Clearly, there is not total certainty here. However, if the risk is sufficiently great, we take steps even without certainty. I'm part of a resiliency caucus that is looking at things we can do to design safer buildings so we survive storms better, whether they're tornadoes or hurricanes. We take steps—most of us carry insurance on our homes, even though we've probably never lived in a home that's burned to the ground.

So in addition to whatever you discover and whatever the disputes may be about science, there's significant research showing that humans have some impact, right, and we're not talking trivial either. I don't think anyone at this table has talked trivial impact. So I believe we should be continuing to fund research, but make no mistake, even if it's—whether it's 20 percent, 30 percent, 50 percent, the consequences to human beings now and in the future are significant.

I want to note that I was at a conference 15 years ago, RAND Corporation conference, talking about how the next wars would be over water. This is a national security issue. So even if, for example, overall water patterns, the amount of rainfall is the same, where it flows, when it flows, how fast it comes down has major implications for crops, major implications for the stability of other countries. So I think these are the kinds of issues that we should be funding, because it's not simply a question of who gets the research dollars. The consequences for this country are very grave for our citizens.

So I would ask you as much as possible to join us in funding robust research and then let those of us in elected positions make decisions in that band of uncertainty. Because I can tell you right now that constituents in my district in Connecticut are deeply concerned at what they see as an over-politicization of science right now, and I'm afraid I saw that in this room today, which I deeply regret and I hope we can get agreement to fund robust, open-source research that allows decision making by this body in light of that

uncertainty. So I will side, however, with Dr. Mann that at some point, we have to go with consensus for the time being as we continue research. And I would say that is the prudent course is to go with consensus, while continuing research. That doesn't mean stopping research. That means continuing research, and yet we cannot wait for final ultimate truth to make decisions.

And with that, I yield back my 12 seconds.

Chairman SMITH. Thank you, Ms. Esty.

Thank you all for your testimony today. This has obviously been enlightening, sometimes a little contentious, but nevertheless, informative to all of us who are up here. I appreciate your attendance and we stand adjourned.

[Whereupon, at 12:29 p.m., the Committee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Michael Mann

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
“Climate Science: Assumptions, Policy Implications, and the Scientific Method”

Dr. Michael Mann, Distinguished Professor of Atmospheric Science and Director, Earth System Science Center (ESSC), The Pennsylvania State University

Questions submitted by Ranking Member Eddie Bernice Johnson

- 1) Several of the witnesses made statements which seem to contravene known facts. For example, Dr. Curry stated, “Current global climate models are not fit for the purpose of attributing the causes of recent warming or for predicting global or regional climate change on timescales of decades to centuries, with any high level of confidence.”
- How would you respond to this comment?
 - Please provide additional comments on other statements made by any of the witnesses that may have been incorrect or misleading.

Thank you for this question and for your other thoughtful questions

Congresswoman Johnson.

As with much of Judith Curry’s public statements about climate change, there is an ever-so-small grain of truth to what she says. Challenges still do remain in predicting the precise details of climate change at small scales owing to the role of local atmospheric and oceanic variability at small spatial scales. Indeed, I co-authored an article (Exhibit A) on this matter in the peer-reviewed literature just

last year [Zhang, F., Li, W. Mann, M.E., Limits to Regional-scale Climate Predictability over North America, *Advances in Atmospheric Sciences*, 33, 905-918, 2016].

However, her extreme claim that we can neither attribute nor predict *global* climate change using climate models is simply absurd. The assertion confirms, once again, the point that I made in my original written comments that Dr. Curry is in denial of basic accepted climate science.

It is in fact the consensus of the world's scientists, as expressed in major assessment reports such as those of the Intergovernmental Panel on Climate Change (IPCC) and the U.S. National Academy of Sciences that the large-scale warming over the past century is predominantly if not entirely due to human causes.

Using climate models in combination with climate observations, scientists have established with great confidence that the observed warming is not natural. In fact, natural factors like solar output and volcanic eruptions were pushing us slightly in the opposite direction (cooling) over the past half-century. In other words, the accelerated warming over that time frame occurred *in spite of* natural factors that were temporarily offsetting that warming.

That is why the IPCC has concluded that the most likely human contribution to warming is actually 110%. Please see (Exhibit B) the commentary by Gavin Schmidt, Director of the NASA Goddard Institute for Space Studies ("IPCC attribution statements redux: A response to Judith Curry", RealClimate.org, Aug 27, 2014) in which Schmidt points out that fact, and notes that Curry's claim that less than half of

the warming might be due to human activity has an estimated probability of 1 in 10,000 of being correct. With regard to the misleading claims made by Dr. Curry about the issue of scientific “uncertainty” and its implications, please also see my response to question #4 below.

I have also attached (Exhibit C) a recent commentary by Dr. Schmidt (“Judy Curry’s attribution non-argument”, RealClimate.org, Apr 18, 2017) wherein he refutes essentially all of the main claims by Dr. Curry made at the recent congressional hearing.

Quoting Dr. Schmidt:

Following on from the ‘interesting’ House Science Committee hearing two weeks ago, there was an excellent rebuttal curated by ClimateFeedback of the unsupported and often-times misleading claims from the majority witnesses. In response, Judy Curry has (yet again) declared herself unconvinced by the evidence for a dominant role for human forcing of recent climate changes. And as before she fails to give any quantitative argument to support her contention that human drivers are not the dominant cause of recent trends.

Her reasoning consists of a small number of plausible sounding, but ultimately unconvincing issues that are nonetheless worth diving into. She summarizes her claims in the following comment:

“They use models that are tuned to the period of interest, which should disqualify them from be used in attribution study for the same period (circular reasoning, and all that). The attribution studies fail to account for the large multi-decadal (and longer)

oscillations in the ocean, which have been estimated to account for 20% to 40% to 50% to 100% of the recent warming. The models fail to account for solar indirect effects that have been hypothesized to be important. And finally, the CMIP5 climate models used values of aerosol forcing that are now thought to be far too large.”

These claims are either wrong or simply don't have the implications she claims...

I've pointed out some misleading claims by Dr. Pielke in my response to question #7 below.

Finally, let me also clarify some of my own comments from the hearing and in the process respond to some false and specious accusations that were leveled against me at the hearing by representatives or witnesses for the majority. I pointed out at the hearing that I had not called any of the witnesses a “denier” at the hearing. In my *written testimony*, I referred to Judith Curry as a “*climate science* denier” (not a “climate change denier” or a plain “denier”). That is a very specific choice of wording—and it is absolutely correct in this case. As I explained both at the hearing, and have elaborated on here, Judith Curry is in denial of basic accepted climate science. Despite the crocodile tears by those who don't like that label, it is part of the accepted scientific lexicon to refer to those who reject mainstream climate science as climate science (or climate change) deniers. In fact, there are peer-reviewed articles in our most respected journals that use precisely that terminology [e.g. “Promoting pro-environmental action in climate change deniers” by P.G. Bain et al, *Nature Climate Change*, 2, 600-603 (2012)—Exhibit D].

Let me also respond to another matter, the effort by congressman Higgins to seek to impeach my integrity by linking me to various groups that he and his colleagues malign and mischaracterize as having some nefarious agendas (groups that, I might add, are doing excellent work). First, he asked me if I was “affiliated or associated with” the Union of Concern Scientists (UCS). When I tried to get him to clarify what he meant, he insisted on interrupting me so that it was never possible for me to clarify what he actually meant by “affiliated or associated with”. I began to explain that I know people at UCS and correspond with them, but he interrupted me before I could complete my statement. The fact is that I am neither “affiliated” nor “associated” with them in any formal capacity, but I do happily contribute to UCS and support the wonderful work they are doing.

The congressman then went on to use the same ambiguous language (“affiliated”) in querying me about my relationship with yet another organization (the “Climate Accountability Institute”). Frustrated by his refusal to clarify what he meant by this term, I simply pointed out that I had already submitted my CV to the Committee and that this document lists any formal relationships I have with various organizations. I serve on more than a dozen advisory boards and have not committed to memory the precise names of all of them. I receive absolutely no compensation whatsoever for belonging to these advisory boards, and in most cases the relationship is strictly *pro forma*. As my CV indicates, the “Climate Accountability Institute” is indeed one of them.

But there is a larger issue here. I absolutely support the efforts by both of these groups to hold major corporate funders of climate change denialism responsible for their actions, which includes mechanisms (e.g. RICO) that have been used in the past in similar cases (e.g. the tobacco industry's conspiracy to hide from public view the adverse health impacts of its products). The congressman falsely characterized these efforts as "efforts to prosecute climate skeptics", to which I replied "the way you phrased it, I would find it extremely surprising if what you said was true". I should have gone further. What the congressman asserted—that these groups are trying to prosecute *climate skeptics*" [i.e. by implication, individuals who are "skeptical" about climate change] is FALSE. It is in fact a scurrilous and reckless accusation. The entire line of questioning by the Congressman, which some observers have summarized as "Are you now or have you ever been a member of the Union of Concerned Scientists?" frankly smacked of modern-day McCarthyism.

- 2) How does the scientific process account for "minority" views or "fringe" views? Is there a distinction between the two, and are they treated differently?

Answer: The scientific community, ever since its origins in early modern times, has understood that important scientific ideas always originate with a single person or small group. The originators may even be looked at askance as a "fringe" ----- let's call it the new-idea fringe. If the idea withstands criticism and gathers powerful arguments and evidence, its adherents progress to a minority and eventually a majority. Eventually, if the evidence and arguments for the new view become overwhelming, the dwindling number who disagree come to be disregarded as a "fringe" --- let's call it the obsolete-view fringe.

Recognizing this process, the scientific community has always given a sympathetic hearing to new ideas, even “fringe” ones. It waits to see how lines of reasoning and predictions hold up under criticism and new research. Eventually the community may become unsympathetic to minorities who cling to ideas that have not survived these tests.

Global warming caused by greenhouse gas emissions is a good example. It was first proposed in 1896 by one man. For half a century most scientists thought such warming was unlikely, but textbooks continued to mention the idea as something worth further study. For the next half century, as new techniques were brought to bear, global warming was the subject of intensive research and debate. Gradually the evidence for the idea became overwhelming, convincing nearly all who studied it closely. The few who continued to insist that human activities are not strongly influencing the climate have now been relegated to the obsolete-view fringe.

- 3) As a climate scientist and previous contributor and author of chapters within Intergovernmental Panel on Climate Change (IPCC) Assessment Reports, can you comment on concerns that the other witnesses raised during the hearing, suggesting that there is a widespread belief within the climate science community that the IPCC is not a legitimate scientific intergovernmental body. Do you believe that to be an accurate assessment?

Thanks for the question Congresswoman. The claim is pure nonsense. The IPCC is arguably the most authoritative and rigorous scientific body that exists for evaluating the state-of-the-art in our understanding of climate science and the issue of human-caused climate change. The IPCC—as every authoritative scientific body that has weighed in on the matter of human-caused climate change—has been attacked by the fossil fuel industry-driven denial machine because of the inconvenient nature of its findings.

Let me quote from Chapter 6 (“A Candle In The Dark”) of my book *The Hockey Stick and the Climate Wars* (Columbia University Press, 2012):

At the international level, in the world of climate science there are no assessments as important as those of the Intergovernmental Panel on Climate Change (the IPCC), which in 2007 was awarded the Nobel Peace Prize “for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the

foundations for the measures that are needed to counteract such change". The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), and tasked with assessing the evolving state of scientific understanding of climate change. Beginning in 1990, the IPCC has every 5 to 7 years published a weighty three-volume set of reports addressing a) the basic science of climate change ("working group 1"), b) the projected impacts ("working group 2"), and c) the potential for mitigation of climate change ("working group 3").

The report of each of the three working groups consists of detailed individual chapters assessing developments in the various relevant sub-disciplines of climate science. Each IPCC report chapter is 50 to 100 pages long, written by about a dozen scientific experts in that sub-discipline who serve as "lead authors" (I was one in the 2001 Third Assessment). Along with fifty or more additional "contributing authors" to each chapter, they collectively review the developments detailed in hundreds of peer-reviewed research articles relevant to the topic at hand. Each of the three working groups also produces a "summary for policy makers," which provides a brief summary of the working group's key findings written in language accessible to a lay audience, and to policy makers.

The IPCC review process remains the most rigorous, comprehensive, and transparent of any major scientific document. IPCC reports are subject to three distinct rounds of peer review, each of which takes place over a period of roughly two months. First, there is an initial round of "expert review" wherein several thousand scientists of

all disciplines, drawn from academic, government, non-governmental organizations, and industry, with a wide range of backgrounds and perspectives are called upon to provide detailed comments on the content of the report. Lead authors are required to consider and respond to all comments and make appropriate revisions, all of which are documented and available online. The revision process is overseen by two independent review editors with expertise in the specific subject areas of the chapter, to insure that any legitimate issues reviewers raise are dealt with in a satisfactory manner.

The revised draft report is then subject to the next round of review, the so-called "government review," which includes re-review by the original expert reviewers, and additional review by government representatives from all participating U.N. nations. Each government may choose how it implements its review. The U.S. government, for example, solicits public comments through a notice in the Federal Register, in essence allowing anyone at all to serve as a "reviewer" of the IPCC report. The revision process is once again repeated. Finally, national governments are once again invited to comment on the report.

The final wording of the all-important summary for policy-makers report for each of the three working groups is agreed upon word-by-word in a final plenary meeting in which government delegations are present and can propose variant terms or make objections to specific wording, but the scientists are in charge. The final version reflects a consensus on the precise wording of the report between the scientists involved in the writing of the report and the representatives of the government

delegations. It is difficult to imagine a more open, inclusive, and responsible assessment process than that the IPCC follows.

Given the nature of the IPCC assessment process, it should come as little surprise that their reports remain the gold standard for evaluating the state of scientific understanding of climate change. The IPCC assessments are intended to inform but, importantly, not prescribe policies for avoiding so-called “dangerous anthropogenic interference” with the climate system. The actual policy prescriptions, as they should be, are left for policymakers and their constituents to decide

These assessments are in every respect consensus documents. They emphasize conclusions that are based on results that have been replicated by independent studies, using differing approaches and assumptions. They highlight where there is true uncertainty. They put greatest weight on findings that are widely accepted by the scientific community, and downplay the more tentative findings of individual articles departing from conventional wisdom that, as we have seen, frequently—but not always—do not hold up when subject to further scrutiny by subsequent independent efforts.

Given the importance placed on IPCC reports, there should be little surprise that a prime tactic of climate change denialists has been to attempt to discredit the IPCC itself and the IPCC process. We saw such attacks in the assaults in 1995 on Ben Santer and the Second Assessment Report, and they have escalated in more recent times.

Some of the attacks against the IPCC appeal to the belief that the organization is somehow beholden to an activist U.N. agenda aimed at establishing a “new world order”. This is a curious notion. In 2001 the NAS reviewed the findings of the IPCC at the request of Republican president George W. Bush. They concluded that “changes observed over the last several decades are likely mostly due to human activities”—almost word-for-word what the IPCC had concluded. The NAS conclusions were in turn endorsed by the national academies of science of all of the major industrialized countries. In order to believe that climate change science is part of some “new world order” plot, one would therefore need to imagine a rather implausible conspiracy among the world’s leading capitalist nations to undermine their own power and authority through the creation of a world government. Ironically, while the Bush Administration was casting doubt on the science of global warming, the Pentagon was already getting busy planning for it, with their primary concerns not about international regulation, but about the national security threats posed by a changing climate.

Despite the multiple layers of review, errors sometime occur, not surprising given the huge size of the multi-volume reports. Detractors of the IPCC, for example, seized upon two minor errors in the impacts (“Working Group 2”) part of the report in an attempt to undermine confidence in the 2007 IPCC 4th assessment, as will be discussed in a later chapter. One instance involved the year projected for the disappearance of Himalayan glaciers which, thorough a transposition error, turned 2350 into 2035. In the other error, the report mistakenly cited the area of the

Netherlands currently lying below sea level as 55% rather than the true value of 26%. Neither of these two minor errors in the several thousand page-long report made it into the technical summary report or the summary for policy makers.

Ironically, a more defensible criticism was that the IPCC underestimated prospects for future sea level rise. The report estimated the maximum sea level rise by the end of this century at less than a foot and a half. However, that estimate—as the IPCC itself readily acknowledged—did not include the effects of melting ice sheets, which are already known to be contributing to sea level rise. More recent, alternative estimates that attempt to account for such contributions, estimate the maximum at about four feet of sea level rise. So there was reason to be skeptical of the IPCC sea level rise estimates, but for a reason opposite to what climate change deniers argue.

- 4) In her written testimony, Dr. Curry asserted that the consensus conclusion on anthropogenic climate change is manufactured and that the idea that humans have had an outsized impact on rising global temperatures due to the burning of fossil fuels is overblown. She recommends that additional discussion and debate must be undertaken on this topic before the hypothesis of anthropogenic climate change can be considered a widely accepted theory.
- Does the consensus conclusion that anthropogenic climate change is occurring and has been largely impacted by the burning of fossil fuels need additional discussion and debate? At what point does a theory become widely accepted?
 - Please comment on Dr. Curry's claim that mainstream climate scientists intentionally understate uncertainty.

I thank the Congresswoman once again for the pertinent questions. It is precisely these sorts of assertions by Dr. Curry that led me to characterize her, accurately, as a "climate science denier" in my written testimony. She, quite simply, is denying the overwhelming consensus of the world's scientists. This is clear, as I noted in question #1 above, with

regard to her dismissive comments about the extent to which human activity is response for observed warming. This is also very much true with respect to her distorted views and claims about scientific “uncertainty”, e.g. her

absurd climate that scientists “intentionally understate uncertainty”. The accusation is both offensive and completely false.

The reality is the opposite of what Curry claims. The recognition of scientific uncertainty is what guides scientific research. It is filling in the blanks, resolving apparent inconsistencies, investigating apparent paradoxes, and solving difficult problems, which drives modern climate research. Note for example that our original 1999 “Hockey Stick” article [Mann, M.E. *et al*, Northern Hemisphere Temperatures During the Past Millennium: Inferences, Uncertainties, and Limitations, *Geophysical Research Letters*, 26, 759-762, 1999] that is so much maligned by climate change contrarians, contained the words “uncertainties” and “limitations” in the very title. Rather than understating uncertainty, mainstream climate scientists embrace uncertainty—it is where the forefront of knowledge lies.

Curry’s framing of uncertainty, however, is flawed at an even deeper level, as it is premised on several false assumptions. Firstly, she invokes the common fallacy of climate change contrarians that because we don’t know everything, we know nothing. It’s like warning the flight attendant that the plane can’t possibly fly because you noticed that the armrest is loose. There are always uncertainties, but that doesn’t mean there aren’t things we know with great confidence. In this case, we know with great confidence that Earth is warming, that human activity is the overwhelming driver, that the impacts are already negative, and that they will become far worse if we do not act.

The second fallacy adopted by Curry is that the existence of uncertainty necessarily somehow implies that the magnitudes and impacts of climate change won't be as great as scientists currently estimate. That premise is nonsensical. Uncertainty cuts both ways, and in many ways—as I mentioned in my testimony—it is cutting against us (e.g. when it comes to the loss of Arctic Sea Ice and collapse of the major continental ice sheets, both of which are occurring *faster* than climate models originally predicted).

Leading economists like Marty Weitzman of Harvard have shown that uncertainty is most likely a *reason for even more concerted* action to mitigate climate change because of the huge potential costs if the impacts turn out to be even greater than predicted. I am co-author of a brand new peer-reviewed article [Lewandowsky, S., Freeman, M.C., Mann, M.E., Harnessing the uncertainty monster: Putting quantitative constraints on the intergenerational social discount rate, *Global and Planetary Change* (in press)(Exhibit E)] demonstrating that the net effect of uncertainty is that the social cost of carbon (the damage done by the burning of fossil fuels) is likely *greater* than the current *very conservative* consensus of the academic community.

Finally, it should be noted that while estimating and characterizing uncertainty is critical for risk assessment, *exaggerating* uncertainty—as contrarians like Dr. Curry are wont to do—is potentially dangerous. As I noted in my testimony, Dr. Curry is on record implying it is plausible that increasing greenhouse gas concentrations might ultimately cool the planet. That is in fact absurd. The science in no way

supports such a scenario. It goes against basic planetary physics. And it would be disastrous for us to divert our attention and resources to plan for such a scenario.

Much of the uncertainty, e.g., whether we get 3C or 10C of global warming by the end of this century, is in our hands—it is a consequence of the policy choices we make and how intently we work to lower global carbon emissions. Simply throwing our hands up and arguing, “there is so much uncertainty, there is no way to know if we should cut carbon emissions,” would be both foolish and dangerous. Yet this is precisely the course of action that some seem to be promoting.

- 5) Recently Dr. William Happer suggested that climate science needs “Red Teams” or a “Team B” in order to address disagreement about key scientific conclusions. We heard similar positions taken by some of the witnesses during the hearing.
 - How do you respond to Dr. Happer or those who suggest climate science needs a “red team?”

This suggestion sounds reasonable at a superficial level, but is seen to be entirely without merit when one scratches beneath the surface. It ignores the fact that these “red teams” or “team B” *already exist* in science. There has always been a Team B, abundantly represented by peer reviewers of every paper submitted for publication and among members of every study committee of every national academy and other body. Skeptical criticism has been the essence of scientific work for centuries. It is intrinsic to the culture of science. Real skepticism—good faith skepticism—is the “self-correcting machinery” as Carl Sagan referred to it, that keeps science on the path toward truth. Quoting again from Chapter 6 (“A Candle In The Dark”) of my book *The Hockey Stick and the Climate*

Wars (Columbia University Press, 2012):

Skepticism plays an essential role in the progress of science. Properly employed, it is a key self-correcting mechanism that helps lead science inexorably, if erratically, towards a better understanding of the natural world. Yet, as the philosopher Bertrand Russell's quote above reveals, skepticism in science can also be abused. His admonition

has certainly proven remarkably prophetic in the context of the climate change denial movement, wherein the term “skeptic” has often been co-opted to describe those who simply deny, rather than appraise critically.

and

Skepticism in the sense of critical consideration of evidence is intrinsic to the scientific enterprise. It is inherent in the challenges scientists make of each other to back up claims with logical reasoning and, where possible, hard data. The scientist must be willing to confront any holes in logic or flaws in reasoning noted by their fellow scientists and, ultimately, their results must be subject to independent replication. This give-and-take occurs at scientific conferences, where scientists give presentations and can question each other on the details. It is exercised more formally through so-called “peer review,” a process that applies to articles describing original research, as well as to formal criticism of previously published work. Editors of scientific journals send papers out for formal evaluation of their intellectual merit— typically anonymously--by the authors’ scientific peers-- other scientists who work in the same or a closely related area. Peer review is a kind of scientific “natural selection”; those papers which can withstand the scrutiny of this process will find their way to publication and are often substantially the stronger for it. Those papers which cannot are, by contrast, rejected

and

Science advances, then, not simply through the confirmation of previous findings, but through scientists trying to understand the data and observations that don't fit, that don't seem to make sense—the anomalies. That too is scientific skepticism in action.

All of the major international assessment efforts including those of the IPCC, the National Academy of Sciences, and inter-agency assessments do exactly what the critics claim they want from a scientific perspective. They include all viewpoints, invite critiques, address and respond to criticism. But what the critics really want is continued public "debate" where the consensus (97% of scientists) and contrarians (3%) are given essentially equal weight.

This serves the agenda of fossil fuel interests who, like Tobacco Interests before them, sought to manufacture fake doubt and uncertainty in our public discourse to prevent policy action. The critics start out with an ideological position (i.e. "regulation of carbon emissions is bad") and then work backwards to decide which science they like and which they don't. I'm reminded here of the stunning confession by Senator James Inhofe (R-OK) in March 2012 who, while being interviewed by MSNBC's Rachel Maddow about the science of climate change said "I thought it must be true until I found out what it cost." That statement betrayed that Inhofe's denial of climate change isn't driven by an objective assessment of scientific evidence but by a pro fossil fuel agenda. That's not how scientific research works.

It's not a buffet where you get to selectively pick and choose what to believe. It's not

about belief. It's about evidence. The critics—including those now crying for “red teams” and “team B” don't seem to grasp that. Or they don't want go grasp that.

- 6) President Trump's “skinny budget” cuts funding to earth sciences, environmental science, and environmental observation programs.
 - Why is it important that we continue to invest in Earth system observations, modeling, and other research necessary to advancing data on short-term climate variability to support resource management?

A reason to continue research in this area is because—in addition to informing our understanding of the impacts of climate change—we will have to adapt to the changes that are already locked in (some amount of sea level rise, shifting rainfall patterns, increased drought and heat waves). The best way to plan for adaptations is to have a solid scientific understanding of what is likely to happen. As noted in my response to question #1, there is still more research that needs to be done in order to improve the predictability of climate change at smaller regional scales. These are the scales at which critical decisions must be made by stakeholders.

The same models that we develop for climate change assessments are also used for seasonal climate predictability, which serves a large number of private sector interests who rely on seasonal climate prediction for estimating fuel demand, agricultural planning decisions, etc. I am reminded in the late 1990s, I just happened to catch on CSPAN a congressional hearing about seasonal climate forecasting by

governmental laboratories. At that hearing, Tim Barnett of the Scripps Institution for Oceanography testified about the great promise of state-of-the-art climate models in seasonal-scale weather prediction. The skill in these forecasts comes from the ability of the climate models to predict the evolution of phenomena like the El Nino/Southern Oscillation and its impact on seasonal temperature and rainfall patterns in the U.S. Representative Rohrabacher (R-CA) of this committee was questioning Barnett at the time. He proceeded to applaud Barnett's efforts, informing him that *this* was the sort of work government climate modeling labs should be involved in, rather than the "nonsense" of climate change. Barnett proceeded to politely explain to Congressman Rohrabacher that the models he was talking about were in fact the very same models that are used for climate change research. The point is that these things are inextricable. We cannot improve our capabilities in long-range weather forecasting and environmental prediction without supporting basic climate research.

- 7) In response to member questions about the connection between climate change and extreme weather events, Dr. Pielke responded, "there's no evidence to suggest that hurricanes either in the United States or globally are increasing, and the same goes for floods, drought and tornado."
- Is Dr. Pielke correct? What is the connection between climate change and extreme weather events?
 - Why is the connection between climate change and extreme weather events important to understand?

Dr. Pielke's statements are misleading. The language used is curiously ambiguous in a way that blurs absolutely essential distinctions—what does "hurricanes are...increasing" mean? Increasing in *frequency*? *Intensity*? First of all, there has been

in increase in *both* the number and intensity of Atlantic hurricanes, and that increase is reproduced by model simulations driven by anthropogenic factors. Globally, it is less clear whether there is an increase in frequency, but the increase in intensity is fairly clear. The foremost expert in the country and perhaps the world on this matter is Kerry Emanuel of the Massachusetts Institute of Technology, and he has taken Pielke to task for misrepresenting what we know about the impact of climate change on hurricanes and other extreme weather phenomenon. I quote from a March 13 2014 commentary by Emanuel (Exhibit F) entitled “MIT Climate Scientist Responds on Disaster Costs And Climate Change” at the website FiveThirtyEight.com. Quoting from that commentary:

As someone who has spent some time looking at changes in the incidence of hurricanes around the planet, I have been asked to provide a response to Roger Pielke Jr.'s article "Disasters Cost More Than Ever — But Not Because of Climate Change." published at FiveThirtyEight earlier this month.

Let me begin by saying that I am sympathetic to Pielke's emphasis on the role of changing demographics in increasing damages from natural disasters. This is a serious problem that could be addressed by wiser policies. For example, in the United States, policies regulating insurance and providing federal flood insurance and disaster relief have the effect of subsidizing risk-taking, and the recent repeal of large sections of the 2012 Biggert-Waters Federal Flood Insurance Reform Act shows just how difficult it is to reform these risk-inducing policies.

Having said that, I'm not comfortable with Pielke's assertion that climate change has played no role in the observed increase in damages from natural hazards; I don't see how the data he cites support such a confident assertion. To begin with, it's not

necessarily appropriate to normalize damages by gross domestic product (GDP) if the intent is to detect an underlying climate trend. GDP increase does not translate in any obvious way to damage increase; in fact, wealthier countries can better afford to build stronger structures and to protect assets (for example, build seawalls and pass and enforce building regulations). A grass hut will be completely destroyed by a hurricane, but a modern steel office building will only be partially damaged; damage does not scale linearly with the value of the asset.

More seriously, a casual inspection of both graphs (normalized and non-normalized damage over time) presented by Pielke leads me to question the statistical significance of either. This is hardly surprising, since 23 years is not a very long time to detect trends in natural hazard damages, whether such trends are caused by demographics or by climate change. A 2012 study² by London School of Economics researchers Fabian Barthel and Eric Neumayer looked at damage trends normalized by GDP, a measure they used because others are not universally available. For Germany and the United States, with 29 and 36 years of data, respectively, they detected “statistically significant upward trends in normalized insured losses from all non-geophysical disasters as well as from certain specific disaster types,” but for the globe as a whole, with 19 years of data available, they could find no significant trends.

Since the U.S. alone accounted for roughly half the insured losses over this period, the significance of the longer U.S. record and lack thereof in the shorter global record suggests that 20 years may be too short to detect significant trends. The increasing normalized trends in the U.S. were evident in convective storms, winter storms, flooding events and high temperature-related losses, and were almost statistically

significant for hurricanes at the conventional 95 percent confidence level.³ In view of data like this, it's very hard to accept Pielke's confident assertion that "[n]o matter what President Obama and British Prime Minister David Cameron say, recent costly disasters are not part of a trend driven by climate change." There is an even more significant problem with Pielke's analysis. In a nutshell, he addresses trend detection when what we need is event risk assessment. The two would be equivalent if the actuarial data was the only data available pertaining to event risk. But that is far from the case; we often have much more information about risk.

Let me illustrate this with a simple example. Suppose observations showed conclusively that the bear population in a particular forest had recently doubled. What would we think of someone who, knowing this, would nevertheless take no extra precautions in walking in the woods unless and until he saw a significant upward trend in the rate at which his neighbors were being mauled by bears?

The point here is that the number of bears in the woods is presumably much greater than the incidence of their contact with humans, so the overall bear statistics should be much more robust than any mauling statistics. The actuarial information here is the rate of mauling, while the doubling of the bear population represents a priori information. Were it possible to buy insurance against mauling, no reasonable firm supplying such insurance would ignore a doubling of the bear population, lack of any significant mauling trend notwithstanding. And even our friendly sylvan pedestrian, sticking to mauling statistics, would never wait for 95 percent confidence before adjusting his bear risk assessment. Being conservative in signal detection (insisting on high confidence that the null hypothesis is void) is the opposite of being conservative in

risk assessment.

When it comes to certain types of natural hazards, there are more bears in the woods. For example, there is a clear upward trend in overall North Atlantic hurricane activity by virtually all metrics, over the past 30 years or so, though the cause of this is still uncertain. But given that only about a third of Atlantic hurricanes strike the U.S.; hurricanes do damage during a very small fraction of their typical lifetimes; and only intense hurricanes (a small fraction of the total) do significant damage, the amount of hurricane data pertinent to U.S. damage is a tiny fraction of the entire database of North Atlantic hurricanes. Thus it is hardly surprising that the upward trend in U.S. hurricane damage is of only marginal statistical significance, and Pielke's own analysis shows that it takes several decades for such a trend to emerge.

This does not mean that there is no underlying change in the risk, and the priors we have in this case point to a significant increase in such risk. One would be foolish to make plans that have to deal with U.S. hurricane risk without accounting for the evidence that the underlying risk is increasing, whether or not actuarial trends have yet emerged at the 95 percent confidence level.

This is particularly so when one accounts for another form of prior information: theory and models. While some disagreement remains about projections of the weakest storms, which seldom do much damage, both theory and models are now in good agreement that the frequency of high category hurricanes should increase, as should hurricane rainfall and the flooding it produces.

Looking ahead, I collaborated with Yale economist Robert Mendelsohn and his colleagues in estimating global hurricane damage changes through the year 2100,

based on hurricanes “downscaled” from four climate models. We estimate that global hurricane damage will about double owing to demographic trends, and double again because of climate change. These projections are not inconsistent with what we’ve been seeing in hurricane data and in economic damage from hurricanes. Besides this study, there are robust theory and modeling results that show increased risk of hydrological extremes (floods and droughts) and heat-related problems.

Some of these predicted trends are beginning to emerge in actuarial data. Governments, markets and ordinary people are beginning to account for the increased risk. Those who wait for actuarial trends to emerge at the 95 percent confidence level before acting do so at their peril.

My own recent work, which I mentioned in my testimony [Mann, M.E., Rahmstorf, S., Kornhuber, K., Steinman, B.A., Miller, S.K., Coumou, D., Influence of Anthropogenic Climate Change on Planetary Wave Resonance and Extreme Weather Events, *Scientific Reports*, 7, 19831, 2017; Exhibit G] indicates yet an additional newly identified mechanism by which climate change may be altering the Northern Hemisphere jet stream in a way that favors an increase in extreme weather events such as floods, droughts, and heat waves.

Perhaps the most authoritative consensus statement on the matter is from the conservative National Academy of Sciences [National Academies of Sciences, Engineering, and Medicine. Committee on Extreme Weather Events and Climate Change (2016). *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington, DC: National Academies Press [doi:10.17226/21852] online at

<https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change>].

Quoting from their summary: “Warming increases the likelihood of extremely hot days and nights [i.e., heat waves], favors increased atmospheric moisture that may result in more frequent heavy rainfall and snowfall, and leads to evaporation that can exacerbate droughts.”

In summary, Dr. Pielke’s dismissive statements about the linkage between climate change and extreme weather events are simply not consistent with the best, most up-to-date science.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

“Climate Science: Assumptions, Policy Implications, and the Scientific Method”

Dr. Michael Mann, Distinguished Professor of Atmospheric Science and Director, Earth System Science Center (ESSC), The Pennsylvania State University

Questions submitted by Representative Jacky Rosen, House Committee on Science, Space, and Technology

- 1) My state of Nevada is already seeing the effects of climate change with increased temperatures, extreme weather, and persisting drought in the Colorado River basin. Last year, Lake Mead — which feeds 90 percent of the water supply in Las Vegas, alone — dropped to its lowest levels in eighty years, creating a “bathtub ring” around the shoreline. These changes threaten our wildlife, health, agricultural production, and even national security.
 - Despite 97% of climate scientists concluding that climate change is real and having adverse impacts, a minority of scientists reject this consensus. What kind of effect does climate change denial or criticism have on climate research?

I thank the Congressman for the thoughtful question. As you note, the western U.S. is seeing some of very worst impacts of human-caused climate change, including unprecedented drought, heat and, as a consequence, more devastating and widespread wildfires. The drought in the Colorado River basin impacting Lake Mead and the Las Vegas region that you describe has in fact been attributed to climate change (see e.g. Overpeck, J. and B. Udall. 2010. Dry Times Ahead. *Science* 328 1642-1643).

Ironically, while Nevada, and so many other regions, are now already dealing with the devastating impacts of climate change, the climate change denialism you allude

to, which is a result of a massively funded disinformation campaign conducted by fossil fuel interests and their political advocates, has forestalled the very sort of policy action that is necessary to bring down carbon emissions and prevent even worse climate change impacts.

- 2) I am proud that Nevada is taking action to counter climate change through increasing renewable energy and developing technologies to become energy independent. Research organizations like the Desert Research Institute are at the forefront of atmospheric and climate science research, utilizing innovative technologies to study air quality, meteorology, and renewable energy.
 - What can we do to further scientific inquiry on climate change? How can we support researchers and institutions?

Thanks again for the question Congressman. As you allude to, states, including Nevada and my home state of Pennsylvania, are taking a leadership role when it comes both to efforts to transition toward clean, renewable energy and to support research at our great research institutions and universities to understand how human activity is impacting our environment and our climate. Such state-level efforts will prove critical in the years ahead if we are to fill the vacuum left behind by an anticipated withdrawal of federal support for these programs.

The U.S. is currently an international leader when it comes to climate research thanks to a combination of support for government research institutes and a thriving academic sector research capability supported by government science funding agencies including NSF, NOAA, NASA, DOE, EPA, USAID and others. The

private sector greatly benefits from government-supported climate research, in the form of seasonal weather forecasting and weather and climate risk assessment.

A withdrawal of federal support would almost certainly threaten that mission, and cost the U.S. its leadership status in the global scientific community. However, a combination of state-level support and private sector sponsorship (something that has been alluded to by some leading companies) could help us to mitigate the damage if it is not sustained beyond four years.

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“Climate Science: Assumptions, Policy Implications, and the Scientific Method”

Dr. Michael Mann, Distinguished Professor of Atmospheric Science and Director, Earth System Science Center (ESSC), The Pennsylvania State University

Questions submitted by Representative Dan Lipinski, House Committee on Science, Space, and Technology

- 1) When we talk about “weather” and “climate,” they are two sides of the same coin. Weather projections pretty much stop at about 10 days out. While climate models are often used to project years in the future, they are often what’s used to understand what’s going to happen in the next season. So, for example, climate models help farmers in the Midwest understand what crops they should plant for the best yields, and how to best manage their farms.
 - My question for you is – do you think that those who express concerns about the uncertainties of climate research are suggesting that we take this type of valuable information away from farmers? Could you talk about what some of the negative impacts of such a move would be?

Thank you Congressman for the question. Indeed, as I alluded to above in my response to question #6, the very same modeling approaches that are used for seasonal climate forecasts that inform decision-making and risk mitigation by stakeholders such as farmers, provide longer-term information about climate change that can aid longer-term decision-making by these same stakeholders. Taking this information away from them would be akin to asking a pilot to fly blind over dangerous topography.

- 2) The USDA has climate hubs around the country to deliver science-based knowledge, practical information, and program support to farmers, ranchers, forest landowners, and resource managers. This information supports climate-informed decision-making in light of the increased risks and vulnerabilities associated with a changing climate.

- If we were to cut off federal funding to climate change research, as the White House has recently proposed, can you speak to the potential impacts on these programs that help key sectors of our economy adapt to coming changes?

Thanks for the question Congressman. I would iterate what was said in my responses above to questions 8-10. In short, we have stakeholders in the private and government sectors alike (farmers, heating fuel providers, the recreational industry, the insurance and reinsurance industries) that all rely heavily on our climate prediction capabilities in both the short and long-term. To reduce or eliminate these capabilities, as the White House's proposals threaten to do, would place us, our business community, and indeed our entire economy, at great risk.

- 3) Many decisions – policy and adaptation decisions – at the national and local levels are based on climate science, and specifically on the consensus view of the vast majority of climate scientists. A few examples include helping to map out flood resilience plans based on how the climate is changing rather than how it was 100 years ago, or helping coastal communities plan their zoning to take into account the risks of storm surge with rising sea levels.
 - What is the risk to these types of risk management decisions if we conflate climate science with mitigation policy or power plant regulations?

Policymakers should be supporting work that helps people integrate climate projections into extant processes, including coastal planning and mitigation strategies. As I have indicated in my responses to questions 8-11 above, we imperil our people, our stakeholders, our business community and our economy if we conflate science with politics and allow an agenda of fossil fuel industry profiteering to trump the greater welfare of our people and our nation.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY*“Climate Science: Assumptions, Policy Implications, and the Scientific Method”*

Dr. Michael Mann, Distinguished Professor of Atmospheric Science and Director, Earth System Science Center (ESSC), The Pennsylvania State University

Questions submitted by Representative Charlie Crist, House Committee on Science, Space, and Technology

1) I represent Florida’s 13th Congressional District, which is a beach community that includes St. Petersburg and Clearwater. My District is quite literally a peninsula on a peninsula; and my constituents feel the effects of climate change daily. Our shorelines are impacted by severe storms and constant coastal erosion. And, as a result, there are real concerns that one of our key revenue sources – tourism - may wash away bit by bit.

- My question to you, Dr. Mann, is - What can we do to address these coastal erosion issues? And how important are federal agencies like NOAA and EPA in helping us understand the science of our climate and helping Americans cope with the realities of climate change that are already here?”

Thank you for the question Representative Crist, and thank you for the leadership role you have taken when it comes to the issue of climate change and coastal risk. As you note, Florida is very much on the front lines of dealing with climate change impacts. I have published research on the threat to our coastlines of the combined impact of sea level rise and more intense hurricanes [see e.g. Lindeman, K.C., Dame, L.E., Avenarius, C.B., Horton, B.P., Donnelly, J.P., Corbett, D.R., Kemp, A.C., Lane, P., Mann, M.E., and Peltier, W.R., Science needs for sea-level adaptation planning: comparisons among three U.S. Atlantic coast regions, *Coastal Management*, 43, 555-574, 2015 and also, Reed, A.J., Mann, M.E., Emanuel, K.A., Lin, N., Horton, B., Kemp, A.C., Donnelly, J.P., Increased threat of tropical cyclones and coastal flooding to New

York City during the anthropogenic era, *Proc. Nat. Acad. Sci.*, 112, 12610-12615, 2015]. For this reason, I'm especially familiar with the coastal threat posed to Florida and other coastal states along from coastal flooding, beach erosion, saltwater intrusion, and all of the other detrimental impacts of coastal inundation.

As I mentioned in my response to question #9 above, government research agencies such as NOAA and EPA play a critical role in maintaining our research capabilities when it comes to climate and weather risk including coastal threats and coastal risk mitigation. The threatened cuts in the budgets of these agencies would therefore imperil both us and our business community.

Scale-dependent Regional Climate Predictability over North America Inferred from CMIP3 and CMIP5 Ensemble Simulations

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ABSTRACT

Through the analysis of ensembles of coupled model simulations and projections collected from CMIP3 and CMIP5, we demonstrate that a fundamental spatial scale limit might exist below which useful additional refinement of climate model predictions and projections may not be possible. That limit varies among climate variables and from region to region. We show that the uncertainty (noise) in surface temperature predictions (represented by the spread among an ensemble of global climate model simulations) generally exceeds the ensemble mean (signal) at horizontal scales below 1000 km throughout North America, implying poor predictability at those scales. More limited skill is shown for the predictability of regional precipitation. The ensemble spread in this case tends to exceed or equal the ensemble mean for scales below 2000 km. These findings highlight the challenges in predicting regionally specific future climate anomalies, especially for hydroclimatic impacts such as drought and wetness.

Key words: regional climate predictability, CMIP5 ensemble, North America climate change

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1. Introduction

There is widespread scientific consensus that the accumulation of greenhouse concentrations from fossil fuel burning and other human activities is leading to a warming of the globe and other associated changes in large-scale climate (IPCC, 2013). Most assessments indicate that the cost of the resulting damage from climate change will rise to several percent of the global economy in the decades ahead if left unchecked. Yet, our ability to assess the regional impacts of climate change, which are critical both to assessing the damage caused by climate change and the implementation of adaptive strategies, remains hampered by the remaining substantial uncertainties associated with regional climate projections (Murphy et al., 2004; Tebaldi et al., 2005; Hawkins and Sutton, 2009; Deser et al., 2012; Watterson et al., 2014).

Regional climate projections are typically derived by one of two methods: statistical downscaling or dynamical downscaling (IPCC, 2013). In the former case, statistical relationships between coarse and fine scales derived from modern climate data are used to take coarse-scale climate model predictions/projections and estimate the likely impact on climate

statistics at finer spatial and temporal scales. In the latter case, information from coarse climate models is used as boundary constraints on a finer resolution model (a regional climate model) that resolves the smaller spatiotemporal scales of interest. In either case, there is an assumption of a predictable relationship between the large scales captured in the coarse climate model projection and the local scales sought by the downscaling method.

Downscaled climate model projections have increasingly been used as guidance for policymakers and stakeholders at the local, national, and international level in assessing potential impacts and risks associated with human-caused climate change (von Storch et al., 1993; Mearns et al., 1999; Jones et al., 2011). However, the reliability of these projections continues to be debated. There is clearly skill in the largest-scale quantities; for example, the observed increase in global mean temperature (and even continental mean temperatures) can be detected and attributed to anthropogenic climate change (IPCC, 2007). However, confidence in regional-scale projections of surface temperature and precipitation is considerably lower (Whetton et al., 2007; Separovic et al., 2008; Watterson and Whetton, 2011; Deser et al., 2012; Li et al., 2012).

In the current study, we seek to quantify the predictability of regional-scale climate change, with an emphasis on surface temperature and precipitation, across the coterminous United

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States and surrounding areas, through analysis of the multimodel ensembles of coupled model simulations collected from both CMIP3 and CMIP5. In section 2 we describe the data and methods used in the study. In section 3 we present an analysis of regional climate predictability based on CMIP5 multimodel historical simulations. In section 4 we provide a complementary analysis of CMIP3 multimodel simulations, analyzing both historical simulations and future projections. Conclusions are presented in section 5.

2. Data and methodology

We analyze surface temperature and precipitation fields across the coterminous United States and neighboring oceanic regions (15°–60°N, 70°–130°W), as derived from both observational data and an ensemble of climate model simulations.

Observational data analyzed include monthly mean 5° latitude × 5° longitude grid-box near-surface temperature anomalies over 1850–2014 from HadCRUT4. We add the reference period climatology over 1961–90 to yield absolute surface temperatures. Precipitation data are taken from the 1° latitude × 1° longitude GPCC dataset over the period 1979–2004.

For the climate model simulations, monthly mean surface (2 m) air temperature and precipitation spanning the period 1979–2004 are available for 38 climate models in the historical late 19th to early 21st century 20C3M CMIP5 simulation archives, and 18 for CMIP3 (Taylor et al., 2012) (Table 1). Where multiple simulations are available for a given model, a single ensemble mean is calculated to ensure that each distinct model is represented equally in the ensuing analysis.

We focus our analysis on the boreal summer (June–August) climatological period during the 1979–2004 period of overlap between observations and model simulations. Both observational and model data are interpolated to a common (T85, ~1.4° latitude × 1.4° longitude) spatial resolution prior to analysis. For the purpose of the ensuing analyses, we define the following terms:

- (1) Ensemble mean: the uniform arithmetic mean of all ensemble members;
- (2) Ensemble spread: the uniform arithmetic mean of the absolute difference between any two members across all ensemble members;
- (3) Ensemble mean error or bias: the (signed) difference between the model ensemble mean and the observational analysis.

In addition to evaluating the ensemble mean, ensemble spread, and error for the observational and model fields themselves, we perform a power spectral analysis (using the Fast Fourier transform) of the fields to evaluate the power spectral density (PSD) characteristics of the various quantities in wavenumber space. In these analyses:

- (1) The ensemble mean power spectrum (P) is defined as the PSD of the non-weighted arithmetic mean (V_m) for all ensemble members ($M = 38$):

$$P = \text{PSD}(V_m), V_m = (1/M) \sum_i V_i, M = 38;$$

- (2) The PSD of the ensemble spread is defined as:

$$\Delta P = (1/N) \sum_{i=1}^N P_d, P_d = \text{PSD}(V_i - V_j), \text{ where } i \text{ and } j \text{ are any pair of ensemble members and } N = 703.$$

- (3) The PSD of the ensemble mean error or bias is defined as the power spectra of the difference between the ensemble mean and the observation, i.e.,

$$P' = \text{PSD}(V_m - V_o), \text{ where } V_m \text{ and } V_o \text{ refer to the ensemble mean and observational variables, respectively.}$$

The ratio of the PSD ensemble mean (signal) and ensemble spread (noise) as a function of wavenumber defines a scale-dependent SNR measure (Bci and Zhang, 2007). A ratio smaller than unity indicates that the noise amplitude is greater than the signal amplitude, and implies that model estimates of mean changes are unreliable at that spatial scale. Wavenumber 1 corresponds to a single sinusoidal fluctuation over the entire circle of latitude, i.e., it is the coarsest possible measure of zonal variability (wavenumber 0 represents the zonal mean). Since the selected U.S. domain is precisely 1/6 of a circle of latitude, the lowest resolvable wavenumber for that domain is global wavenumber 6. The horizontal scale (wavelength) for a given wavenumber is the length of the circle of latitude divided by the wavenumber, e.g., the length scale corresponding to wavenumbers 1, 2, 3, 4, 5, 6 and 9 are ~36 000, 18 000, 12 000, 9000, 7200, 6000 and 4000 km, respectively.

3. CMIP5 multimodel historical experiments

We form estimates of the internal variability in the climate means of summertime precipitation and surface air temperature during the period 1979–2004 using the multimodel ensemble of 38 CMIP5 historical simulations (Fig. S1 in electronic supplementary material). The mean difference between any two models within the 38-model ensemble is defined as the ensemble spread; a measure of uncertainty of any deterministic prediction assuming the truth (as well as any single deterministic prediction) is a random draw out of the multimodel ensemble. The ensemble spread can be regarded as a lower bound on the model uncertainty, since it neither accounts for the potential bias due to deficiencies in model physics that are common among models, nor uncertainties in forcing (both anthropogenic and natural).

Figures 1a and b show the resulting mean and ensemble spread of surface temperature and monthly precipitation over the U.S. domain. The largest uncertainty for the surface temperature field is found over the western U.S., with the ensemble spread as high as 5°C–6°C; followed by the central U.S., with a spread of 3°C–5°C; and the eastern U.S., with a spread of ~1.5°C–3°C (all higher than the surrounding oceans, at ~0.5°C–1.5°C). It is worth noting that the warming trend over the U.S. during the past century is on the order of 1°C (Ji et al., 2014), though it is beyond the scope of this study to examine the scale-, variable- and location-dependent predictability of the climate trend.

The large uncertainty in the mean surface temperature

Table 1. List of the CMIP5 models used in this study (IPCC, 2013).

Model	Sponsor	Atmospheric resolution (lat × lon)
BCC.CSM1.1	Beijing Climate Center, China Meteorological Administration	2.8° × 2.8°
BCC.CSM1.1(m)	Beijing Climate Center, China Meteorological Administration	2.8° × 2.8°
CanCM4	Canadian Centre for Climate Modeling and Analysis	2.8° × 2.8°
CanESM2	Canadian Centre for Climate Modeling and Analysis	2.8° × 2.8°
CCSM4	National Center for Atmospheric Research	0.9° × 1.25°
CESM1-BGC	Community Earth System Model Contributors	0.9° × 1.25°
CESM-CAM5	Community Earth System Model Contributors	0.9° × 1.25°
CESM1-FASTCHEM	Community Earth System Model Contributors	0.9° × 1.25°
CESM1-WACCM	Community Earth System Model Contributors	1.875° × 2.5°
CMCC-CESM	Centro Euro-Mediterraneo per i Cambiamenti Climatici	3.75° × 3.75°
CMCC-CM	Centro Euro-Mediterraneo per i Cambiamenti Climatici	0.75° × 0.75°
CMCC-CMS	Centro Euro-Mediterraneo per i Cambiamenti Climatici	1.875° × 1.875°
CNRM-CM5-2	Centre National de Recherches Météorologiques/Centre Européen de Recherche et Formation Avancée en Calcul Scientifique	1.4° × 1.4°
CNRM-CM5	Centre National de Recherches Météorologiques/Centre Européen de Recherche et Formation Avancée en Calcul Scientifique	1.4° × 1.4°
CSIRO Mk3.6.0	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence	1.875° × 1.875°
EC-EARTH	EC-EARTH consortium	1.125° × 1.125°
GFDL CM2.0p1	NOAA Geophysical Fluid Dynamics Laboratory	2° × 2.5°
GFDL CM3	NOAA Geophysical Fluid Dynamics Laboratory	2° × 2.5°
GFDL-ESM2G	NOAA Geophysical Fluid Dynamics Laboratory	2° × 2.5°
GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory	2° × 2.5°
GISS-E2-H-CC	NASA Goddard Institute for Space Studies	2° × 2.5°
GISS-E2-H	NASA Goddard Institute for Space Studies	2° × 2.5°
GISS-E2-R-CC	NASA Goddard Institute for Space Studies	2° × 2.5°
HadCM3	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)	2.5° × 3.75°
HadGEM2-AO	National Institute of Meteorological Research/Korea Meteorological Administration	1.25° × 1.9°
HadGEM2-CC	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)	1.25° × 1.9°
HadGEM2-ES	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)	1.25° × 1.9°
INM-CM4.0	Institute for Numerical Mathematics	1.5° × 2°
IPSL-CM5A-LR	L'Institut Pierre-Simon Laplace	1.875° × 3.75°
IPSL-CM5A-MR	L'Institut Pierre-Simon Laplace	1.25° × 2.5°
IPSL-CM5B-LR	L'Institut Pierre-Simon Laplace	1.875° × 3.75°
MIROC5	Atmospheric and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	1.4° × 1.4°
MIROC-ESM-CHEM	Japan Agency for Marine-Earth Science and Technology, Atmospheric and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies	2.8° × 2.8°
MIROC-ESM	Japan Agency for Marine-Earth Science and Technology, Atmospheric and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies	2.8° × 2.8°
MRI-CGCM3	Meteorological Research Institute	1.125° × 1.125°
MRI-ESM1	Meteorological Research Institute	1.125° × 1.125°
NorESM1-ME	Norwegian Climate Centre	2.5° × 2.5°
NorESM1-M	Norwegian Climate Centre	1.875° × 2.5°

field (Fig. 1a) can be interpreted through a parallel assessment using the observational (HadCRUT4) surface temperature during the overlapping time period (Fig. 1c). The error/bias can be estimated as the model ensemble mean minus the observations. The domain-averaged ensemble spread ($\sim 2.1^\circ\text{C}$) is found to be larger but grossly comparable to the domain-averaged root-mean-square of this estimate of error/bias (1.2°C). Moreover, the spatial pattern of the error/bias is similar to that of the ensemble spread, with the western U.S. displaying the largest mean error, followed by the Great Plains in the central U.S., and finally the eastern U.S. There are, however, some notable differences as well. Of particular interest is the relatively low spread over the North American west and east coasts and neighboring ocean regions (Fig. 1a), which contrasts with the large error/bias estimates over these same regions (Fig. 1c). This suggests the presence of a systematic bias that is common to most or all of the climate models, perhaps associated with deficiencies in the

models' representations of land-sea contrast or continental sea-breeze circulations.

The region of maximum uncertainty (ensemble spread) for precipitation (Fig. 1b) is found over lower latitudes (the south central U.S. and Latin America), with an ensemble spread exceeding 2.5 mm d^{-1} —roughly half the amplitude of the observed mean (signal). A second uncertainty maximum in precipitation is located over the northern Great Plains in the lee of the Rockies, with an ensemble spread exceeding 1.5 mm d^{-1} . The spatial pattern of the ensemble mean error (Fig. 1d) is once again grossly consistent with that for the ensemble spread (uncertainty), in that regions of peak amplitude are similar (e.g., common maxima along the southern edge of the domain and northern Great Plains), though the ensemble mean errors of approximately -2.5 mm d^{-1} are considerably larger than the ensemble spread for the Gulf Coast and Florida Peninsula. In addition, the North American domain-mean absolute ensemble mean error and spread

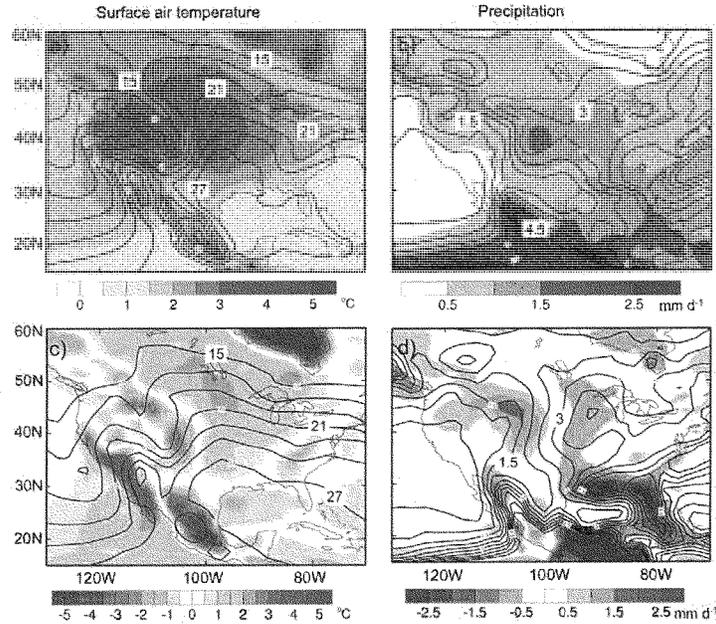


Fig. 1. Ensemble mean and spread/error for CMIP5 historical simulations and observations of summer (June–August) surface air temperature and precipitation over the U.S. during 1979–2004. Top: ensemble mean (contours) and ensemble spread (color-shaded) for (a) surface air temperature and (b) precipitation. Bottom: observational mean (contours) and error (color-shaded) for (c) surface air temperature and (d) precipitation. The corresponding domain-mean spreads are 2.09°C for (a), 0.97 mm d^{-1} for (b), 1.16°C for (c), and 0.58 mm d^{-1} for (d).

are also comparable in magnitude (0.58 mm d^{-1} and 0.97 mm d^{-1} , respectively).

Unlike surface temperature, which is primarily determined by large-scale processes, precipitation is heavily influenced by smaller-scale processes including moist convection, land–sea contrast, and orographic lifting. This distinction is exemplified by the local maxima for both ensemble mean error and spread over the Gulf of Mexico (hot spot of convection) and the mountainous areas of the western U.S. (where orographic effects are important). Comparing Figs. 1b and d suggests that, for the CMIP5 simulations of climatological mean precipitation, the ensemble spread can be used qualitatively to assess the uncertainty in the ensemble mean estimate. To place the U.S. results in a broader perspective, we also compare the ensemble mean, spread, and error for the global domain (not shown). The basic results discussed above appear to apply at this larger scale as well (though a detailed analysis of the global domain is beyond the scope of the current study).

The spatial scale–dependence of the predictability of surface temperature and precipitation is quantified by evaluating the PSD along both global circles of latitude and a latitudinal/longitudinal sub-region containing the coterminous U.S. (15° – 60° N, 70° – 130° W). Figure 2 shows the ensemble mean (left) and ensemble spread (middle) PSD for the CMIP5 surface temperature and precipitation fields, along with the ratio of the ensemble mean to the ensemble spread, i.e., the SNR (right) as a function of global wavenumber. For the global circle of latitude ensemble mean temperature (Fig. 2a), the PSD exhibits a peak at lower wavenumbers (1–3) for the midlatitudes (40° – 60° N); while for the subtropics (20° – 40° N), three distinct spectral peaks are observed (wavenumbers 1, 3 and 5). By contrast, for the ensemble spread, the PSD (Fig. 2b) decreases quite gradually in both the midlatitudes and the subtropics, though greater amplitudes are found across all wavenumbers for the former. The SNR (Fig. 2c) exceeds unity at all latitude and wavenumber ranges, with the exception of (1) wavenumber 4 between 40° – 60° N, (2) wavenumber 6 poleward of 50° N, and (3) wavenumber 9 between 45° – 55° N. Given the SNRs, surface temperature projections can be considered most reliable for wavenumbers 1–2 in the midlatitudes, and wavenumbers 1, 3 and 5 within the subtropics. Therefore, meaningful surface temperature predictions ($\text{SNR} > 1$) appear possible over a somewhat broad range of latitudes and wavenumbers.

For the more limited U.S. sub-region, the ensemble mean (Fig. 2d) and spread (Fig. 2e) are both larger at lower wavenumbers than for their global counterparts, but the SNR (Fig. 2f) falls below unity for global wavenumber 12 (horizontal scale of 30° longitudinal variation, i.e., distances of ~ 3000 km) over the central latitudes of the U.S. (35° – 45° N), and for nearly all wavenumbers greater than 36 (scales less than 10° in longitudinal distance, i.e., distances less than ~ 1000 km). This observation implies that state-of-the-art (i.e., CMIP5) climate model projections are likely to exhibit very limited skill in predicting regional variations in surface temperature at scales below 1000 km. It is noteworthy that

wavenumber 18 ($\sim 20^{\circ}$ or ~ 2000 km in longitudinal distance) exhibits the maximum SNR at nearly all latitudes for the U.S. domain. We interpret this observation as indicative of the influence of topographical features in the U.S. that induce enhanced predictability at this characteristic spatial scale.

The findings for precipitation (Figs. 2g and h) are quite different from those for surface temperature (Figs. 2a and b). Precipitation exhibits greater spectral amplitude in the subtropics relative to the midlatitudes, especially for lower (1–2) wavenumbers. SNRs at the global scale (Fig. 2i) are generally lower, substantially exceeding unity only for wavenumbers 1–2 between 20° N and 50° N, and wavenumber 4 between 40° N and 60° N. Low predictability ($\text{SNR} < 1$) is observed even at wavenumbers 1–2 poleward of 50° N, implying considerable challenges in predicting regional-scale variations in precipitation at high latitudes. Interestingly, however, for the U.S. regional sub-domain (Figs. 2j–l), there are apparently predictable signals ($\text{SNR} > 1$) for global wavenumbers 6–12 at nearly all latitudes, and for even higher wavenumbers (24–60, i.e., scales as small as 600 km) in the central U.S. latitudes (35° – 45° N). The larger signals over these latitudes in the North American domain may be related to regional-scale terrain effects and land–ocean contrasts, although some models may still have deficiencies in simulating these effects.

To further assess the scale and latitude dependence of surface temperature and precipitation predictability over the U.S. sub-domain, we average the fields over three representative latitude ranges (low latitude, 15° – 30° N; midlatitude, 30° – 45° N; and high latitude, 45° – 60° N; see Fig. 3). Given that the observations represent a single realization drawn from a larger distribution of possible climate histories, if the model ensemble accurately reflects the true climate, the PSD of the observations should be similar to that of individual ensemble members, and the ensemble mean should reflect the approximate mode of the distribution. On the other hand, the PSD of the ensemble spread (representing the uncertainty) should closely resemble that of the difference between the ensemble mean and observations (error/bias) across wavenumbers.

For the global domain, the PSD of the ensemble mean and observational mean are indeed similar for all latitude ranges for both surface temperature and precipitation. An exception is the anomalously low PSD values for surface temperature at wavenumber 2 and those exceeding ~ 50 , the latter of which we attribute to the low spatial density of surface temperature observations over the open ocean. The PSD for the ensemble spread generally exceeds that of the ensemble error/bias at most wavenumbers, and especially at lower wavenumbers (< 10) and for surface temperature. Consistent with our earlier findings (Fig. 2), the PSD for both the ensemble mean and observations (i.e., the signals) exceed those for the ensemble spread and error (noise or uncertainties) for wavenumbers 1–20 for all three latitude ranges for surface temperature (Figs. 3a–c), implying predictability across the associated spatial scales. For precipitation, by contrast, predictability is only evident (Figs. 3g–i) for wavenumbers 1–3 for the low-latitude (15° – 30° N) and midlatitude (30° – 45° N) zone, and

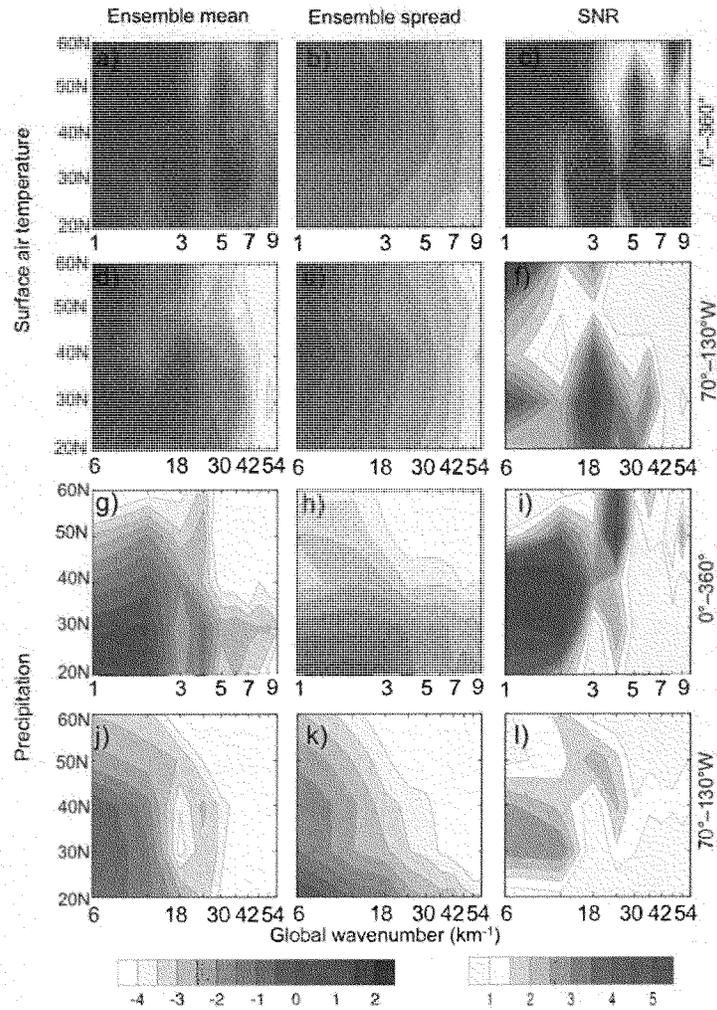


Fig. 2. Wavenumber-latitude distribution of the PSD of (a-f) surface air temperature and (g-l) precipitation over the global (0°-360°) and U.S. regional (70°-130°W) sub-domain. Shown are the PSDs for the ensemble mean, i.e., signal (left); ensemble spread, i.e., noise (middle); and ratio of the former to the latter, i.e., the SNR (right). The PSD amplitude scale is logarithmic.

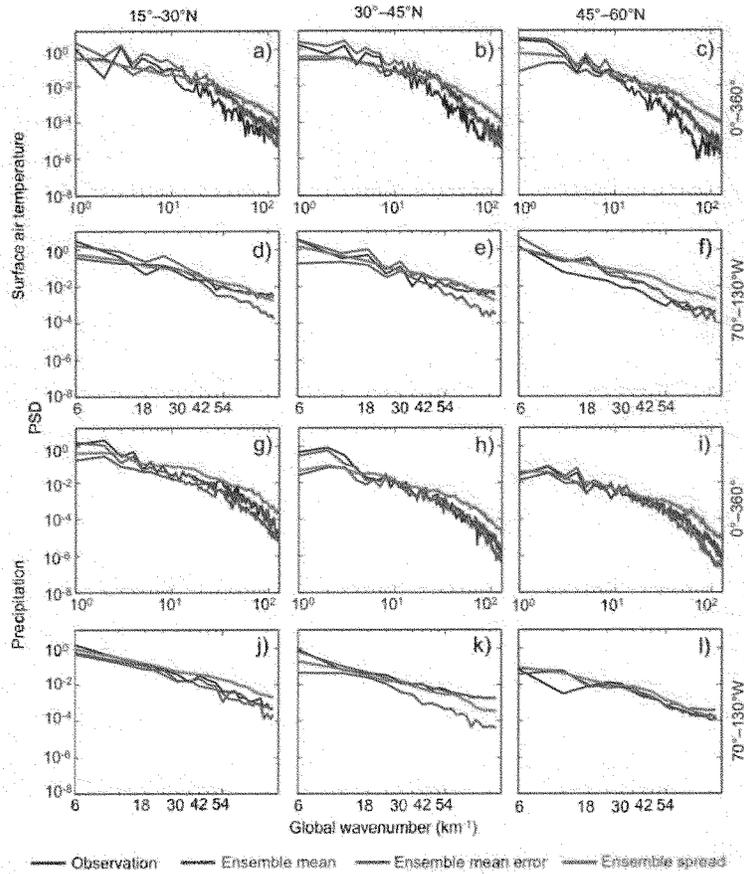


Fig. 3. PSD of the observations (black), ensemble mean (red), ensemble error (blue) and ensemble spread (green) for summer (June–August) (a–f) surface air temperature and (g–l) precipitation over the global (0°–360°E) and U.S. regional (70°–130°W) sub-domain averaged over three different latitude bands (left, 15°–30°N; middle, 30°–45°N; right, 45°–60°N). Scales for both axes are logarithmic.

for almost no wavenumbers for the high-latitude (45°–60°N) zone.

For the U.S. regional sub-domain, the PSD for the ensemble mean is generally consistent with that for the observations for both surface temperature and precipitation, and low and intermediate wavenumbers. However, for the high-latitude

zone (45°–60°N) the ensemble-mean PSD considerably exceeds that of the observations for higher (> 24 for surface temperature and > 12 for precipitation) wavenumbers. The discrepancy between the ensemble spread and the ensemble mean error/bias is considerably greater for the U.S. regional domain than for the global domain as well.

The inferred predictability of surface temperature and precipitation for the U.S. regional domain varies considerably between the two variables and three latitude ranges (Figs. 3d–f, j–l). For example, the SNR for surface temperature exceeds unity for all wavenumbers lower than 36 (spatial scales as small as ~1000 km) for the low-latitude (15°–30°N) zone, but the SNR is close to the “no predictability” value of unity for nearly all wavenumbers for the midlatitude (30°–45°N) and high-latitude (45°–60°N) zones. For precipitation, only for the midlatitude zone (30°–45°N) is there evidence of predictability, and at fairly low (6–12) global wavenumbers (i.e., spatial scales no less than ~6000 km). These examples highlight the challenge for regional-scale climate predictability in North America with existing state-of-the-art global climate models.

4. CMIP3 historical experiments and future projections

To further investigate the robustness of our findings based on the CMIP5 historical simulations (Figs. 1–3) we perform

parallel analyses using the CMIP3 (Meehl et al., 2007; Watterson et al., 2014) (Table 2) multimodel ensemble simulations using both (1) the same historical period (1979–2004) (Zhou and Yu, 2006; Timm and Diaz, 2009) and (2) the CMIP3 (“A2” scenario) 21st century climate change projections.

Our conclusions regarding the predictability of regional-scale climate over North America with the CMIP5 historical simulations (Figs. 1–3) are similar to those obtained with the CMIP3 historical multimodel simulations (Figs. 4–6), with only one minor discrepancy: slightly lower SNR values are found for both the global surface temperature and precipitation fields over the midlatitudes of North America for global wave numbers 6–12. The fact that little-to-no improvement in regional predictability is found to result from the substantial model development and improvement reflected by the 5-year period between CMIP3 and CMIP5 suggests that, even with increasingly refined and detailed climate models, our conclusions regarding an apparent scale limit for regional-scale climate predictability are likely to remain true.

Similar conclusions are also obtained for the 21st century projections using the “A2” emissions scenario for the pe-

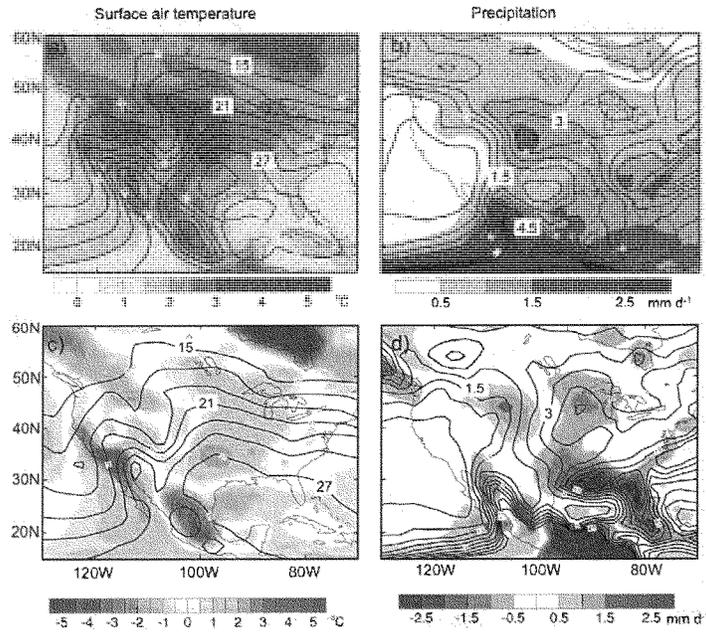


Fig. 4. As in Fig. 1 but using CMIP3 historical simulations.

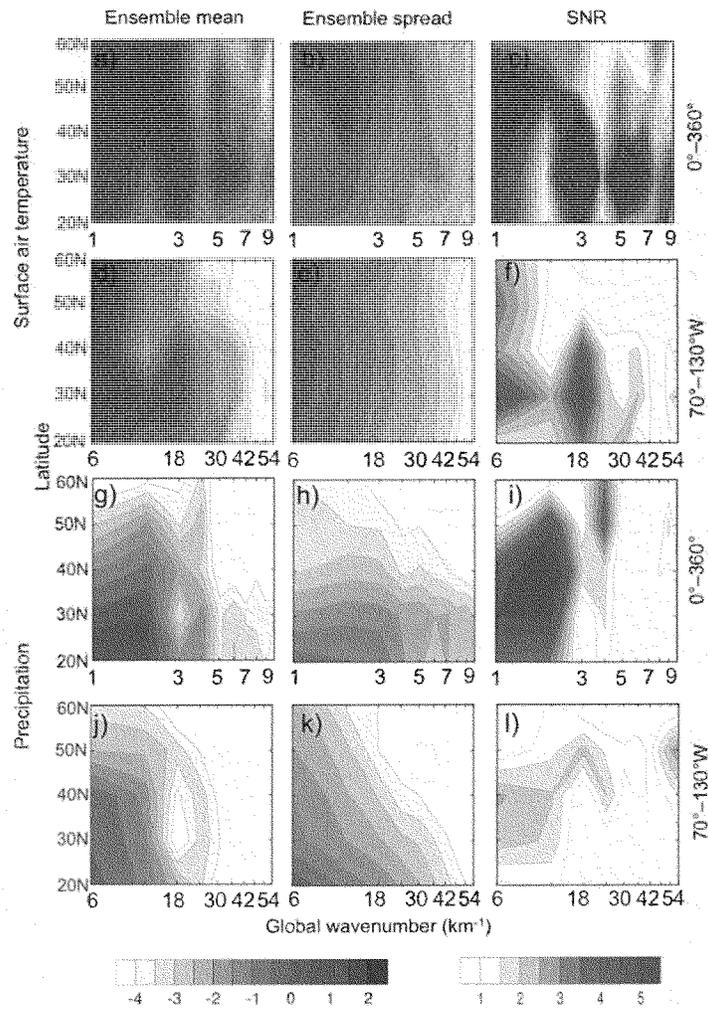


Fig. 5. As in Fig. 2 but using CMIP3 historical simulations.

riod 2074-99 using the CMIP3 multimodel ensemble simulations (Figs. 7-9). Even though obviously we do not have observations to verify these simulations, our conclusions again

remain mostly unchanged: there is an apparent scale limit by which the uncertainty in the prediction (noise) becomes greater than the ensemble mean prediction (signal). This fur-

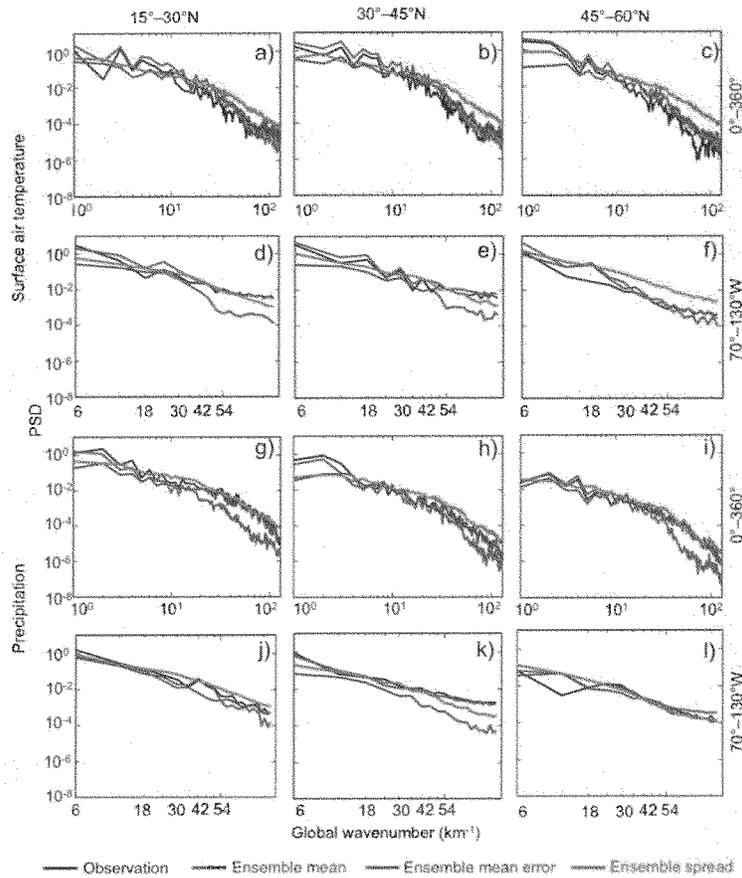


Fig. 6. As in Fig. 3 but using CMIP3 historical simulations.

ther highlights the limited predictability of climate models, especially at regional scales for different climate scenarios.

5. Concluding remarks

In summary, through an analysis of surface temperature and precipitation variability in the CMIP5 historical simu-

lations and comparisons with observational data during the overlapping (1979–2014) interval of the late 20th/early 21st century, we have found that there appears to be a fundamental scale limit below which refinement of climate model predictions may not be possible. While the predictability limit depends on the variables and regions analyzed, the averaging period and/or season, a seemingly robust result is that, for North America, the uncertainty due to intrinsic noise ap-

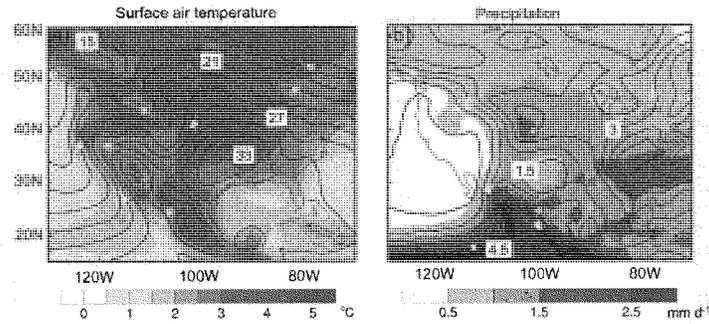


Fig. 7. Ensemble mean (contours) and ensemble spread (color-shaded) for CMIP3 “A2” scenario future projections (AD 2074–99) for (a) averaged summer (June–August) surface air temperature and (b) precipitation over the U.S.

Table 2. List of CMIP3 models used in this study (IPCC, 2007).

Model	Sponsor	Atmospheric resolution (lat × lon)
BCCR-BCM2.0	Bjerknes Centre for Climate Research, Norway	2.8° × 2.8°
CCCMA_CGCM3.1.5	Canadian Centre for Climate Modelling & Analysis	2.8° × 2.8°
CNRM-CM3.1	Météo-France/Centre National de Recherches Météorologiques	2.8° × 2.8°
CSIRO MK3.0.2	CSIRO Atmospheric Research	1.875° × 1.875°
CSIRO MK3.5.3	CSIRO Atmospheric Research	1.875° × 1.875°
GFDL CM2.0.0.3	US Dept. of Commerce/NOAA/Geophysical Fluid Dynamics Laboratory	2.5° × 2°
GFDL CM2.0.1.3	US Dept. of Commerce/NOAA/Geophysical Fluid Dynamics Laboratory	2.5° × 2°
GISS_MODEL_E_R.9	NASA/Goddard Institute for Space Studies	5° × 4°
INGV_ECHAM4.1	Instituto Nazionale di Geofisica e Vulcanologia	1.125° × 1.125°
INM CM3.0.1	Institute for Numerical Mathematics	5° × 4°
IPSL-CM4.1	L’Institut Pierre Simon Laplace	3.75° × 2.5°
MIROC3.2 (medres)	Center for Climate System Research (The University of Tokyo), National Institute for Environmental Studies, and Frontier Research Center for Global Change (IAMSTEC)	2.8° × 2.8°
MPL_ECHAM5.4	Max Planck Institute for Meteorology	1.875° × 1.875°
MRI-CGCM2.3.2A.5	Meteorological Research Institute	2.8° × 2.8°
NCAR_CCSM3.0.8	National Center for Atmospheric Research	1.4° × 1.4°
NCAR_PCM1.4	National Center for Atmospheric Research	2.8° × 2.8°
UKMO_HADCM3.2	Hadley Centre for Climate Prediction and Research/Met Office	3.75° × 2.75°
UKMO_HADGEM1.2	Hadley Centre for Climate Prediction and Research/Met Office	3.75° × 2.75°

proaches in magnitude the amplitude of the climate change signal at horizontal scales below about 1000 km for surface temperature, and 2000 km for precipitation.

Our findings generalize beyond the specifics of the CMIP5 historical simulation ensemble. Parallel analyses of both (i) the earlier generation CMIP3 historical simula-

tion ensemble and (ii) 21st century climate projections based on the CMIP3 “A2” emissions scenario, yield qualitatively very similar conclusions. Given that downscaling methods (whether based on statistical or dynamical approaches) require information from large-scale climate model simulations as boundary conditions and/or reference states, the lack of

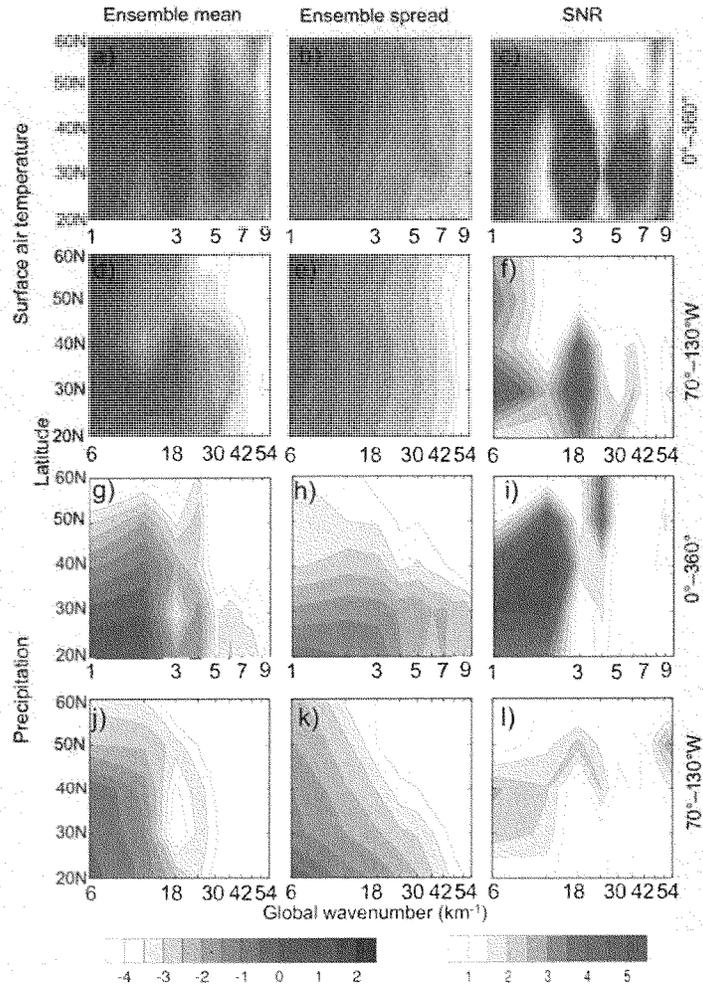


Fig. 8. As in Fig. 2 but using CMIP3 "A2" scenario future projections (AD 2074–99).

predictability at these larger scales likely translates to a lack of predictability at local scales. One apparent exception, based on our findings, are cases where smaller-scale orographic forcing or land–sea contrasts provide additional pre-

dictability at smaller scales.

Given the importance of future projections of surface temperature and precipitation for assessing climate change impacts such as heat stress, flooding potential and drought

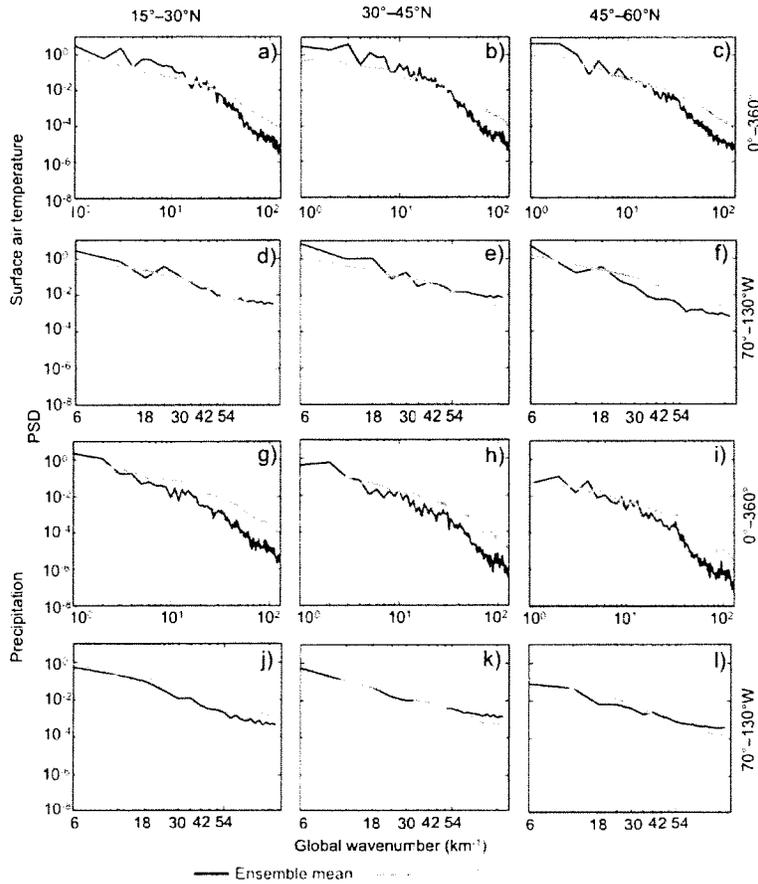


Fig. 9. As in Fig. 3 but using CMIP3 “A2” scenario future projections (AD 2074–2099).

magnitude, duration and extent, our findings suggest great challenges in assessing climate change risk and damage at regional scales most important to stakeholders and policymakers. One potential implication of our findings is that regional adaptation efforts might, in some circumstances, be better focused on reducing vulnerability to climate change in general, rather than planned adaptation to specific projected climate changes.

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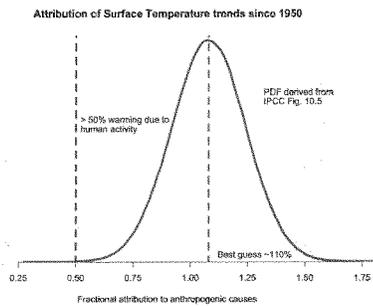


IPCC attribution statements redux: A response to Judith Curry

Filed under: Climate modelling, Climate Science, Instrumental Record, IPCC — gavin @ 27 August 2014

I have written a number of times about the procedure used to attribute recent climate change (here in 2010, in 2012 (about the AR4 statement), and again in 2013 after AR5 was released). For people who want a summary of what the attribution problem is, how we think about the human contributions and why the IPCC reaches the conclusions it does, read those posts instead of this one.

The bottom line is that multiple studies indicate with very strong confidence that human activity is the dominant component in the warming of the last 50 to 60 years, and that our best estimates are that pretty much all of the rise is anthropogenic.



The probability density function for the fraction of warming attributable to human activity (derived from Fig. 10.5 in IPCC AR5). The bulk of the probability is far to the right of the "50%" line, and the peak is around 110%.

If you are still here, I should be clear that this post is focused on a specific claim Judith Curry has **recently blogged** about supporting a "50-50" attribution (i.e. that trends since the middle of the 20th Century are 50% human-caused, and 50% natural, a position that would center her pdf at 0.5 in the figure above). She **also commented** about her puzzlement about why other scientists don't agree with her. Reading over her arguments in detail, I find very little to recommend them, and perhaps the reasoning for this will be interesting for readers. So, here

follows a line-by-line commentary on her recent post. Please excuse the length.

Starting from the top... (note, quotes from Judith Curry's blog are blockquoted).

Pick one:

- a) Warming since 1950 is predominantly (more than 50%) caused by humans.
- b) Warming since 1950 is predominantly caused by natural processes.

When faced with a choice between a) and b), I respond: 'I can't choose, since i think the most likely split between natural and anthropogenic causes to recent global warming is about 50-50'. Gavin thinks I'm 'making things up', so I promised yet another post on this topic.

This is not a good start. The statements that ended up in the IPCC SPMs are descriptions of what was found in the main chapters and in the papers they were assessing, not questions that were independently thought about and then answered. Thus while this dichotomy might represent Judith's problem right now, it has nothing to do with what IPCC concluded. In addition, in framing this as a binary choice, it gives implicit (but invalid) support to the idea that each choice is equally likely. That this is invalid reasoning should be obvious by simply replacing 50% with any other value and noting that the half/half argument could be made independent of any data.

For background and context, see my previous 4 part series **Overconfidence in the IPCC's detection and attribution**.

Framing

The IPCC's AR5 attribution statement:

*It is extremely likely that **more than half** of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. The best estimate of the human induced contribution to warming is similar to the observed warming over this period.*

I've remarked on the 'most' (previous incarnation of 'more than half', equivalent in meaning) in my **Uncertainty Monster** paper:

Further, the attribution statement itself is at best imprecise and at worst ambiguous: what does "most" mean – 51% or 99%?

Whether it is 51% or 99% would seem to make a rather big difference regarding the policy response. It's time for climate scientists to refine this range.

I am arguing here that the 'choice' regarding attribution shouldn't be binary, and there should not be a break at 50%; rather we should consider the following terciles for the net anthropogenic contribution to warming since 1950:

- >66%
- 33-66%
- <33%

JC note: I removed the bounds at 100% and 0% as per a comment from Bart Verheggen.

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Here Judith makes the same mistake that I commented on in my **2012 post** – assuming that a statement about where the bulk of the pdf lies is a statement about where it's mean is and that it must be cut off at some value (whether it is 99% or 100%). Neither of those things follow. I will gloss over the completely unnecessary confusion of the meaning of the word 'most' (again thoroughly discussed in 2012). I will also not get into policy implications since the question itself is purely a scientific one.

The division into terciles for the analysis is not a problem though, and the weight of the pdf in each tercile can easily be calculated. Translating the top figure, the likelihood of the attribution of the 1950+ trend to anthropogenic forcings falling in each tercile is $2 \times 10^{-4}\%$, 0.4% and 99.5% respectively.

Note: I am referring only to a period of overall warming, so by definition the cooling argument is eliminated. Further, I am referring to the NET anthropogenic effect (greenhouse gases + aerosols + etc). I am looking to compare the relative magnitudes of net anthropogenic contribution with net natural contributions.

The two IPCC statements discussed attribution to greenhouse gases (in AR4) and to all anthropogenic forcings (in AR5) (the subtleties involved there are discussed in the **2013 post**). I don't know what she refers to as the 'cooling argument', since it is clear that the temperatures have indeed warmed since 1950 (the period referred to in the IPCC statements). It is worth pointing out that there can be no assumption that natural contributions must be positive – indeed for any random time period of any length, one would expect natural contributions to be cooling half the time.

Further, by global warming I refer explicitly to the historical record of global average surface temperatures. Other data sets such as ocean heat content, sea ice extent, whatever, are not sufficiently mature or long-range (see **Climate data records: maturity matrix**). Further, the surface temperature is most relevant to climate change impacts, since humans and land ecosystems live on the surface. I acknowledge that temperature variations can vary over the earth's surface, and that heat can be stored/released by vertical processes in the atmosphere and ocean. But the key issue of societal relevance (not to mention the focus of IPCC detection and attribution arguments) is the realization of this heat on the Earth's surface.

Fine with this.

IPCC

Before getting into my 50-50 argument, a brief review of the IPCC perspective on detection and attribution. For detection, see my post **Overconfidence in IPCC's detection and attribution. Part I**.

Let me clarify the distinction between detection and attribution, as used by the IPCC. Detection refers to change above and beyond natural internal variability. Once a change is detected, attribution attempts to identify external drivers of the change.

The reasoning process used by the IPCC in assessing confidence in its attribution statement is described by this statement from the AR4:

"The approaches used in detection and attribution research described above cannot fully account for all uncertainties, and thus ultimately expert judgement is required to give a calibrated assessment of whether a specific cause is responsible for a given climate change. The assessment approach used in this chapter is to consider results from multiple studies

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extent to which there is consensus among studies on the significance of detection results, the extent to which there is consensus on the consistency between the observed change and the change expected from forcing, the degree of consistency with other types of evidence, the extent to which known uncertainties are accounted for in and between studies, and whether there might be other physically plausible explanations for the given climate change. Having determined a particular likelihood assessment, this was then further downweighted to take into account any remaining uncertainties, such as, for example, structural uncertainties or a limited exploration of possible forcing histories of uncertain forcings. The overall assessment also considers whether several independent lines of evidence strengthen a result." (IPCC AR4)

I won't make a judgment here as to how 'expert judgment' and subjective 'down weighting' is different from 'making things up'

Is expert judgement about the structural uncertainties in a statistical procedure associated with various assumptions that need to be made different from 'making things up'? Actually, yes – it is.

AR5 Chapter 10 has a more extensive discussion on the philosophy and methodology of detection and attribution, but the general idea has not really changed from AR4.

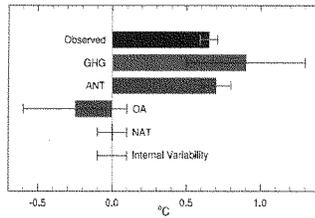
In my previous post (related to the AR4), I asked the question: what was the original likelihood assessment from which this apparently minimal downweighting occurred? The AR5 provides an answer:

The best estimate of the human induced contribution to warming is similar to the observed warming over this period.

So, I interpret this as scything that the IPCC's best estimate is that 100% of the warming since 1950 is attributable to humans, and they then down weight this to 'more than half' to account for various uncertainties. And then assign an 'extremely likely' confidence level to all this.

Making things up, anyone?

This is very confused. The basis of the AR5 calculation is summarised in figure 10.5:



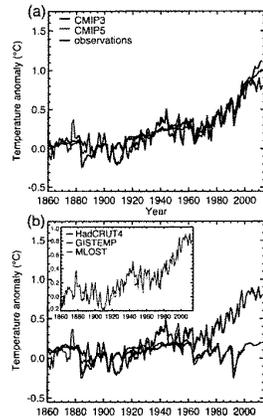
The best estimate of the warming due to anthropogenic forcings (ANT) is the orange bar

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~110%, with a 5-95% range of 80-130%. This easily justifies the IPCC claims of having a mean near 100%, and a very low likelihood of the attribution being less than 50% ($p < 0.0001!$). Note there is no 'downweighting' of any argument here – both statements are true given the numerical distribution. However, there must be some expert judgement to assess what potential structural errors might exist in the procedure. For instance, the assumption that fingerprint patterns are linearly additive, or uncertainties in the pattern because of deficiencies in the forcings or models etc. In the absence of any reason to think that the attribution procedure is biased (and Judith offers none), structural uncertainties will only serve to expand the spread. Note that one would need to expand the uncertainties by a factor of 3 in both directions to contradict the first part of the IPCC statement. That seems unlikely in the absence of any demonstration of some huge missing factors.

I've just reread Overconfidence in IPCC's detection and attribution. Part IV. I recommend that anyone who seriously wants to understand this should read this previous post. It explains why I think the AR5 detection and attribution reasoning is flawed.

Of particular relevance to the 50-50 argument, the IPCC has failed to convincingly demonstrate 'detection.' Because historical records aren't long enough and paleo reconstructions are not reliable, the climate models 'detect' AGW by comparing natural forcing simulations with anthropogenically forced simulations. When the spectra of the variability of the unforced simulations is compared with the observed spectra of variability, the AR4 simulations show insufficient variability at 40-100 yrs, whereas AR5 simulations show reasonable variability. The IPCC then regards the divergence between unforced and anthropogenically forced simulations after ~1980 as the heart of their detection and attribution argument. See Figure 10.1 from AR5 WGI (a) is with natural and anthropogenic forcing; (b) is without anthropogenic forcing:



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the idea that one can estimate the result of a counterfactual: what would the temperature have done in the absence of the drivers compared to what it would do if they were included? GCM results show clearly that the expected anthropogenic signal would start to be detectable ("come out of the noise") sometime after 1980 (for reference, Hansen's public statement to that effect was in 1988). There is no obvious discrepancy in spectra between the CMIP5 models and the observations, and so I am unclear why Judith finds the detection step lacking. It is interesting to note that given the variability in the models, the anthropogenic signal is now more than 5σ over what would have been expected naturally (and if it's good enough for the Higgs Boson...).

Note in particular that the models fail to simulate the observed warming between 1910 and 1940.

Here Judith is (I think) referring to the mismatch between the ensemble mean (red) and the observations (black) in that period. But the red line is simply an estimate of the forced trends, so the correct reading of the graph would be that the models do not support an argument suggesting that all of the 1910-1940 excursion is forced (contingent on the forcing datasets that were used), which is what was stated in AR5. However, the observations are well within the spread of the models and so could easily be within the range of the forced trend + simulated internal variability. A quick analysis (a proper attribution study is more involved than this) gives an observed trend over 1910-1940 as 0.13 to 0.15°C/decade (depending the dataset, with $\pm 0.03^\circ\text{C}$ (5-95%) uncertainty in the OLS), while the spread in my collation of the historical CMIP5 models is $0.07 \pm 0.07^\circ\text{C}/\text{decade}$ (5-95%). Specifically, 8 model runs out of 131 have trends over that period greater than 0.13°C/decade – suggesting that one might see this magnitude of excursion 5-10% of the time. For reference, the GHG related trend in the GISS models over that period is about 0.06°C/decade. However, the uncertainties in the forcings for that period are larger than in recent decades (in particular for the solar and aerosol-related emissions) and so the forced trend (0.07°C/decade) could have been different in reality. And since we don't have good ocean heat content data, nor any satellite observations, or any measurements of stratospheric temperatures to help distinguish potential errors in the forcing from internal variability, it is inevitable that there will be more uncertainty in the attribution for that period than for more recently.

The glaring flaw in their logic is this. If you are trying to attribute warming over a short period, e.g. since 1980, detection requires that you explicitly consider the phasing of multidecadal natural internal variability during that period (e.g. AMO, PDO), not just the spectra over a long time period. Attribution arguments of late 20th century warming have failed to pass the detection threshold which requires accounting for the phasing of the AMO and PDO. It is typically argued that these oscillations go up and down, in net they are a wash. Maybe, but they are NOT a wash when you are considering a period of the order, or shorter than, the multidecadal time scales associated with these oscillations.

Watch the pea under the thimble here. The IPCC statements were from a relatively long period (i.e. 1950 to 2005/2010). Judith jumps to assessing shorter trends (i.e. from 1980) and shorter periods obviously have the potential to have a higher component of internal variability. The whole point about looking at longer periods is that internal oscillations have a smaller contribution. Since she is arguing that the AMO/PDO have potentially multi-decadal periods, then she should be supportive of using multi-decadal periods (i.e. 50, 60 years or more) for the attribution.

Further, in the presence of multidecadal oscillations with a nominal 60-80 yr time scale, convincing attribution requires that you can attribute the variability for more than one 60-80

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change in the late 20th century.

This isn't quite right. Our expectation (from basic theory and models) is that the second half of the 20th C is when anthropogenic effects really took off. Restricting attribution to 120-160 yr trends seems too constraining – though there is no problem in looking at that too. However, Judith is actually assuming what remains to be determined. What is the evidence that all 60-80yr variability is natural? Variations in forcings (in particular aerosols, and maybe solar) can easily project onto this timescale and so any separation of forced vs. internal variability is **really difficult based on statistical arguments alone** (see also **Mann et al, 2014**). Indeed, it is the attribution exercise that helps you conclude what the magnitude of any internal oscillations might be. Note that if we were only looking at the global mean temperature, there would be quite a lot of wiggle room for different contributions. Looking deeper into different variables and spatial patterns is what allows for a more precise result.

The 50-50 argument

There are multiple lines of evidence supporting the 50-50 (middle tercile) attribution argument. Here are the major ones, to my mind.

Sensitivity

The 100% anthropogenic attribution from climate models is derived from climate models that have an average equilibrium climate sensitivity (ECS) around 3C. One of the major findings from AR5 WG1 was the divergence in ECS determined via climate models versus observations. This divergence led the AR5 to lower the likely bound on ECS to 1.5C (with ECS very unlikely to be below 1C).

Judith's argument misstates how forcing fingerprints from GCMs are used in attribution studies. Notably, they are *scaled* to get the best fit to the observations (along with the other terms). If the models all had sensitivities of either 1°C or 6°C, the attribution to anthropogenic changes would be the same as long as the *pattern* of change was robust. What would change would be the scaling – less than one would imply a better fit with a lower sensitivity (or smaller forcing), and vice versa (see **figure 10.4**).

She also misstates how ECS is constrained – all constraints **come from observations** (whether from long-term paleo-climate observations, transient observations over the 20th Century or observations of emergent properties that correlate to sensitivity) combined with some sort of model. The divergence in AR5 was between constraints based on the transient observations using simplified energy balance models (EBM), and everything else. Subsequent work (for instance by **Drew Shindell**) has shown that the simplified EBMs are missing important transient effects associated with aerosols, and so the divergence is very likely less than AR5 assessed.

Nic Lewis at **Climate Dialogue** summarizes the observational evidence for ECS between 1.5 and 2C, with transient climate response (TCR) around 1.3C.

Nic Lewis has a comment at **BishopHill** on this:

The press release for the new study states: "Rapid warming in the last two and a half decades of the 20th century, they proposed in an earlier study, was roughly half due to global warming and half to the natural Atlantic Ocean cycle that kept more heat near the surface." If only half the warming over 1976-2000 (linear trend 0.18°C/decade) was indeed anthropogenic, and the IPCC AR5 best estimate of the change in anthropogenic forcing over
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my and Marcel Crok's report A Sensitive Matter is certainly supported by Chen and Tung's findings.

Since the CMIP5 models used by the IPCC on average adequately reproduce observed global warming in the last two and a half decades of the 20th century without any contribution from multidecadal ocean variability, it follows that those models (whose mean TCR is slightly over 1.8°C) must be substantially too sensitive.

BTW, the longer term anthropogenic warming trends (50, 75 and 100 year) to 2011, after removing the solar, ENSO, volcanic and AMO signals given in Fig. 5 B of Tung's earlier study (freely accessible via the link), of respectively 0.083, 0.078 and 0.068°C/decade also support low TCR values (varying from 0.91°C to 1.37°C), upon dividing by the linear trends exhibited by the IPCC AR5 best estimate time series for anthropogenic forcing. My own work gives TCR estimates towards the upper end of that range, still far below the average for CMIP5 models.

If true climate sensitivity is only 50-65% of the magnitude that is being simulated by climate models, then it is not unreasonable to infer that attribution of late 20th century warming is not 100% caused by anthropogenic factors, and attribution to anthropogenic forcing is in the middle tercile (50-50).

The IPCC's attribution statement does not seem logically consistent with the uncertainty in climate sensitivity.

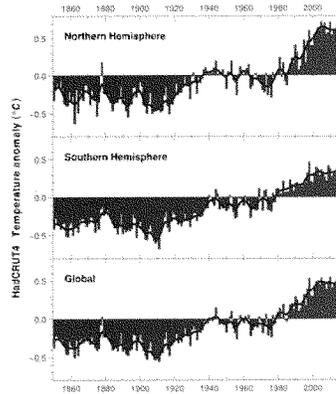
This is related to a paper by **Tung and Zhou (2013)**. Note that the attribution statement has again shifted to the last 25 years of the 20th Century (1976-2000). But there are a couple of major problems with this argument though. First of all, Tung and Zhou *assumed* that all multi-decadal variability was associated with the Atlantic Multi-decadal Oscillation (AMO) and did not assess whether anthropogenic forcings could project onto this variability. It is circular reasoning to then use this paper to conclude that all multi-decadal variability is associated with the AMO.

The second problem is more serious. Lewis' argument up until now that the best fit to the transient evolution over the 20th Century is with a relatively small sensitivity and small aerosol forcing (as opposed to a larger sensitivity and larger opposing aerosol forcing). However, in both these cases the attribution of the long-term trend to the combined anthropogenic effects is actually the *same* (near 100%). Indeed, one valid criticism of the recent papers on transient constraints is precisely that the simple models used do not have sufficient decadal variability!

Climate variability since 1900

From HadCRUT4:

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The IPCC does not have a convincing explanation for:

- warming from 1910-1940
- cooling from 1940-1975
- hiatus from 1998 to present

The IPCC purports to have a highly confident explanation for the warming since 1950, but it was only during the period 1976-2000 when the global surface temperatures actually increased.

The absence of convincing attribution of periods other than 1976-present to anthropogenic forcing leaves natural climate variability as the cause – some combination of solar (including solar indirect effects), uncertain volcanic forcing, natural internal (intrinsic variability) and possible unknown unknowns.

This point is not an argument for any particular attribution level. As is well known, using an argument of total ignorance to assume that the choice between two arbitrary alternatives must be 50/50 is a fallacy.

Attribution for any particular period follows exactly the same methodology as any other. What IPCC chooses to highlight is of course up to the authors, but there is nothing preventing an assessment of any of these periods. In general, the shorter the time period, the greater potential for internal variability, or (equivalently) the larger the forced signal needs to be in order to be detected. For instance, Pinatubo was a big rapid signal so that was detectable even in just a few years of data.

I gave a basic attribution for the 1910-1940 period above. The 1940-1975 average trend in the CMIP5 ensemble is $-0.01^{\circ}\text{C}/\text{decade}$ (range -0.2 to $0.1^{\circ}\text{C}/\text{decade}$), compared to -0.003 to $-0.03^{\circ}\text{C}/\text{decade}$ in the observations and are therefore a reasonable fit. The GHG driven trends for this period are $\pm 0.1^{\circ}\text{C}/\text{decade}$, implying that there is a roughly opposite forcing coming

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2014; Huber and Knutti, 2014). Better information about ocean heat content is also available to help there, but this is still a work in progress and is a great example of why it is harder to attribute changes over small time periods.

In the GCMs, the importance of internal variability to the trend decreases as a function of time. For 30 year trends, internal variations can have a $\pm 0.12^\circ\text{C}/\text{decade}$ or so impact on trends, for 60 year trends, closer to $\pm 0.08^\circ\text{C}/\text{decade}$. For an expected anthropogenic trend of around $0.2^\circ\text{C}/\text{decade}$, the signal will be clearer over the longer term. Thus cutting down the period to ever-shorter periods of years increases the challenges and one can end up simply cherry picking the noise instead of seeing the signal.

A key issue in attribution studies is to provide an answer to the question: When did anthropogenic global warming begin? As per the IPCC's own analyses, significant warming didn't begin until 1950. Just the Facts has a good post on this **When did anthropogenic global warming begin?**

I disagree as to whether this is a "key" issue for attribution studies, but as to when anthropogenic warming began, the answer is actually quite simple – when we started altering the atmosphere and land surface at climatically relevant scales. For the CO₂ increase from deforestation this goes back millennia, for fossil fuel CO₂, since the invention of the steam engine at least. In both cases there was a big uptick in the 18th Century. Perhaps that isn't what Judith is getting at though. If she means when was it easily detectable, I discussed that above and the answer is sometime in the early 1980s.

The temperature record since 1900 is often characterized as a staircase, with periods of warming sequentially followed by periods of stasis/cooling. The stadium wave and Chen and Tung papers, among others, are consistent with the idea that the multidecadal oscillations, when superimposed on an overall warming trend, can account for the overall staircase pattern.

Nobody has any problems with the idea that multi-decadal internal variability might be important. The problem with many studies on this topic is the *assumption* that all multi-decadal variability is internal. This is very much an open question.

Let's consider the 21st century hiatus. The continued forcing from CO₂ over this period is substantial, not to mention 'warming in the pipeline' from late 20th century increase in CO₂. To counter the expected warming from current forcing and the pipeline requires natural variability to effectively be of the same magnitude as the anthropogenic forcing. This is the rationale that Tung used to justify his 50-50 attribution (see also **Tung and Zhou**). The natural variability contribution may not be solely due to internal/intrinsic variability, and there is much speculation related to solar activity. There are also arguments related to aerosol forcing, which I personally find unconvincing (the topic of a future post).

Shorter time-periods are noisier. There are more possible influences of an appropriate magnitude and, for the recent period, continued (and very frustrating) uncertainties in aerosol effects. This has very little to do with the attribution for longer-time periods though (since change of forcing is much larger and impacts of internal variability smaller).

The IPCC notes overall warming since 1880. In particular, the period 1910-1940 is a period of warming that is comparable in duration and magnitude to the warming 1976-2000. Any anthropogenic forcing of that warming is very small (see Figure 10.1 above). The timing of the early 20th century warming is consistent with the AMO/PDO (e.g. the stadium wave; also

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oscillation? Could the same processes causing the early 20th century warming be contributing to the late 20th century warming?

If we were just looking at 30 year periods in isolation, it's inevitable that there will be these ambiguities because data quality degrades quickly back in time. But that is exactly why IPCC looks at longer periods.

Not only don't we know the answer to these questions, but no one even seems to be asking them!

This is simply not true.

Attribution

I am arguing that climate models are not fit for the purpose of detection and attribution of climate change on decadal to multidecadal timescales. Figure 10.1 speaks for itself in this regard (see figure 11.25 for a zoom in on the recent hiatus). By 'fit for purpose', I am prepared to settle for getting an answer that falls in the right tercile.

Given the results above it would require a huge source of error to move the bulk of that probability anywhere else other than the right tercile.

The main relevant deficiencies of climate models are:

- climate sensitivity that appears to be too high, probably associated with problems in the fast thermodynamic feedbacks (water vapor, lapse rate, clouds)
- failure to simulate the correct network of multidecadal oscillations and their correct phasing
- substantial uncertainties in aerosol indirect effects
- unknown and uncertain solar indirect effects

The sensitivity argument is irrelevant (given that it isn't zero of course). Simulation of the exact phasing of multi-decadal internal oscillations in a free-running GCM is impossible so that is a tough bar to reach! There are indeed uncertainties in aerosol forcing (not just the indirect effects) and, especially in the earlier part of the 20th Century, uncertainties in solar trends and impacts. Indeed, there is even uncertainty in volcanic forcing. However, none of these issues really affect the attribution argument because a) differences in magnitude of forcing over time are assessed by way of the scales in the attribution process, and b) errors in the spatial pattern will end up in the residuals, which are not large enough to change the overall assessment.

Nonetheless, it is worth thinking about what plausible variations in the aerosol or solar effects could have. Given that we are talking about the net anthropogenic effect, the playing off of negative aerosol forcing and climate sensitivity within bounds actually has very little effect on the attribution, so that isn't particularly relevant. A much bigger role for solar would have an impact, but the trend would need to be about 5 times stronger over the relevant period to change the IPCC statement and I am not aware of any evidence to support this (and much that doesn't).

So, how to sort this out and do a more realistic job of detecting climate change and attributing it to natural variability versus anthropogenic forcing? Observationally based methods and simple models have been underutilized in this regard. Of great importance is to consider uncertainties in external forcing in context of attribution uncertainties.

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these issues relate to microphysical effects and atmospheric chemistry – neither of which are accounted for in simple models.

The logic of reasoning about climate uncertainty, is not at all straightforward, as discussed in my paper **Reasoning about climate uncertainty**.

So, am I 'making things up'? Seems to me that I am applying straightforward logic. Which IMO has been disturbingly absent in attribution arguments, that use climate models that aren't fit for purpose, use circular reasoning in detection, fail to assess the impact of forcing uncertainties on the attribution, and are heavily spiced by expert judgment and subjective downweighting.

My reading of the evidence suggests clearly that the IPCC conclusions are an accurate assessment of the issue. I have tried to follow the proposed logic of Judith's points here, but unfortunately each one of these arguments is either based on a misunderstanding, an unfamiliarity with what is actually being done or is a red herring associated with shorter-term variability. If Judith is interested in why her arguments are not convincing to others, perhaps this can give her some clues.

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Judy Curry's attribution non-argument

Filed under: [Climate modelling](#) [Climate Science](#) [Greenhouse gases](#) — gavin @ 18 April 2017

Following on from the 'interesting' House Science Committee hearing two weeks ago, there was an excellent rebuttal curated by [ClimateFeedback](#) of the unsupported and often-times misleading claims from the majority witnesses. In response, Judy Curry has (yet again) **declared herself unconvinced** by the evidence for a dominant role for human forcing of recent climate changes. And as **before** she fails to give any quantitative argument to support her contention that human drivers are not the dominant cause of recent trends.

Her reasoning consists of a small number of plausible sounding, but ultimately unconvincing issues that are nonetheless worth diving into. She summarizes her claims in the **following comment**:

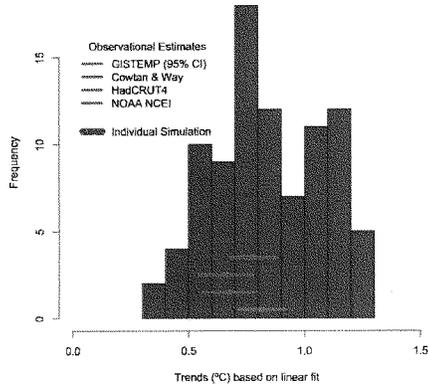
... They use models that are tuned to the period of interest, which should disqualify them from being used in attribution study for the same period (circular reasoning, and all that). The attribution studies fail to account for the large multi-decadal (and longer) oscillations in the ocean, which have been estimated to account for 20% to 40% to 50% to 100% of the recent warming. The models fail to account for solar indirect effects that have been hypothesized to be important. And finally, the CMIP5 climate models used values of aerosol forcing that are now thought to be far too large.

These claims are either wrong or simply don't have the implications she claims. Let's go through them one more time.

1) Models are NOT tuned [for the late 20th C/21st C warming] and using them for attribution is NOT circular reasoning.

Curry's claim is wrong on at least two levels. The "models used" (otherwise known as the CMIP5 ensemble) were *not* tuned for consistency for the period of interest (the 1950-2010 trend is what was highlighted in the IPCC reports, about 0.8°C warming) and the evidence is obvious from the fact that the trends in the individual model simulations over this period go from 0.35 to 1.29°C! (or 0.84±0.45°C (95% envelope)).

Global Surface Temperature Trends 1951-2010 (CMIP5 Simulations)



Ask yourself one question: Were these models tuned to the observed values?

Second, this is not how the attribution is done in any case. What actually happens is that the fingerprint of different forcings are calculated independently of the historical runs (using subsets of the drivers) and then matched to the observations using scalings for the patterns generated. Scaling factors near 1 imply that the models' expected fingerprints fit reasonably well to the observations. If the models are too sensitive or not enough, that will come out in the factors, since the patterns themselves are reasonably robust. So models that have half the observed trend, or twice as much, can still help determine the pattern of change associated with the drivers. The attribution to the driver is based on the best fits of that pattern and others, not on the mean or trend in the historical runs.

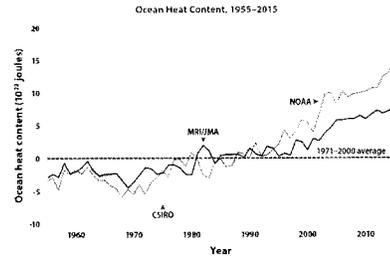
2) Attribution studies DO account for low-frequency internal variability

Patterns of variability that don't match the predicted fingerprints from the examined drivers (the 'residuals') can be large – especially on short-time scales, and look in most cases like the modes of internal variability that we've been used to: ENSO/PDO, the North Atlantic multidecadal oscillation etc. But the crucial thing is that these residuals have small trends compared to the trends from the external drivers. We can also put these modes directly into the analysis with little overall difference to the results.

3) No credible study has suggested that ocean oscillations can account for the long-term trends

The key observation here is the increase in ocean heat content over the last half century (the figure below shows three estimates of the changes since 1955). This absolutely means that more energy has been coming into the system than leaving.

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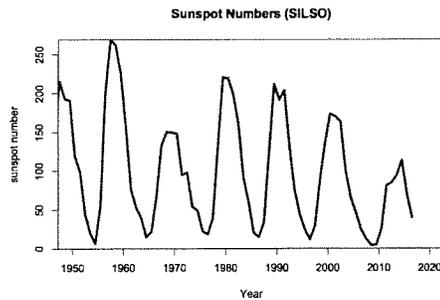
Now this presents a real problem for claims that ocean variability is the main driver. To see why, note that ocean dynamics changes only move energy around – to warm somewhere, they have to cool somewhere else. So posit an initial dynamic change of ocean circulation that warms the surface (and cools below or in other regions). To bring more energy into the system, that surface warming would have to cause the top-of-the-atmosphere radiation balance to change positively, but that would add to warming, amplifying the initial perturbation and leading to a runaway instability. There are really good reasons to think this is unphysical.

Remember too that ocean heat content increases were a *predicted* consequence of GHG-driven warming well before the ocean data was clear enough to demonstrate it.

4) Indirect effects of solar forcing cannot explain recent trends

Solar activity impacts on climate are a fascinating topic, and encompass direct radiative processes, indirect effects via atmospheric chemistry and (potentially) aerosol formation effects. Much work is being done on improving the realism of such effects – particularly through ozone chemistry (which enhances the signal), and aerosol pathways (which don't appear to have much of a global effect i.e. [Dunne et al. \(2016\)](#)). However, attribution of post 1950 warming to solar activity is tricky (i.e. impossible), because solar activity has declined (slightly) over that time:

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5) Aerosol forcings are indeed uncertain, but this does not impact the attribution of recent trends very much.

One of the trickier issues for fingerprint studies is distinguishing between the patterns from anthropogenic aerosols and greenhouse gases. While the hemispheric asymmetries are slightly larger for aerosols, the overall surface pattern is quite similar to that for greenhouse gases (albeit with a different sign). This is one of the reasons why the most confident statements in IPCC are made with respect to the "Anthropogenic" changes all together since that doesn't require parsing out the (opposing) factors of GHGs and aerosols. Therefore in a fingerprint study that doesn't distinguish between aerosols and GHGs, what the exact value of the aerosol forcing right is basically irrelevant. If any specific model is getting it badly wrong, that will simply manifest through a scaling factor very different from 1 without changing the total attribution.

What would it actually take to make a real argument?

As I've been asking for almost **three years**, it is way past time for Curry to shore up her claims in a quantitative way. I doubt that this is actually possible, but if one was to make the attempt these are the kind of things needed:

- Evidence that models underestimate internal variability at ~50-80 yr timescales by a factor of ~5.
- Evidence that indirect solar forcing can increase the long-term impact of solar by a factor of 3 on centennial time-scales or reverse the sign of the forcing on 50-80 yr timescales (one or the other, both would be tricky!).
- Evidence that warm surface ocean oscillations are associated with increased downward net radiation at the TOA. [This is particularly hard because it would mean the climate was fundamentally unstable].
- Evidence that the known fingerprints of different forcings are fundamentally wrong. Say, that CO2 does not cool the stratosphere, or that solar forcing doesn't warm it.

Absent any evidence to support these statements, the claim that somehow, somewhere the straightforward and predictive mainstream conclusions are fundamentally wrong just isn't credible.

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Promoting pro-environmental action in climate change deniers

Paul G. Bain*, Matthew J. Hornsey, Renata Bongiorno and Carla Jeffries

A sizeable (and growing) proportion of the public in Western democracies deny the existence of anthropogenic climate change^{1,2}. It is commonly assumed that convincing deniers that climate change is real is necessary for them to act pro-environmentally^{3,4}. However, the likelihood of 'conversion' using scientific evidence is limited because these attitudes increasingly reflect ideological positions^{5,6}. An alternative approach is to identify outcomes of mitigation efforts that deniers find important. People have strong interests in the welfare of their society, so deniers may act in ways supporting mitigation efforts where they believe these efforts will have positive societal effects. In Study 1, climate change deniers (N = 155) intended to act more pro-environmentally where they thought climate change action would create a society where people are more considerate and caring, and where there is greater economic/technological development. Study 2 (N = 347) replicated this experimentally, showing that framing climate change action as increasing consideration for others, or improving economic/technological development, led to greater pro-environmental action intentions than a frame emphasizing avoiding the risks of climate change. To motivate deniers' pro-environmental actions, communication should focus on how mitigation efforts can promote a better society, rather than focusing on the reality of climate change and averting its risks.

Enormous effort has been devoted to convincing the public that anthropogenic climate change is real. However, these attempts are increasingly failing—since 2008 the number of deniers of anthropogenic climate change has climbed to one-third or more of the population in high-carbon-emitting countries such as the United States and Australia^{1,2,7}. As widespread acceptance of the reality of anthropogenic climate change is considered critical to effective responses^{3,4}, public scepticism about anthropogenic climate change is seen as an important obstacle to meeting the climate change challenge^{3,8}.

A natural response to this challenge is to highlight how deniers are being misled (for example, by media reporting norms and institutions with vested interests^{6,9,10}), and to redouble efforts to convince the public of the reality of anthropogenic climate change^{3,4}. Assuming that denial results from deception, ignorance or misunderstanding, change agents intuit that the answer lies in presenting the evidence for climate change in clearer, more cogent and more convincing ways⁴. However, this intuitive strategy may not be effective¹¹, because believers and deniers evaluate the evidence for climate change using different frameworks¹². Rather than emerging organically from evidence, many attitudes represent public, cultural expressions of a person's values and political and ideological allegiances¹³. Where, for identity reasons, people are motivated to hold a certain attitude, discrepant evidence is more

likely to be avoided, dismissed as biased or judged against an unrealistically high burden of proof, whereas evidence supporting a pre-existing attitude is evaluated with little criticism¹⁴.

Disturbingly for environmentalists, attitudes towards climate change and climate science seem to have become part of a constellation of attitudes defined by the 'culture wars': one may have little more luck of convincing a denier that climate change is real as of convincing a conservative Christian to support abortion, or a committed liberal to oppose it. If taken to its pessimistic extreme, it suggests that activists should give up on deniers and focus on increasing pro-environmental behaviour in climate change believers. This is the implicit message sent by social science research on environmental communication; we are aware of no studies that have explicitly focused on how to promote pro-environmental behaviour among deniers. We argue that this theoretical and empirical silence is a mistake for two reasons. First, the numbers of deniers are now too great to ignore^{1,2}. Second, motives to engage in behaviours are often multiply determined, so deniers might be motivated to act in ways that support mitigation efforts for reasons that do not rely on accepting climate change science.

This is the first study to examine how pro-environmental behaviours can be promoted among those who are anthropogenic climate change deniers. In line with increasing recognition that climate change 'is as much a societal issue as a physical one'^{15,16}, our framework focused on deniers' beliefs about the effects of widespread mitigation efforts on their nation and its people, and how these were related to their intentions to engage in environmental citizenship¹⁷. Environmental citizenship is recognized as an important behaviour in addressing climate change^{18–20}, including supporting pro-environmental organizations and individuals (for whom climate change is likely to be a key concern), and contributing to public pressure for political action (signing petitions, writing to politicians and newspapers).

It has been recognized that acting on climate change can produce 'co-benefits' such as promoting sustainable development and improving health²¹. Far less attention has been paid to the 'identity' benefits of acting on climate change, which may be important for both believers and deniers. Social psychologists have shown that people have a deep concern with their group being seen as interpersonally warm, competent and moral^{22–24}. People typically also want to live in a society with strong societal development (for example, scientific progress and economic growth) and minimal dysfunction (for example, crime and poverty). We predicted that deniers may be motivated to engage in pro-environmental action where they think climate change action would result in people becoming more moral, interpersonally warm and competent, and where action would lead to greater societal development or reduced societal dysfunction. These

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Table 1 | Summary of measures (Study 1).

Construct	Items	Scale	Reliability*
Criterion			
Environmental citizenship	Vote for pro-environmental candidates; sign petitions supporting environmental protection; write to politicians/newspapers in support of environmental protection; donate to environmental organizations; read environmental publications; join environmental groups	1 Not at all likely 5 Very likely	0.88
Predictors			
Personal characteristics			
Interpersonal warmth	Considerate; warm	−5 Much less typical in society in 2050 than today	0.74
Competence	Independent; capable		0.68
Morality	Trustworthy; honest	0 No different to today	0.79
Society-wide characteristics			
Societal dysfunction	Violent crime; corruption; poverty; disease		0.82
Societal development	Technological progress; scientific progress; Financial wealth; economic development	+5 Much more typical in society in 2050 than today	0.89

*For two-item scales, correlations are reported. For other scales, Cronbach's alpha is reported.

Table 2 | Predictors of environmental citizenship for climate change deniers (Study 1).

	Mean (s.d.)	Beta	t-value	p
Interpersonal warmth	−0.21 (2.26)	0.33	2.34	0.020
Competence	0.00 (2.27)	0.03	0.24	0.809
Morality	−0.48 (2.21)	−0.08	−0.68	0.495
Societal dysfunction	0.60 (2.18)	−0.04	−0.56	0.577
Societal development	0.13 (2.22)	0.32	3.83	<0.001

Model $R^2 = 0.28$, $F(5, 148) = 11.32$, $p < 0.001$.

consequences of taking action need not depend on climate change actually being mitigated.

Study 1 examined basic relationships between beliefs about these social consequences of climate change action and environmental citizenship intentions. Data from 155 climate change deniers from the general public were identified through a larger survey ($N = 488$; see Supplementary Information for selection criteria and demographic analyses). We asked participants how their nation would be different in 2050 if widespread action to mitigate climate change was taken from the present year (2011), a time frame chosen to mirror common climate change projections (for example, Intergovernmental Panel on Climate Change reports²⁵). We measured the extent to which climate change action would influence people's character, including interpersonal warmth (being caring and friendly to others), competence (having the capacity and skills to achieve goals) and morality (being virtuous and trustworthy). At a broader societal level, we assessed societal dysfunction (for example, crime and poverty), and societal development (for example, economic and scientific progress). Table 1 describes the measures, and Table 2 shows mean ratings. Ratings spanned both positive and negative endpoints on all scales, indicating a wide range of views across individuals.

Regression analysis was used to determine relationships between these projections about societal change and deniers' environmental citizenship intentions. This model (Table 2) showed that environmental citizenship intentions were greater where deniers believed action on climate change would result in people becoming more

interpersonally warm and considerate, and where they thought climate change action would promote societal development.

Responses to an initial survey question, where deniers described their first thoughts about the consequences of acting on climate change, succinctly encapsulate these findings. Some pointed to economic benefits: "while I personally don't believe in climate change as a recent phenomenon, I do agree with reducing our carbon emissions ... think of the possibilities that this would open to individuals and business alike, it would create jobs". Others pointed to mitigation efforts ultimately increasing consideration for others: "if we took action it would show we do care for the environment and therefore care for the human race" and "people would be more conscious of their impact on the environment and each other". In short, a substantial proportion of climate change deniers believed mitigation efforts would have positive effects on their nation and on people's character, and deniers who made more positive projections on these dimensions intended to act more pro-environmentally.

Study 2 examined whether framing climate change action in these ways (increasing interpersonal warmth and societal development) may be a more effective approach for motivating action in deniers than the more traditional focus on the reality and risks of climate change. Drawing on research showing that how issues are framed can influence public opinion²⁶, participants in this experiment read a statement, ostensibly from a previous research participant, about the outcomes of acting on climate change using one of three frames: the reality of climate change and how acting would avert its environmental and health risks (Real frame); climate change action would increase interpersonal warmth in society (Warmth frame); or climate change action would promote economic and scientific development (Development frame; see Supplementary Information). We expected that intentions to engage in environmental citizenship would be greater using the Warmth and Development frames than the Real frame. We also included people who believe in anthropogenic climate change, as we were concerned that focusing on interpersonal warmth and development may be counterproductive if it increased deniers' action intentions, but reduced believers' willingness to act.

Although environmental citizenship, such as joining/supporting pro-environmental organizations, could reasonably be seen to function as support for action on climate change, this link was not made explicit in Study 1. Therefore, in Study 2 participants

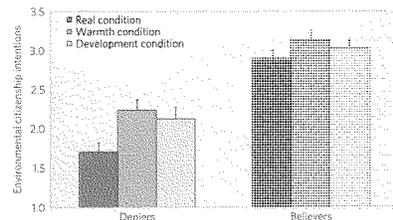


Figure 1 | Means (with standard errors) of environmental citizenship intentions across climate change action frames for climate change deniers and believers (Study 2).

were informed that addressing climate change was a key concern for many pro-environmental groups and individuals immediately before they made environmental citizenship ratings.

We obtained a nationally representative sample of the general public ($N = 347$; see Methods and Supplementary Information for details), who were randomly assigned to the experimental conditions. Mean environmental citizenship ratings ($\alpha = 0.92$) are shown in Fig. 1. Overall, Believers ($M = 3.03$, $s.d. = 0.96$) showed higher environmental citizenship intentions than Deniers ($M = 2.02$; $s.d. = 0.91$), $F(1,341) = 92.47$, $p < 0.001$. More importantly, there was significant variability across experimental conditions, $F(2,341) = 4.87$, $p = 0.008$, with post hoc comparisons showing a significant difference between the Real and Warmth frames ($p = 0.012$), and Real and Development frames ($p = 0.013$). We also compared conditions for Deniers alone, with significant differences between the Real and Warmth conditions ($p = 0.008$), and the Real and Development conditions ($p = 0.045$). Although Fig. 1 shows that the differences between conditions were smaller for Believers (differences were non-significant, all p values > 0.13), the pattern of means was similar, resulting in a non-significant interaction between group (Deniers, Believers) and frame (Real, Warm, Development), $F(2,341) = 0.77$, $p = 0.463$. These results show that, overall, framing climate change action in terms of producing greater interpersonal warmth or societal development was more effective in promoting environmental citizenship than a frame focusing on the reality and risks of climate change, and this was particularly the case for deniers.

Figure 1 shows that environmental citizenship intentions for deniers were below the scale midpoint, but Believers were only around the midpoint, giving a baseline comparison for reasonable expectations of change in deniers' citizenship intentions. Thus, framing climate change action using Warmth and Development frames bridged one-third of the gap in environmental citizenship intentions between the Real frame for Deniers and the average of Believers. It is remarkable that this substantial difference between the Real and the Warmth/Development conditions emerged from a relatively minor experimental manipulation—briefly reading the view of a single research participant. If coordinated social and media efforts were focused on these societal outcomes, the willingness of deniers to act in ways that support climate change action could be even greater.

Critics might speculate that focusing debates on societal outcomes of mitigation efforts could soon reach the same ideological impasse as for debates about the reality of climate change. Although there are no guarantees, there are reasons for optimism. Deniers are united in disbelieving in anthropogenic climate change, but many already believe that mitigation efforts can have positive effects on society. Ordinary citizens may

also find it easier to relate to how mitigation efforts affect society, compared with esoteric technical issues in climate change science^{4,27}. Moreover, the consequences of climate change action on society are a concern shared by climate change deniers and believers, which may help circumvent ideological believer/denier labels in the service of common goals. Accordingly, Study 2 showed that these social frames for climate change action can foster intentions to act in deniers without harming the intentions of believers. Finally, this approach avoids some prominent counter-claims made by conservative think-tanks²⁸, including denying the existence of climate change, and the need to delay action until there are comprehensive international treaties.

Deniers may eventually be convinced by sustained efforts at communicating climate science, or through personal experiences attributable to climate change such as flooding²⁹. However, the recent trend of increasing denial suggests that relying on 'converting' climate change deniers may not be a successful or timely strategy. Broadening the debate to encompass outcomes that are related to deniers' willingness to act, and which are already accepted by many deniers, may be more likely to foster the widespread consensus and support that governments need to enact effective mitigation policies. Communication about the reality of climate change should continue, but public discussion should broaden to encompass the societal effects of action, especially how mitigation efforts will promote scientific and economic progress, and can make us more caring and considerate people.

Methods

Study 1 data were collected in May–July 2011. From an overall sample of 488 people, a screening item asked whether participants (1) believed humans were contributing substantially to climate change, (2) believed climate change was occurring, but that humans were not contributing substantially to it, or (3) did not believe the climate was changing. Those who chose (2) ($n = 119$) or (3) ($n = 57$) were classified as climate change deniers ($n = 176$, 36% of total sample) and completed the survey. They first provided a short written description of what society would be like in 2050 if widespread action on climate change were to commence from 2011. Next, adapting an approach used previously to investigate the social effects of industrialization³⁰, they rated differences in the future society they described compared with today on the dimensions in Table 1. They then made environmental citizenship ratings. Twenty-one participants did not follow instructions as they failed to describe a future society, and their data were omitted, leaving a final sample of 155 (53% female).

Study 2 data were collected in February 2012. Participants ($N = 347$) completed an online questionnaire. Using the same question as Study 1 to classify deniers/believers, 37% of the sample were deniers ($n = 128$; 56% male; see Supplementary Information for further details and exclusions). Participants were randomly assigned by computer to one of three framing conditions (Real, Warmth, Development), reading a statement ostensibly from a previous research participant. They were asked to write a summary of the person's position, followed by the environmental citizenship scale and additional measures (reactions to the statement, identification with/typicality of the person making the statement, demographics).

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Author contributions

P.G.B. designed the studies, coordinated data collection, analysed the data and wrote the paper. M.J.H. contributed to the design and analysis of both studies and writing the paper. R.B. contributed to the design and analysis of Study 2 and writing the paper. C.I. contributed to the analysis of Study 1 and writing the paper.

Additional information

The authors declare no competing financial interests. Supplementary information accompanies this paper on www.nature.com/natureclimatechange. Reprints and permissions information is available online at www.nature.com/reprints. Correspondence and requests for materials should be addressed to P.G.B.

APPENDUM

Promoting pro-environmental action in climate change deniers

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Nature Climate Change **2**, 600–603 (2012); published online 17 June 2012; corrected online 4 July 2012.

In the above Letter, we used the term 'denier' to describe people who are not convinced that anthropogenic climate change is occurring. The denier label refers to an image held by some in the mainstream climate science community that such people are contrarian, which other terms like 'sceptic' do not capture. We hoped our findings would suggest to mainstream climate scientists the benefit of looking beyond this contrarian image, by showing that deniers were more supportive of actions to address climate change where these actions produced beneficial social outcomes. However, since publication we were contacted by people offended by the label denier to describe their group due to its broader negative connotations. We acknowledge this point and regret any offence caused.

Accepted Manuscript

Harnessing the uncertainty monster: Putting quantitative constraints on the intergenerational social discount rate

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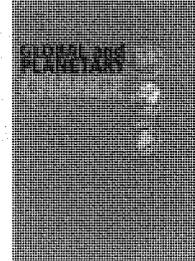
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Running head: UNCERTAINTY AND SOCIAL DISCOUNT RATES

Harnessing the uncertainty monster: Putting quantitative constraints on the
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Abstract

There is broad consensus among economists that unmitigated climate change will ultimately have adverse global economic consequences, that the costs of inaction will likely outweigh the cost of taking action, and that social planners should therefore put a price on carbon. However, there is considerable debate and uncertainty about the appropriate value of the social discount rate, that is the extent to which future damages should be discounted relative to mitigation costs incurred now. We briefly review the ethical issues surrounding the social discount rate and then report a simulation experiment that constrains the value of the discount rate by considering 4 sources of uncertainty and ambiguity: Scientific uncertainty about the extent of future warming, social uncertainty about future population and future economic development, political uncertainty about future mitigation trajectories, and ethical ambiguity about how much the welfare of future generations should be valued today. We compute a certainty-equivalent declining discount rate that accommodates all those sources of uncertainty and ambiguity. The forward (instantaneous) discount rate converges to a value near 0% by century's end and the spot (horizon) discount rate drops below 2% by 2100 and drops below previous estimates by 2070.

Harnessing the uncertainty monster: Putting quantitative constraints on the intergenerational social discount rate

In its guidance on public sector project appraisal, Her Majesty's Treasury in the United Kingdom states that society "prefers to receive goods and services sooner rather than later, and to defer costs to the future" (HM Treasury Green Book, Para. 5.49). Such sentiment also influences social cost-benefit analysis guidelines in a wide range of countries across the world. This desire of governments to receive benefits early and defer costs to later underlies the concept of "social discounting"—that a dollar received tomorrow is worth less than a dollar received today even when ignoring the effects of inflation ("real discounting").

There are a variety of arguments that support this approach. First, it is clear that we are, by nature, impatient. When offered a reward of \$15 right now, people on average would require \$20 a month from now to delay their reward till then (Thaler, 1981), even though the accrual during that delay corresponds to an annualized interest rate of nearly 345%. Nearly indistinguishable results are obtained when respondents make intertemporal choices between goods, rather than monetary rewards. For example, Pender (1996) describes the strong desire of rural Indians to receive rice income sooner rather than later.

Although the particulars may vary across experiments, the basic finding that people heavily discount rewards over short time periods, forms a pervasively replicated benchmark finding in behavioral economics, with more than 3,000 articles on the topic being indexed by the PsycArticles data base at the time of this writing. (For a review, see Coller & Williams, 1999 or Frederick, Loewenstein, & O'Donoghue, 2002). This entrenched preference for the present, and the discounting of the future it entails, appears to be an immutable aspect not just of human cognition but of organisms more generally. When given the choice between a smaller reward now or a larger reward later, most animals generally prefer the immediate reward (Stevens & Stephens, 2010).

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One reason for this impatience is, of course, that we may no longer be alive to enjoy future benefits, or pay future costs, by the time they are due. A million dollars 10 years hence may not appear worth terribly much to an 80-year-old, who might therefore rationally prefer an immediate \$100,000. Accordingly, people's propensity to discount the future is found to increase with age (Trostel & Taylor, 2001). Contrary to the proverbial notion that impatience is a particular prerogative of the young, the data suggest that we become more impatient—that is, more insistent on receiving rewards immediately rather than later—as we age.

But impatience lies deeper than pure realization of our own mortalities. In humans, decisions relating to the present involve regions of the brain (viz. limbic and paralimbic cortical structures) that are also consistently implicated in impulsive behavior and cravings such as heroin addiction, whereas decisions that pertain to the future involve brain regions (viz. lateral prefrontal and parietal areas) known to support deliberative processing and numerical computation (McClure, Laibson, Loewenstein, & Cohen, 2004). Our strong preference for immediate rewards may therefore reflect the proverbial “reptilian brain,” which competes with our “rational brain” that is telling us to consider and plan for the future.

When evaluating longer time horizons, not only do we continue to show impatience, even if at a lower annualized rate (e.g., Henderson & Bateman, 1995), we should also allow for the underlying economic situation to change. In general, societies have become wealthier over time, and this is also the forecast of most, but not all, experts for the future (Drupp, Freeman, Groom, & Nesje, 2016). Since the poor are not generally expected to subsidize the rich, societies should, all else being equal, prioritize the now over the future. Economic growth forecasts and the strength of our desire to reduce consumption inequality across time both affect governments decisions over discounting.

These underlying features also help determine how financial markets set interest rates; investors are also impatient and require capital growth that reflects changes in the underlying macroeconomy. But once these bond yields are set, then they present observable opportunity costs against which other projects can be appraised. For example, if one were so inclined, one could compare the present cost of one's education (tuition fees due today) against the delayed rewards (higher expected salaries upon graduation) using prevailing market interest rates.

Extending this markets-based approach to discounting in the public sector has been favored by a number of international governments, including the United States. This is described as the "positive" or "descriptive" approach to social discounting (e.g., Davidson, 2014). For example, suppose that the one year interest rate is 3%. Then, on the assumption that a government wishes to recognize the opportunity cost of capital, it would not choose to invest in a social project that cost \$100 today but only gives societal value of \$102 in a year. Accordingly, the discounting of future costs and benefits is part of the basic canon of economics. In general, an amount x_0 today is worth x_t in t years time, where $x_t = x_0 \times (1 + \rho)^t$, where ρ is the applicable discount rate. Equivalently, if we wish to determine the present value of an amount x_t that is due in t years time, then $x_0 = x_t / ((1 + \rho)^t)$. A preference for smaller immediate rewards over delayed larger rewards is thus rational—and advisable—so long as social project appraisal decisions are calibrated to plausibly achievable interest rates.

Enter climate change. The situation changes dramatically when inter-temporal decisions cross generational boundaries and extend into the distant future. Today's policy decisions with respect to climate change will affect people who have not yet been born, and whom today's decision makers will never meet. The extended temporal horizon has particularly pronounced implications vis-a-vis the discount rate. We illustrate with an example provided by Dubgaard (2002) involving the future of Denmark. If the present

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value of real estate in Denmark is considered to be around \$238 billion, then applying a discount rate of 5%, \$6 invested now will be worth the same as the current value of the whole of the housing stock in Denmark in 500 years (Dubgaard, 2002). If we applied a discount rate of 1% instead, then the future Denmark around the year 2500 would be “worth” \$1.6 billion of mitigation efforts today. The striking difference between \$6 and \$1.6 billion reveals why “the biggest uncertainty of all in the economics of climate change is the uncertainty about which interest rate to use for discounting” (Weitzman, 2007, p. 705). Seemingly slight variations in the discount rate suffice to make climate mitigation efforts appear either very compelling and highly cost effective (Stern, 2007) or less pressing (Nordhaus, 2007).

The choice of an appropriate discount rate for climate economics has therefore been hotly contested in policy, economics, and ethics. This debate has failed to yield a consensual value, with some scholars proposing that the discount rate for climate change should be *negative* (Fleurbaey & Zuber, 2012) and others permitting a rate in excess of 6% (Nordhaus, 2007). Central to this argument has been whether the descriptive approach to discounting is appropriate in a social context when projects span generations. In particular the highly influential Stern Review (Stern, 2007) and a number of governments in Europe, prefer to estimate the social discount rate directly from its primitives rather than using market rates of interest. There are a number of reasons for this choice (see, e.g., Drupp et al., 2016). For example, while we know that individuals are impatient for themselves, many economists and philosophers would argue that we cannot be impatient with respect to future generations. In addition, those most affected by climate change—the poor, often in developing countries, who have not yet been born—cannot influence bond yields. This places a burden on governments to take a wider ethical perspective than investors do when trading in financial markets. This alternative approach to estimating the social discount rate, which underlies this paper, is called the

“normative”, or “prescriptive”, approach (Davidson, 2014) and is often represented through the Ramsey Rule (Ramsey, 1928).

In this article we provide quantitative constraints on the discount rate for climate change by considering several sources of uncertainty and ambiguity about its appropriate value. Specifically, we report a simulation experiment that explored the parameter space underlying the social discount rate and computed a single “certainty-equivalent” rate (explained below) that integrates across all those sources of uncertainty. Figure 1 provides an overview of the experimental design and guides the discussion. To foreshadow our principal conclusion, when all those sources of uncertainty and ambiguity are considered simultaneously, the certainty-equivalent discount rate declines over time and converges to a value below that of various previous estimates by 2070.

Experimental design

Disentangling discounting

The social discount rate, also referred to as the consumption discount rate, is conventionally understood within the framework developed by Ramsey (1928), which expresses the social discount rate, ρ_s , as a function of two distinct components:

$$\rho_s = \eta \times g + \delta, \quad (1)$$

where g is the expected average annual real economic growth rate, δ represents a “pure time preference”, and η is a parameter that captures people’s risk aversion and inequality aversion. The rationale for inclusion of the growth rate, g , is that growing wealth makes a given cost for future generations more bearable than it appears to us now, in the same way that \$100 is valued a great deal more by a poor student than by a wealthy industrialist. The effect of future wealth is modulated by η , which variously describes risk aversion or inequality aversion.¹ The pure time preference component, δ , which is also

referred to as the utility discount rate, reflects people's intrinsic preference for the present, or their "impatience" (e.g., Thaler, 1981).

Within the Ramsey framework we thus have to consider three quantities to determine the social discount rate: Future economic growth (g), risk aversion (η), and pure time preference (δ). All three of those quantities are at least partially amenable to quantitative estimation. Future growth rates can be estimated by economic modeling (e.g. Nordhaus, 2007), risk aversion can be inferred from asset markets (Epstein & Zin, 1991) and behavioral surveys (Barsky, Kimball, Juster, & Shapiro, 1997), and pure time preference can be inferred by behavioral experiment (e.g., Zauberman, Kim, Makoc, & Bettman, 2009). It is therefore in principle possible to estimate the social discount rate—with some degree of uncertainty—using the earlier descriptive approach (Davidson, 2014).

However, because of the far-reaching implications of the discount rate, many scholars have argued against a descriptive solution and in favor of a *prescriptive* approach, whereby the social discount rate is determined, at least in part, by ethical and moral considerations (e.g., Adler & Treich, 2015; Davidson, 2014; Stern, 2007). To illustrate, assume that $g = 0$ in Equation 1 and that empirical estimates of δ are in the range of 5%. In that case, we would burden our descendants with the disappearance of Denmark because we were unwilling to expend more than \$6 on climate mitigation, based entirely on estimates of how strongly people prefer instant gratification over a delayed reward (because with $g = 0$ future generations are assumed to be no wealthier than us). Ethical considerations also apply to determining the value of η : risk aversion and inequality aversion are moral constructs, and Hume's dictum that the "ought" cannot be derived from the "is" therefore casts doubt on the relevance of its estimability.

We next briefly discuss those ethical ambiguities and other sources of uncertainty about the discount rate. This defines the multi-dimensional variable space which we then explore in our simulation experiment (Figure 1).

Ethical ambiguities of discounting

We abhor slavery and other forms of domination, defined as situations in which one group of persons can determine arbitrarily and without significant reciprocation the conditions of another group's lives (Nolt, 2011). Because "future people have no power to resist or retaliate against our emission of greenhouse gases" (Nolt, 2011, p. 67), some ethicists have argued that the adverse future effects of climate change (e.g., the risk of displacement of up to 187 million people through sea level rise; Nicholls et al., 2011) constitutes unacceptable inter-generational domination. Considerations along those lines are frequently taken to imply that δ should be set to zero. Ramsey (1928) himself called it "ethically indefensible" to "discount later enjoyments in comparison with earlier ones" (p. 543). Likewise, Adler and Treich (2015) argue that any value $\delta > 0$ "embodies a clear violation of the attitude of impartiality that is foundational to ethics" (p. 283).

The notion of "stewardship" towards future generations is also intrinsic to most world religions and was articulated poignantly in the recent encyclical of Pope Francis (2015). Accordingly, (Stern, 2007) set $\delta = 0.1\%$, with the residual positive value representing a presumed risk of human extinction.

However, the seemingly attractive idea of treating all generations equally by setting $\delta \cong 0$ entails some unnering consequences (Pearce, Groom, Hepburn, & Koundouri, 2003). In general, the lower the discount rate, the more future consumption matters and hence the more we should set aside for the benefit of future generations. When $\delta = 0.1\%$ and $\eta = 1$, as favored by Stern (2007), the mathematically implied savings rate is 97% (Dasgupta, 2008). That is, out of \$100 we may only consume \$3, with the remainder

being taxed away for the benefit of our children. Our children, in turn, would also only be allowed to spend \$3 of their considerably greater wealth, with the remainder being passed on to their children, and so on ad infinitum. An implication of zero discounting therefore is the impoverishment of each current generation for the benefit of the succeeding one.

To avoid this conundrum, scholars have variously proposed an alternative, rank-based discounting schemes (Zuber & Asheim, 2012) or have argued for a higher value of δ on the basis of moral considerations. For example, Nordhaus (2007) assumed $\delta = 1.5\%$. Because this ethical debate is ongoing, we explore values of δ of 0% (with 65% weighting) and 3.15% (with 35% weighting); see top left of Figure 1. Those estimates of δ and their probability weighting are based on a recent survey of 200 experts by Drupp et al. (2016) and are thus empirically constrained vertices of this ethical space.

Similarly, we let η take on values of 0.5 and 2.2 with equal probability. Although risk aversion and inequality aversion are informed by ethical considerations, these boundaries are broadly consistent with findings from the expert survey by Drupp et al. (2016). The values of η and δ were fully crossed (top left of Figure 1), thereby providing an exploration of the space of likely ethical considerations.

Uncertainties about future growth

Modeling the effects of warming on economic production. Application of Equation 1 requires knowledge of future economic growth. Conventionally, those estimates may be obtained by economic modeling of the future (e.g., Nordhaus, 2007) or by extrapolation from historical data on the assumption of a steady-state economy. Here we rely on a recent empirical model reported by Burke, Hsiang, and Miguel (2015) that examined the marginal effects of temperature on gross domestic product (GDP) for more than 160 countries during the last 50 years (1960–2010) while controlling for a host of other variables (e.g., secular trends, country-specific idiosyncracies, and so on). Burke et al.'s

principal finding was that temperature has a curvilinear relationship with economic production, with an optimum at around 13°C . All other variables being equal, economic production declines with lower or higher average temperatures. The curvilinear relationship holds equally for rich and poor countries, and it holds equally for the early part of the period examined (1960–1989) and the late period (1990–2010). The relationship is also robust to a wide variety of other variables (Burke et al., 2015, Supplementary Methods).

The empirical model permits projection of economic growth through the end of the century as a function of three variables that are the source of considerable uncertainty: the sensitivity of the climate to carbon emissions, the emissions trajectory that results as a result of policy choices, and the socio-economic development pathway that the world is following. We orthogonally combine those three variables to examine their effect on projected global growth (top-right panel of Figure 1).

Scientific uncertainty about climate sensitivity. There is no doubt about the fact that the globe is warming in response to greenhouse gas emissions from human economic activity, and that this warming has been ongoing without notable interruption or cessation (Cahill, Rahmstorf, & Parnell, 2015; Lewandowsky, Risbey, & Oreskes, 2016, 2015). There is, however, some uncertainty about *how much* warming can be expected in response to emissions. This scientific uncertainty is encapsulated in the standard deviation of the estimate of a quantity known as climate sensitivity, which refers to the amount of warming (in $^{\circ}\text{C}$ or, equivalently, K) that is expected in response to a doubling of atmospheric CO_2 concentrations compared to preindustrial levels. Estimates of sensitivity have ranged from around 1.5°C to 4.5°C for more than 4 decades (Freeman, Wagner, & Zeckhauser, 2015, see also further discussion below). There are compelling reasons, relating to feedback loops, why this uncertainty range is unlikely to be substantially reducible (Roe & Baker, 2007).

We represent uncertainty by the standard deviation of the (lognormal) distribution of possible realizations of climate sensitivity in our climate model, which we varied in 6 steps; $0.26^{\circ}C$, $0.37^{\circ}C$, $0.64^{\circ}C$, $0.83^{\circ}C$, $1.17^{\circ}C$, and $1.66^{\circ}C$. Mean sensitivity was kept constant. Exploring the effects of different levels of uncertainty about climate sensitivity is important in light of the fact that greater uncertainty translates into *greater* risks and damage costs in nearly all circumstances (Freeman et al., 2015; Lewandowsky, Risbey, Smithson, Newell, & Hunter, 2014; Lewandowsky, Risbey, Smithson, & Newell, 2014). It is unknown, however, how the effects of uncertainty interact with other variables that contribute to global growth paths.

Policy uncertainty about emissions trajectories. We compared the “Representative Concentration Pathways” (RCPs) that are used by the IPCC to explore different climate futures (Bindoff et al., 2013). Although RCPs are not directly interpretable as policy choices and emissions trajectories (because they are defined by the atmospheric concentrations of greenhouse gases rather than emissions), they represent the likely *consequences* of policy choices.

We employed the climate forcings (i.e., the imbalance of incoming and outgoing energy that results from atmospheric greenhouse gases) provided by RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5 for the period 2000 through 2100 as input to our climate model. These RCPs span the range from aggressive mitigation and limiting global temperature rises to approximately 2° (RCP 2.6), to continued business as usual and extensive warming (RCP 8.5). (Data available at: <http://tntcat.iiasa.ac.at:8787/RcpDb/dsd>).

Uncertainty about future economic development. We compared two “Shared Socio-Economic Pathways” (SSPs). SSPs form the basis of the IPCC’s projections of future global development in Working Group 3. We employed two scenarios, SSP3 and SSP5, also used by Burke et al. (2015). SSP3 assumes low baseline growth and slow global

income convergence between rich and poor countries; SSP5 assumes high baseline growth and fast global income convergence. (Data available at: <https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd>). The SSPs provide the “base rate” growth rates that were entered into the empirical model described above to obtain climate-adjusted growth projections.

Summary

The orthogonal combination of the variables just described yields an experimental design for uncertainties about future growth that fully crosses 6 levels of scientific uncertainty with 4 levels of policy uncertainty (RCPs) and 2 levels of uncertainty about future global development (SSPs). For each of the 48 cells of this design, 1,000 simulation replications were performed by sampling a realization of climate sensitivity from the appropriate lognormal distribution. For each realization, global temperatures were projected to the end of the century and the economic effects of climate change were derived by considering the relevant SSP in conjunction with the empirical model relating temperature to economic production. Cumulative average growth rates for the remainder of the century were then computed across the 1,000 replications in each cell of the design.

These 48 projected global economic trajectories to the end of the century, each of which represented the expectation under one set of experimental conditions, were then converted into candidate social discount rates. At this stage the ethical considerations (top left Figure 1) were applied to each trajectory, by combining each of the 48 projected global economic growth rates (g) with the four combinations of δ and η using Equation 1. This yielded 192 candidate discount rates (48×4) across all combinations of experimental variables. In a final step, those candidates were integrated into a single certainty-equivalent declining discount rate (CE-DDR) using a process known as “Gamma

discounting” (K. Arrow et al., 2013; Pearce et al., 2003; Weitzman, 2001), which is sometimes known instead as “Expected Net Present Value”.

Gamma discounting: Harnessing uncertainty about the discount rate

If the future discount rate is uncertain, what is the appropriate way to handle this uncertainty? Suppose we believe that future interest rates could be 1% or 7% with equal probability? How do we best plan for that future? Recent work in economics has yielded considerable progress on this issue (e.g., K. Arrow et al., 2013; K. J. Arrow et al., 2014; Freeman, 2010; Gollier, 2002; Weitzman, 1998, 2001). One outcome of this research has been that it is not the discount rates that are to be averaged (e.g., by computing the mean of 1% and 7%, viz. 4%), but the (discounted) net present values associated with those rates at various points in the future. Weitzman (2001) termed this Gamma discounting and we use his terminology here.

Table 1 illustrates Gamma discounting using an example provided by K. Arrow et al. (2013). The table shows discounted values of \$1,000 at various times in the future for three different discount rates (ρ). For example, if $\rho = 4\%$, then the present value of \$1,000 after 50 years is \$135.34, and so on. Uncertainty about the discount rate is represented by the heterogeneity among the discounted values across the entries for each time t . For example, assuming an equal probability of ρ being 1% or 7%, then 50 years from now our \$1,000 can be worth either \$606.53 or \$30.20. It follows that the average of those two uncertain values represents the probability-weighted expectation for our \$1,000, which 50 years from now is $(\$30.20 + \$606.53)/2 = \$318.36$. These mean expected present values are shown in the column labeled MEV in Table 1 for our \$1,000 at various points in the future on the assumption that the discount rate is either 1% or 7% with equal probability. The temporal relationship between successive MEVs, finally, yields a single

certainty-equivalent discount rate (CE-DDR) for any given point in time. For example, the MEV at $t = 50$ is \$318.36, and the MEV at $t = 51$ is \$314.33. The ratio between those successive values, $\$318.37/\$314.33 = 1.0128 = 1.28\%$, provides the *instantaneous* CE-DDR at time $t = 50$ (also known as “forward” rate), and those values are shown in the second-to-last column of Table 1. This single declining discount rate can be applied with 100% certainty, and will yield the same discounted values as application of multiple rates with less than 100% certainty (K. Arrow et al., 2013).

While the forward (or instantaneous) CE-DDR captures the slope of the declining discount rate function between times t and $t + 1$, those rates cannot be used to discount an amount from the present to time t —that is, the MEV at time $t = 50$, for example, cannot be obtained by discounting \$1,000 at a rate of 1.28%. This requires a different certainty-equivalent discount rate, which is also declining but has generally higher values than the instantaneous rate. This rate is called the “spot” (or “horizon”) CE-DDR and is shown in the final column of the table. Application of this rate to our present-day \$1,000 (or any project amount that is small relative to the size of the economy; Dietz & Hepburn, 2013) for time t will yield the MEVs for that time shown in the table. We report both forward (instantaneous) and spot (horizon) CE-DDRs from our experiment.

Gamma discounting has been applied in a variety of contexts where the discount rate is uncertain, including situations in which there is uncertainty about future economic growth (Fleurbaey & Zuber, 2012). The theoretical grounding for Gamma discounting is particularly firm when the candidate fixed discount rates (first three columns in Table 1) arise from irreducible heterogeneity among expert opinions rather than from random variation about an imprecise estimate (Freeman & Groom, 2015). Different ethical positions about risk aversion (η) and pure time preference (δ) are clear instances of irreducible heterogeneity, and we likewise consider the different levels of the remaining variables in our experimental design to represent the views of different hypothetical

experts: Some experts might opine that the world will follow an SSP5 trajectory whereas others argue that the world will follow an SSP3 trajectory and so on. By contrast, the replications within each cell of the design are not considered to constitute irreducible heterogeneity but realizations of the future under a homogeneous, but noisy, scenario. It is for these theoretical reasons that we integrate across replications within each experimental cell to obtain a single expected growth trajectory that is then entered into Gamma discounting together with its counterparts, as noted earlier.

Simulation procedure and results

Emulating global climate change

Global temperature projections were obtained from a climate emulator proposed and tested by Raupach et al. (2011). Unlike a general circulation model (GCM), which models the atmosphere (and/or oceans) at a high resolution and therefore requires immense computing power, an emulator captures the behavior of a GCM at a global level and can be computed more rapidly.

The emulator converts radiative forcings into global temperatures, using a climate step-response function that is characterized by (in this case) three terms, obtained by inverting the Laplace transform of the climate response function for the HadCM3 model reported by Li and Jarvis (2009). The climate response function includes a parameter for climate sensitivity, represented by λ_q . (See Equation A6 and Table A2 in Raupach et al., 2011).

There are different ways in which climate sensitivity—i.e., warming in response to CO₂ doubling—can be operationalized, depending on how much time elapses after CO₂ doubling before the temperature increase is measured. The IPCC relies primarily on equilibrium climate sensitivity (ECS), which involves timescales of years to decades after CO₂ doubling, during which the atmosphere and upper oceans have had time to come into

temperature balance. There are, however, numerous other feedback loops that operate at longer time scales, such as ice sheets and ocean circulation (Lunt et al., 2010), and the ultimate warming in response to CO₂ doubling may be greater and much delayed compared to ECS. This ultimate sensitivity to greenhouse gas emissions is labeled earth system sensitivity (ESS) and has been estimated to be 30-50% greater than ECS (Lunt et al., 2010).

Because the longest time scale in the three-term climate response function in our emulator is nearly 1500 years, the modeled climate sensitivity is best understood as ESS rather than ECS. We kept ESS constant at $\lambda_T = 4.6^\circ C$ ($1.235 KW^{-1}m^2$), the value used by Raupach et al. (2011) in a validation of the emulator against the IPCC's projections. This value is higher than estimates of ECS, which typically range from $1.5^\circ C$ to $4.5^\circ C$ (Freeman et al., 2015). For each simulation replication, a realization of ESS was sampled from a lognormal distribution with mean $\mu_{ESS} = 4.6$ and standard deviation σ_{ESS} , where the value of σ_{ESS} depended on the experimental condition.

Figure 2 illustrates the combined effects of scientific uncertainty (changes in σ_{ESS}) and climate policy uncertainty (RCPs) on global temperature projections from our emulator.

Relating global temperature to economic production

Using the data made available by Burke et al. (2015), we estimated regression weights for their (unlagged) base model with per capita GDP growth as the criterion. Our estimates of 0.0103 for temperature and -0.0004 for the square of temperature correspond closely to the values reported by Burke et al. (see their Extended Data Table 1; first column).

Projected global temperatures were obtained from the emulator for 2010–2100 and expressed as anomalies relative to 2010. Those global projections were converted into

country-specific projections using the relationships observed under the RCP8.5 scenario for the mean projections of the CMIP5 model ensemble (Taylor, Stouffer, & Meehl, 2012). That is, the mean projected temperature increases for the CMIP5 ensemble between the reference periods 2080–2100 and 1986–2005 were used to estimate the factor by which each country differed from the global average (e.g., Botswana is expected to warm by 1.45 times the global average, whereas Argentina is only expected to experience 0.90 of the average, and so on). Those factors translated projected global temperatures into expected warming for each country, which in turn were converted into country-specific marginal effects of climate change on economic growth. That is, the economic growth trajectory expected for each country from the relevant pathway (SSP3 or SSP5) was adjusted upward or downward by the temperature-determined marginal effect of climate change.

Global GDP projections. Global GDP trajectories, obtained by summing the country-specific trajectories, are shown in Figure 3 for the two most extreme RCPs (RCP 2.6 and RCP 8.5, in the top and bottom row of panels, respectively) and the two most extreme values of uncertainty about climate sensitivity ($\sigma_{ESS} = 0.24^{\circ}C$ and $\sigma_{ESS} = 1.66^{\circ}C$ in the left-hand and right-hand column of panels, respectively).

Note that global GDP is expected to increase under most circumstances, except in Panel d, when scientific uncertainty is greatest ($\sigma_{ESS} = 1.66^{\circ}C$), expected growth smallest (SSP3), and mitigation absent (RCP 8.5).

Figure 4 summarizes the average global GDP growth rates through the end of the century across all conditions of the experiment. The greatest source of difference again arises from which shared socioeconomic pathway that the world will follow (SSP3 vs. SSP5), with all other sources of uncertainty being subsumed under that primary variable. When year-to-year growth is considered, it is clear that under SSP3 without mitigation overall global growth may be negative for decades towards the end of the century (Panel a). When the cumulative average annual growth is considered, as required for

computation of discount rates (Panel b), growth no longer turns negative (because the annual rates late in the century are averaged into all rates leading up to that point) but nonetheless declines late in the century.

By the year 2099, the cumulative average growth rate across the 48 cells of the experimental design is 1.60%, with a standard deviation of 0.88% (Figure 4 panel b). These values are almost identical to the mean (1.70%) and standard deviation (0.91%) of expert opinions on future long-term economic growth rates reported by Drupp et al. (2016).

Country-specific GDP projections. The aggregation at the global level obscures considerable variability among countries: Although some cool countries are expected to benefit from climate change, countries that are already near or beyond the optimum temperature will suffer. Figure 5 shows the proportion of countries (out of 165) whose year-to-year per capita GDP growth rate is projected to be negative, again showing the most extreme levels of climate uncertainty (in columns) and the most extreme RCPs (rows).

Except in the most favorable circumstances (SSP5 with strict mitigation; Panels a and b), a notable share of countries will experience economic decline at some point during the remainder of the 21st century. Under unfavorable conditions (SSP3 without mitigation; Panels c and d) around two thirds of all countries will experience decline by the end of the century.

Notably, even under stringent mitigation (RCP 2.6, top panels), when uncertainty about climate sensitivity is large (Panel b), under SSP3 more than 20% of countries experienced decline late in the century for at least 10% of the realizations (solid red line in Panel b). For the same mitigation path, when uncertainty was at its lowest (Panel a), this proportion was notably less and even the most extreme realization (dotted red line in Panel a) caused less than 20% of countries to decline. This pattern (comparing columns of

panels) extends earlier results showing that greater uncertainty about the value of climate sensitivity creates greater adaptation and mitigation risks (Freeman et al., 2015; Lewandowsky, Risbey, Smithson, Newell, & Hunter, 2014; Lewandowsky, Risbey, Smithson, & Newell, 2014).

Relating uncertain future economic production to the social discount rate

The certainty-equivalent discount rates obtained from the projected growth rates via Equation 1 are shown in Figure 6 for various ethical scenarios. In an all inclusive scenario, all conjunctions of δ (0; 3.15%, probability-weighted 65% and 35%, respectively) and η (0.5; 2.2) contribute to the distribution of candidates for Gamma discounting; this scenario is labeled “Gamma” in the figure. In the remaining 4 scenarios, δ and η are set to the values indicated in the legend.

It can be seen that when all ethical ambiguities are considered, the forward (instantaneous) rate declines very rapidly, falling below 2% by around 2040 and heading towards a value near 0 by century’s end. The spot (horizon) rate, which integrates across all intervening values of the forward rate and is applicable when seeking to discount the costs and benefits of a present project, naturally falls off less rapidly but dips below 2% by century’s end. Note that this result is obtained using a realistic probabilistic weighting of the alternative values of the ethical variables based on expert responses (Drupp et al., 2016).

The declining schedule obtained by our experiment is placed into a broader context in Figure 7. The figure compares our results to relevant precedents that also estimated the social discount rate applicable to climate change. Previous estimates were variously based on analysis of historical interest rates (Groom, Koundouri, Panopoulou, & Pantelidis, 2007; Newell & Pizer, 2003), analysis of expert surveys (Freeman & Groom, 2015; Weitzman, 2001), or policy recommendations (e.g., the U.K. Treasury’s “Green Book”).

Our approach differs from those precedents by relying on explicit modeling of the impact of future climate change on economic production. When the likely impact of climate change on the global economy is considered, a more rapid decline of the discount rate is observed than in previous work. By 2070, our estimates of the spot (horizon) rate dips below the other past benchmark estimates considered here.

Discussion

We conclude from the experiment that when the full range of uncertainties is considered, then irrespective of one's ethical stance towards inter-generational discounting, the computationally-constrained value of the social discount rate declines steeply across the remainder of the century and dips below 2% for the end of the century, when the effects of climate change will be felt most acutely. This meshes well with the median long-run social discount rate elicited from experts (Drupp et al., 2016). We consider our work to provide a proof of concept, with much further exploration remaining to be performed. Potential limitations of our work must be noted before we can suggest some implications.

Potential limitations

Limitations of the climate emulator. Two caveats apply to our climate emulator that concern the conversion of emulated global temperatures into country-specific warming. Those conversion factors were calibrated against the ensemble mean of the CMIP5 model projections for RCP8.5. However, the regional details of warming are quite uncertain given that they depend on dynamical climate responses, such as the El Niño Southern Oscillation (ENSO) or changes in atmospheric circulation patterns related to the Arctic Oscillation, which vary widely across models. Therefore, a logical extension of our analysis would add yet another degree of freedom to the phase space where we explore the varying spatial footprints of predicted warming across models within the CMIP5 ensemble.

Moreover, it is unknown whether the global-to-country conversion factors estimated for RCP8.5 remain invariant under different warming scenarios, such as the other RCPs examined here. Future work has to examine the robustness of this calibration across warming scenarios, as well as across models.

Limitations of the empirical model. Several caveats also apply to the empirical model relating temperature to economic productivity (Burke et al., 2015). First, our simulation used a point estimate of the regression parameters for temperature (and its square), as did Burke et al. This ignores a further source of uncertainty, namely the parametric uncertainty in the empirical model. Future work might usefully include that additional source of uncertainty in an experiment. A second caveat concerns the upper limit on temperatures in the empirical model: To avoid out-of-sample predictions, Burke et al. limited all future temperatures to the maximum observed in their historical sample, and we followed that practice here. Accordingly, the consequences of extreme future warming would have been curtailed by the model for countries that are already hot or warm. It remains to be seen whether removal of this ceiling would exacerbate the economic consequences already seen with RCP 8.5 towards the end of the century.

The final caveat concerns the presumed benefits of warming that is expected for cool countries from the empirical model. The model is limited in two ways: First, it considers only the effects of average temperature, which ignores the increase of extreme weather events (including floods, storms, and heat waves) that even cool countries are arguably already beginning to experience (e.g., AghaKouchak, Cheng, Mazdiyasi, & Farahmand, 2014; Coumou & Rahmstorf, 2012; Seneviratne, Donat, Mueller, & Alexander, 2014). Those extreme events may increasingly offset the benefit of slightly warmer temperatures in the historical record. Similarly, in a globalized economy, cool countries may suffer economic losses when hitherto unprecedented climatic events occurring elsewhere disrupt supply chains (Levermann, 2014). Second, the empirical model is based on historical data

and its application to the future thus tacitly assumes a stationary environment. It is therefore unclear whether the model can deal with historically-out-of-sample effects when the environment becomes increasingly non-stationary. Non-stationary environments provide a particular challenge to estimating return-periods and return-levels of extreme events, although some promising developments exist (e.g., Cheng, AghaKouchak, Gilleland, & Katz, 2014). An extreme form of non-stationarity involves tipping points, beyond which irreversible large-scale impacts become inescapable. Expert elicitation reveals that at least five potential tipping points—reorganization of the Atlantic meridional overturning circulation; collapse of the Greenland Ice Sheet; collapse of the West Antarctic Ice Sheet; dieback of the Amazon rainforest; and an increase in the amplitude of ENSO—are consensually considered to constitute a significant risk (Kriegler, Hall, Held, Dawson, & Schellnhuber, 2009). Specifically, Kriegler et al. put the lower bound on the probability of triggering at least one of those events in response to $2^{\circ}\text{C} - 4^{\circ}\text{C}$ warming at 16%, and at 56% (i.e., better than even) if global temperatures exceed 4°C warming relative to 2000 temperatures. A conservative estimate of the impact of such tipping points is in the vicinity of 10% of global GDP (Lontzek, Cai, Judd, & Lenton, 2015).

We therefore suggest that the model may underestimate the adverse impact of climate change on future economic activity.

Assumptions about mitigation costs. We used the same empirical model to relate temperatures to economic production in all cells of the experimental design. This may be potentially problematic for any RCP other than 8.5 because we do not model mitigation costs explicitly. We believe that this omission is justified for several reasons: first, because the projected growth rates for the other RCPs are consistently above those for RCP 8.5, the declining discount rates rates we obtain in the end are conservative and constitute an upper bound—that is, they could not be *higher* if mitigation costs are considered. If

mitigation reduced growth rates compared to RCP 8.5 then Gamma discounting would yield even lower declining rates. We find this unlikely based on indicative work by van Vuuren et al. (2011).

Second, it is far from clear that the impact of mitigation on economic growth can be modeled with any degree of reliability. Recent work has suggested that even the direction of the effect—i.e., whether mitigation accelerates growth or decreases it—cannot be firmly established (Rosen & Guenther, 2015). We therefore believe that a demonstrably robust (Burke et al., 2015) empirical model that is not adjusted for mitigation costs may yield better insights into the future than attempts of explicit modeling that are associated with greater uncertainty (Rosen & Guenther, 2015).

Assumptions underlying the social discount rate. Several assumptions underlying our approach need to be highlighted. First, the candidate distribution of discount rates determines the value of the CE-DDR. If the distribution of candidates shifts, so does the CE-DDR. In the experiment, we estimated the values and weights associated with δ and η based on expert responses (Drupp et al., 2016). However, for the uncertainty variables and their conjunctions (top-right panel in Figure 1), we have no information about the likelihood of the realization of their various values (e.g., whether RCP 2.6 is more or less likely to materialize than RCP 8.5) and in the absence of such knowledge all levels of were considered to be equally likely. It remains for future research to determine whether this assumption is plausible. Likewise, the consequences of adding intermediate levels to the experimental factors (e.g., intermediate values of η) remain to be observed.

Second, our main result relied on the gamma discounting proposed by (Weitzman, 2001). The boundary conditions of gamma discounting are a source of active debate (e.g., Freeman & Groom, 2016; Jouini & Napp, 2014), although it can be theoretically defended in many situations; for example, when experts have irreducibly different ethical opinions (e.g., about pure time preferences; see Freeman & Groom, 2016). It is, however,

theoretically less well-established whether gamma discounting is also applicable when experts differ in risk aversion (cf. Jouini & Napp, 2014).

Third, our analysis has focused on a single global CE-DDR. This may be an over-simplification and some researchers have argued for its disaggregation into country-specific (and indeed person-specific) discount rates. One analysis along those lines has converged on the conclusion that the discount rate should be negative for climate change (Fleurbaey & Zuber, 2012). Further work along those lines is particularly important for ethical reasons (Singer, 2006): A single global discount rate tacitly presumes that the beneficiaries of current and future wealth are the same—after all, discounting according to Equation 1 presumes that our descendants are sufficiently wealthy to cope with the damages that we cause by limiting mitigation costs. Given that it is poor countries that will bear a disproportionate burden from climate change whereas rich countries benefit from avoiding mitigation (Costello et al., 2009), the global discount rate carries considerable hidden ethical baggage (Singer, 2006).

Implications

There has been much recent work on declining discount rates. A common theme of this work is the convergence to a low value over time (e.g., K. Arrow et al., 2013; K. J. Arrow et al., 2014; Freeman, 2010; Freeman & Groom, 2015; Gollier, 2002; Gollier & Hammitt, 2014; Groom et al., 2007; Newell & Pizer, 2003; Pearce et al., 2003; Weitzman, 2001). Our results confirm this convergence under a new set of circumstances, when various different sources of uncertainty and ambiguity are considered and when future growth rates are modeled based on a robust historical relationship between temperatures and economic production.

The suggested value of the CE-DDR that arises from our analysis is considerably lower than some previous estimates (e.g. Freeman & Groom, 2015; Groom et al., 2007;

Newell & Pizer, 2003). This meshes with the results of Burke et al. (2015), who found that their projected economic damages from climate change were far greater than estimates obtained from conventional economic models. We suggest that this difference reflects the fact that our modeling, like Burke et al.'s, explicitly takes into account the non-stationarity of economic production that arises under climate change. Whenever non-stationarity has been explicitly considered in previous work, the anticipated consequences have been far more dire than anticipated under stationary modeling (e.g., Lontzek et al., 2015; Moyer, Woolley, Matteson, Glotter, & A, 2014).

One immediate implication of the lower estimate yielded by our analysis is that it will further strengthen the impetus for climate mitigation by increasing the social cost of carbon. Compared to a constant discount rate of 4%, a declining discount rate that reaches 2% somewhere around 2100, doubles or triples the social cost of carbon emissions (K. Arrow et al., 2013). If our even lower value turns out to be robust, this would further increase the social cost of carbon although the magnitude of the effect remains to be determined.

However, at least one note of caution applies to declining discount rates because they may engender unexpected resource depletion in a "tragedy-of-the-commons" situation (Hepburn, 2003, cited in Pearce et al., 2003). It remains to be seen whether this result is robust, but it would be of particular concern in the context of climate change, which is perhaps the greatest "tragedy-of-the-commons" problem faced by humanity to date.

Conclusion

We aimed to provide quantitative constraints on the social discount rate that is applicable to climate change. Our estimates decline rapidly to below 2% at the end of the century when we integrate across a range of contrasting ethical positions about pure time preference and risk aversion.

Although this estimate is lower than that obtained by related previous work, it may nonetheless be conservative in light of the fact that possible tipping points in the climate system are not considered. Moreover, our work does not resolve other equally pressing ethical issues arising from cost-benefit economics in climate change, such as the valuation of environmental goods. We may be able to put a (discounted) price tag on all the real estate in Denmark, but that tells us nothing about the value of natural goods such as the natural beauty of the Danish country side, the existence of song birds, or species diversity (e.g., Ackerman & Heinzerling, 2004; Freeman & Groom, 2013; Funtowicz & Ravetz, 1994).

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Author Note

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Footnotes

¹ The role of η is quite nuanced and intricate, as it can in turn be decomposed into various additional components (K. J. Arrow et al., 2014; Atkinson, Dietz, Helgeson, Hepburn, & Slen, 2009; Gollier, 2002; Kaplow & Weisbach, 2011; Pearce et al., 2003). For present purposes those details need not concern us because our analysis explores a range of values of η and the precise underlying factors that determine those values do not affect the outcome.

Table 1

Present value of \$1,000 received or expended after t years with various discount rates and their certainty-equivalent declining discount rate obtained by Gamma discounting

t	\$1,000 at time t^a			MEV ^b	CE-DDR (%) ^c	
	1%	4%	7%		Forward	Spot
1	990.05	960.79	932.39	961.22	3.94	4.03
10	904.84	670.32	496.59	700.71	3.13	3.62
50	606.53	135.34	30.20	318.36	1.28	2.32
100	367.88	18.32	0.91	184.40	1.02	1.71
150	223.13	2.48	0.03	111.58	1.01	1.47
200	135.34	0.34	0	67.67	1.01	1.36
300	49.79	0.01	0	24.89	1.01	1.24
400	18.32	0	0	9.16	1.01	1.18

^aColumn entries are values of \$1,000 at time t (years hence) discounted by the rate (ρ) for that column.

^bMEV = Mean expected present value if $\rho = 1\%$ or $\rho = 7\%$ with equal probability.

^cCE-DDR = Certainty-equivalent declining discount rates.

Figure Captions

Figure 1. Overview of experimental design. The variables in the top panels are combined in an orthogonal design. Full crossing of levels of each factor is represented by the \otimes operator, and factor levels are shown in each box. Sampling from all combinations of sources of uncertainty (top right panel) yields a probability distribution of projected economic growth rates (shown by the shaded distribution), whose average is combined with the parameters determined by ethical considerations (top left panel) to yield candidate social discount rates, ρ_s . Candidate rates are then combined into a single certainty-equivalent declining social discount rate (CE-DDR) using the process known as gamma discounting (Table 1).

Figure 2. Representative emulator output. Panel **a** shows 1,000 realizations for each RCP drawn from a lognormal distribution with $\sigma_{ESS} = 0.24^\circ C$, and Panel **b** uses $\sigma_{ESS} = 1.66^\circ C$. In each panel, the mean projection across the 1,000 realizations is shown by a bold solid line with the shaded polygon representing the observed variation across realizations. Observations for 1950–1999 (drawn in black) are based on historical forcing estimates (Hansen, Sato, Kharecha, & von Schuckmann, 2011) and observations from 2000 onward are based on RCP projections.

Figure 3. Global GDP trajectories for two RCPs (RCP 2.6 in the top row and RCP 8.5 in the bottom row) and two levels of uncertainty about climate sensitivity ($\sigma_{ESS} = 0.24^\circ C$ in the left-hand column of panels and $\sigma_{ESS} = 1.66^\circ C$ in the right-hand panels). Each panel presents two scenarios of economic development (SSP3 and SSP5). Plotting symbols represent mean trajectories across 1,000 realizations of climate sensitivity, solid lines represent the 10th percentile of realizations, and the dashed lines the minimum of the 1,000 realizations.

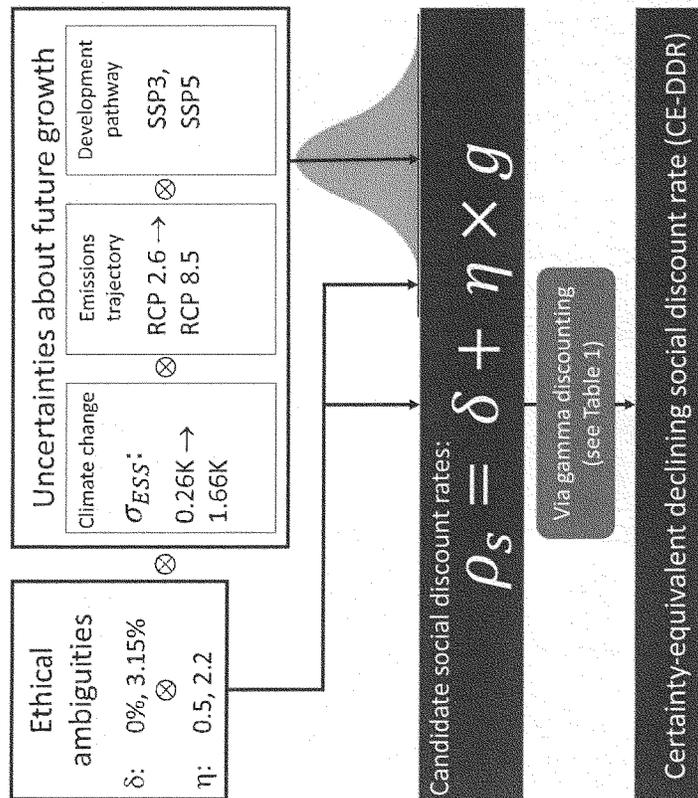
Figure 4. Global growth rate trajectories for year-to-year annual growth (left panel) and cumulative average annual growth from 2010 onward (right panel). The socio-economic pathways (SSP3 and SSP5) are represented by the two pairs of lines as indicated.

Figure 5. Proportion of countries (out of 165) with a net negative growth rate for two RCPs (RCP 2.6 in the top row and RCP 8.5 in the bottom row) and two levels of uncertainty about climate sensitivity ($\sigma_{ESS} = 0.24^{\circ}C$ in the left-hand column of panels and $\sigma_{ESS} = 1.66^{\circ}C$ in the right-hand panels). Each panel presents two scenarios of economic development (SSP3 and SSP5). Plotting symbols represent mean trajectories across 1,000 realizations of climate sensitivity; solid lines represent the 90th percentile of realizations, and the dashed lines the maximum of the 1,000 realizations.

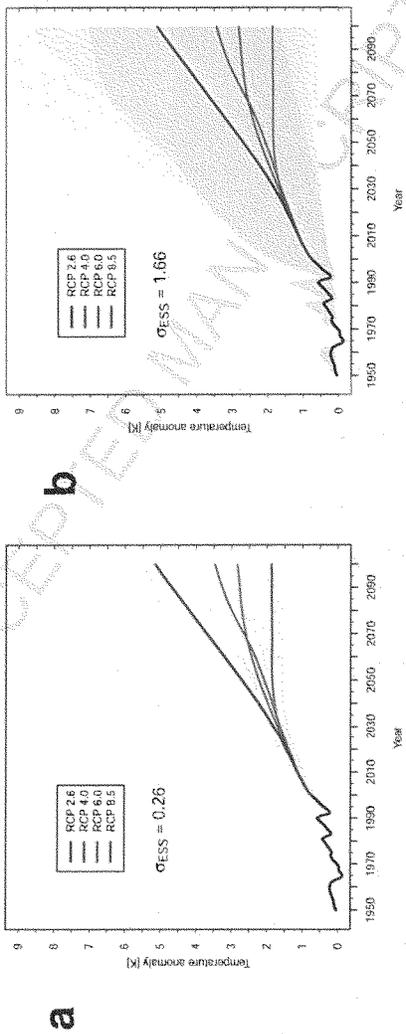
Figure 6. Certainty-equivalent declining discount rates obtained in the experiment. Panel a shows forward (instantaneous) rates and panel b spot (horizon) rates. The different parameters in each panel refer to different ensembles of candidate rates that are integrated by Gamma discounting. The line labeled “Gamma” integrates across all sources of uncertainty and ambiguity using 192 candidates, and the remaining 4 lines integrate across 48 candidates using the particular conjunction of η and δ as indicated in the legend. Rates are quoted on a continuously compounded basis for comparability with previous research.

Figure 7. Comparison of spot (horizon) CE-DDRs obtained in the experiment in this paper to current practice (U.K. Treasury) and previous research by Freeman & Groom (2015), Weitzman (2001), Newell & Pizer (2003), and (Groom et al., 2007). The line for our experiment represents Gamma integration across all 192 candidate rates; see Figure 6, panel b.

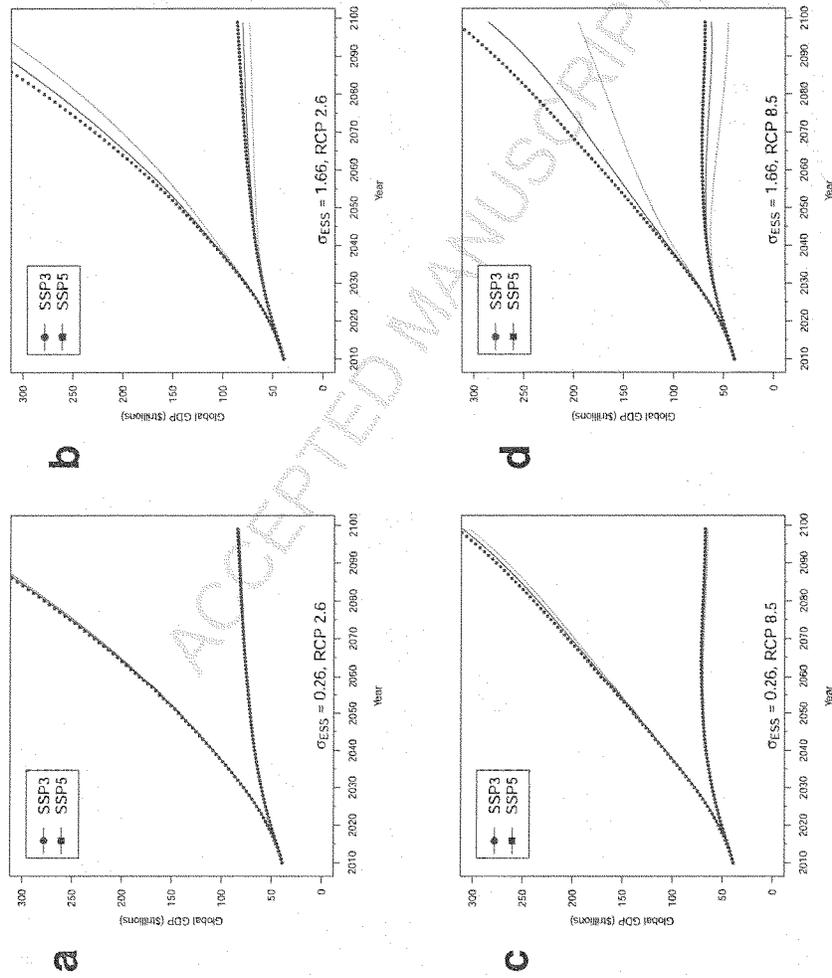
Uncertainty and Social Discount Rates, Figure 1



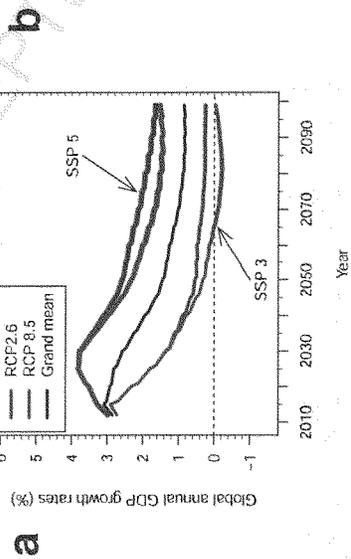
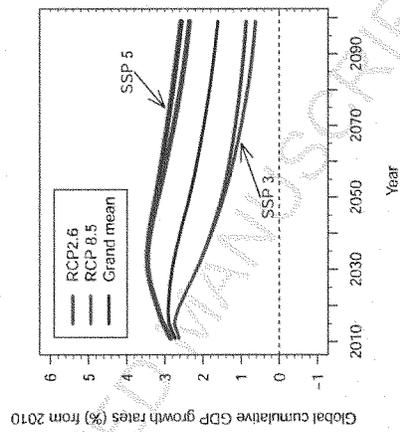
Uncertainty and Social Discount Rates, Figure 2



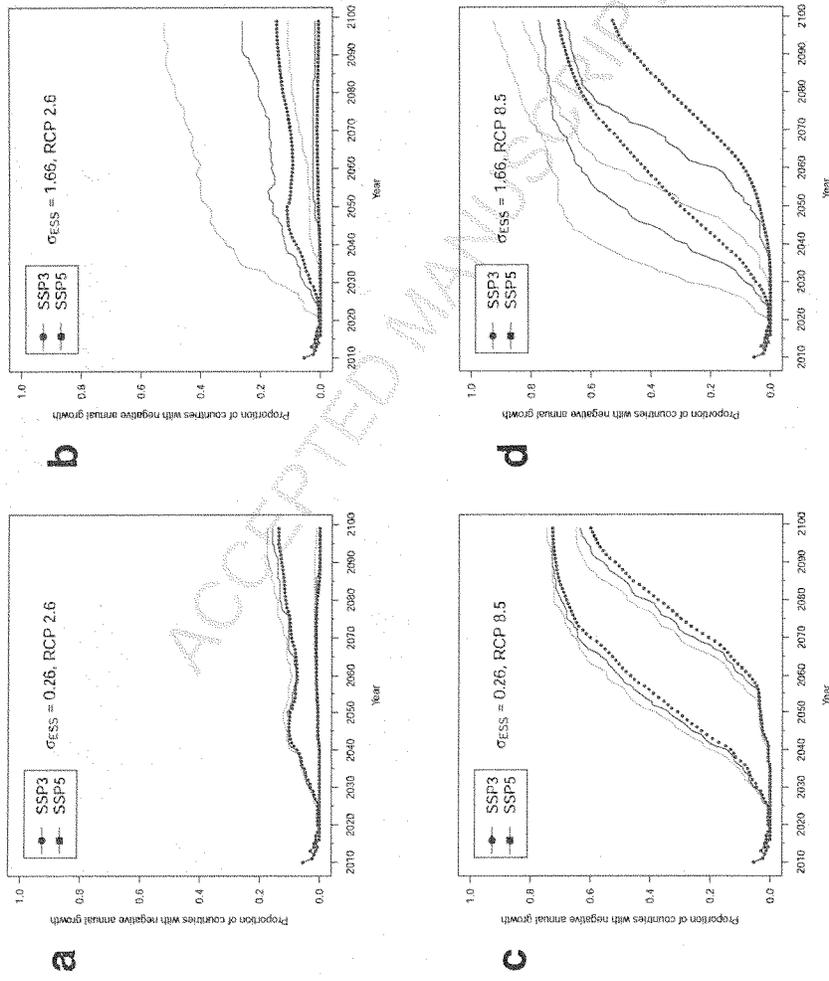
Uncertainty and Social Discount Rates, Figure 3



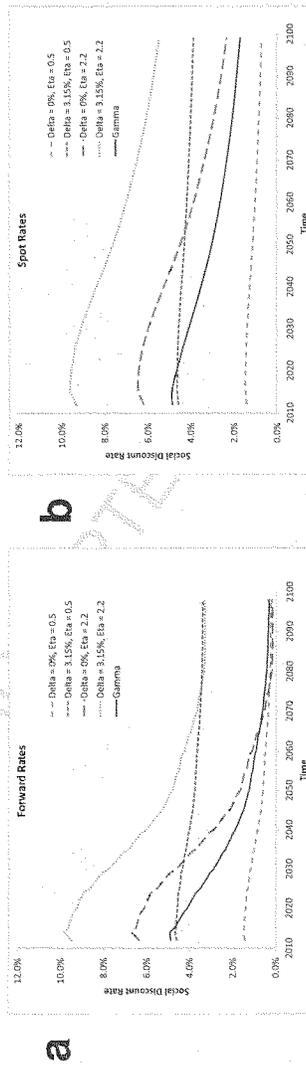
Uncertainty and Social Discount Rates, Figure 4



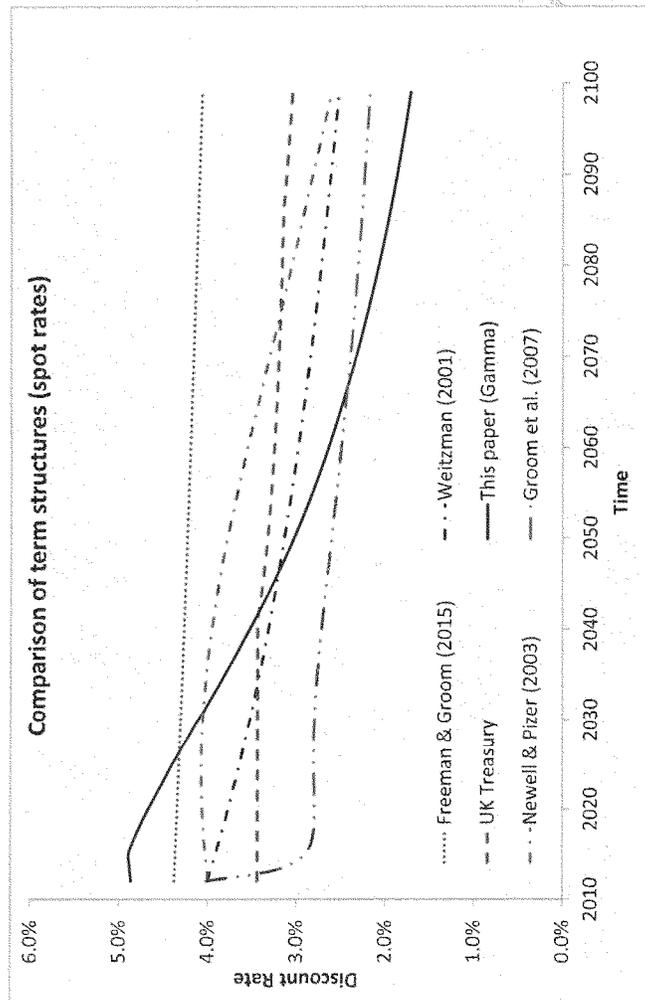
Uncertainty and Social Discount Rates, Figure 5



Uncertainty and Social Discount Rates, Figure 6

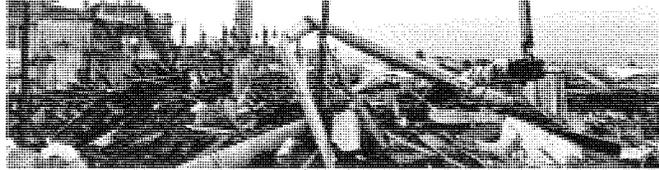


Uncertainty and Social Discount Rates, Figure 7



Highlights

- The greatest source of uncertainty in climate economics involves the social discount rate.
- Current mitigation decisions depend crucially on the value of the social discount rate.
- Debates about the social discount rate involve ethical considerations, such as concerns about inter-generational equity, as well as considerations of various sources of uncertainty about the future.
- We report a simulation experiment that examines various different sources of uncertainty and ethical ambiguity and explores their implications on the social discount rate.
- We use an empirical model of the relationship between economic productivity and temperatures to forecast global economic growth under various scenarios.
- We derive a single declining social discount rate by aggregating across all sources of uncertainty using consensually established techniques.
- The obtained social discount rate declines rapidly and falls below existing proposals by mid-century.



Debris of houses destroyed by Typhoon Haiyan in the town of Tacloban, in the Philippines. TED ALJIBE / AFP / GETTY IMAGES

MAR. 31, 2014 AT 12:13 PM

MIT Climate Scientist Responds on Disaster Costs And Climate Change

Kerry Emanuel

Filed under [Natural Disasters](#)

As someone who has spent some time looking at changes in the incidence of hurricanes around the planet, I have been asked to provide a response to Roger Pielke Jr.'s article "Disasters Cost More Than Ever — But Not Because of Climate Change," published at FiveThirtyEight earlier this month.

Let me begin by saying that I am sympathetic to Pielke's emphasis on the role of changing demographics in increasing damages from natural disasters. This is a serious problem that could be addressed by wiser policies. For example, in the United States, policies regulating insurance and providing federal flood insurance and disaster relief have the effect of subsidizing risk-taking, and the recent repeal of large sections of the 2012 Biggert-Waters Federal Flood Insurance Reform Act shows just how difficult it is to reform these risk-inducing policies.

Having said that, I'm not comfortable with Pielke's assertion that climate change has played no role in the observed increase in damages from natural hazards; I don't see how the data he cites support such a confident assertion. To begin with, it's not necessarily appropriate to normalize damages by gross domestic product

(GDP) if the intent is to detect an underlying climate trend. GDP increase does not translate in any obvious way to damage increase; in fact, wealthier countries can better afford to build stronger structures and to protect assets (for example, build seawalls and pass and enforce building regulations).¹ A grass hut will be completely destroyed by a hurricane, but a modern steel office building will only be partially damaged; damage does not scale linearly with the value of the asset.

More seriously, a casual inspection of both graphs (normalized and non-normalized damage over time) presented by Pielke leads me to question the statistical significance of either. This is hardly surprising, since 23 years is not a very long time to detect trends in natural hazard damages, whether such trends are caused by demographics or by climate change. A 2012 study² by London School of Economics researchers Fabian Barthel and Eric Neumayer looked at damage trends normalized by GDP, a measure they used because others are not universally available. For Germany and the United States, with 29 and 36 years of data, respectively, they detected “statistically significant upward trends in normalized insured losses from all non-geophysical disasters as well as from certain specific disaster types,” but for the globe as a whole, with 19 years of data available, they could find no significant trends.

Since the U.S. alone accounted for roughly half the insured losses over this period, the significance of the longer U.S. record and lack thereof in the shorter global record suggests that 20 years may be too short to detect significant trends. The increasing normalized trends in the U.S. were evident in convective storms, winter storms, flooding events and high temperature-related losses, and were almost statistically significant for hurricanes at the conventional 95 percent confidence level.³ In view of data like this, it's very hard to accept Pielke's confident assertion that “[n]o matter what President Obama and British Prime Minister David Cameron say, recent costly disasters are not part of a trend driven by climate change.”

There is an even more significant problem with Pielke's analysis. In a nutshell, he addresses trend detection when what we need is event risk assessment. The two would be equivalent if the actuarial data was the only data available pertaining to event risk. But that is far from the case; we often have much more information about risk.

Let me illustrate this with a simple example. Suppose observations showed conclusively that the bear population in a particular forest had recently doubled. What would we think of someone who, knowing this, would nevertheless take no extra precautions in walking in the woods unless and until he saw a significant upward trend in the rate at which his neighbors were being mauled by bears?

The point here is that the number of bears in the woods is presumably much greater than the incidence of their contact with humans, so the overall bear statistics should be much more robust than any mauling statistics. The actuarial information here is the rate of mauling, while the doubling of the bear population represents a priori information. Were it possible to buy insurance against mauling, no reasonable firm supplying such insurance would ignore a doubling of the bear population, lack of any significant mauling trend notwithstanding. And even our friendly sylvan pedestrian, sticking to mauling statistics, would never wait for 95 percent confidence before adjusting his bear risk assessment. Being conservative in signal detection (insisting on high confidence that the null hypothesis is void) is the opposite of being conservative in risk assessment.

When it comes to certain types of natural hazards, there are more bears in the woods. For example, there is a clear upward trend in overall North Atlantic hurricane activity by virtually all metrics, over the past 30 years or so, though the cause of this is still uncertain. But given that only about a third of Atlantic hurricanes strike the U.S.; hurricanes do damage during a very small fraction of their typical lifetimes; and only intense hurricanes (a small fraction of the total) do significant damage, the amount of hurricane data pertinent to U.S. damage is a tiny fraction of the entire database of North Atlantic hurricanes. Thus it is hardly surprising that the upward trend in U.S. hurricane damage is of only marginal statistical significance, and Pielke's own analysis shows that it takes several decades for such a trend to emerge.

This does not mean that there is no underlying change in the risk, and the priors we have in this case point to a significant increase in such risk. One would be foolish to make plans that have to deal with U.S. hurricane risk without accounting for the evidence that the underlying risk is increasing, whether or not actuarial trends have yet emerged at the 95 percent confidence level.

This is particularly so when one accounts for another form of prior information:

theory and models. While some disagreement remains about projections of the weakest storms, which seldom do much damage, both theory and models are now in good agreement that the frequency of high category hurricanes should increase, as should hurricane rainfall and the flooding it produces.

Looking ahead, I collaborated with Yale economist Robert Mendelsohn and his colleagues in estimating global hurricane damage changes through the year 2100, based on hurricanes “downscaled” from four climate models. We estimate that global hurricane damage will about double owing to demographic trends, and double again because of climate change. These projections are not inconsistent with what we’ve been seeing in hurricane data and in economic damage from hurricanes. Besides this study, there are robust theory and modeling results that show increased risk of hydrological extremes (floods and droughts) and heat-related problems.

Some of these predicted trends are beginning to emerge in actuarial data. Governments, markets and ordinary people are beginning to account for the increased risk. Those who wait for actuarial trends to emerge at the 95 percent confidence level before acting do so at their peril.

Footnotes

1. Indeed, according to a 2012 paper published in the journal *Climate Change*, “A Trend Analysis of Normalized Insured Damage from Natural Disasters” by Fabian Barthel and Eric Neumayer, “[GDP] is a relatively poor proxy for the physical wealth stock potentially destroyable by disasters.” Barthel and Neumayer write, “Moreover, the increasing share of GDP consisting of intangible components such as services, which is observed in many, but not all, countries implies that the growth rate of GDP possibly overestimates the growth rate of the physical wealth stock. This will bias the results against finding a positive trend since disasters from past periods are scaled up too strongly as a result of normalization.”
2. “A Trend Analysis of Normalized Insured Damage from Natural Disasters,” published in the journal *Climate Change*.
3. In an earlier study, Neumayer and Barthel proposed to normalize damage by local wealth rather than GDP. (That paper was titled “Normalizing economic loss from natural disasters: A global analysis” and published in the journal *Global Environmental Change* in 2011.) When they attempted to do this, using total rather than insured damage, they did not find

statistically significant trends in normalized global damage. But, as the authors point out in their later paper, the data on local wealth is difficult to attain and suffers some of the same problems as GDP in assuming a linear relationship between wealth and damageability.

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Influence of Anthropogenic Climate Change on Planetary Wave Resonance and Extreme Weather Events

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Persistent episodes of extreme weather in the Northern Hemisphere summer have been shown to be associated with the presence of high-amplitude quasi-stationary atmospheric Rossby waves within a particular wavelength range (zonal wavenumber 6–8). The underlying mechanistic relationship involves the phenomenon of quasi-resonant amplification (QRA) of synoptic-scale waves with that wavenumber range becoming trapped within an effective mid-latitude atmospheric waveguide. Recent work suggests an increase in recent decades in the occurrence of QRA-favorable conditions and associated extreme weather, possibly linked to amplified Arctic warming and thus a climate change influence. Here, we isolate a specific fingerprint in the zonal mean surface temperature profile that is associated with QRA-favorable conditions. State-of-the-art (‘‘CMIP5’’) historical climate model simulations subject to anthropogenic forcing display an increase in the projection of this fingerprint that is mirrored in multiple observational surface temperature datasets. Both the models and observations suggest this signal has only recently emerged from the background noise of natural variability.

A series of persistent, extreme summer weather events in recent years including the 2003 European Heat Wave, the 2010 Pakistan flood/Russian heatwave, 2011 Texas drought and the unprecedented, ongoing drought in California, has led to a continuing discussion in the scientific literature regarding the relationship between anthropogenic climate change and the spate of recent weather extremes^{1–3}.

Some of the increase in extreme events can be explained by relatively straightforward thermodynamics, wherein modest shifts in mean temperature lead to increases in the frequency of heatwaves^{4–12} or wherein rising temperatures favor more intense precipitation events via moist thermodynamics^{13–15}. However, a growing number of studies suggests that these mechanisms alone are not sufficiently explanatory, and more complex mechanisms may be involved as well in some (or many) of the recent strong or even unprecedented extremes^{16–19}. Explanations include changes in soil-moisture^{17,18}, changing tropical Pacific sea surface temperature^{20,21}, and the potential impact of rapid Arctic warming^{16,22–25}.

Coumou *et al.*¹⁹ showed that the Northern Hemisphere summer jet and associated storm activity have weakened since 1979 and hypothesized that this could lead to more persistent, and therefore more extreme, summer weather. Decreases in summer cyclone activity also lead to a decrease in cloud cover, giving rise to higher maximum temperatures²⁴. This weakening in storm activity is seen in future climate model projections as well, linked to rapid warming in the Arctic, but the observed decline is faster than predicted^{19,26}.

In earlier work, Hoskins and Karoly²⁷ and Hoskins and Ambrizzi²⁸ demonstrated that Rossby waves within a certain wavenumber range can become effectively trapped in a latitudinal waveguide depending on the structure of the mid-latitude westerlies. Petoukhov *et al.*²⁹ showed that if these waves have similar length-scales to those imposed by orographic and thermal forcing, a pronounced amplification of waves can occur due to resonance¹. The shape of the North-South profile of the zonal-mean westerlies influences the occurrence of this phenomenon

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of quasi-resonant amplification (QRA)^{1–4}. This profile can change due to changes in the poleward temperature gradient and thus, to the Arctic amplification of greenhouse warming through the thermal wind equation. Tropical expansion can also affect the latitudinal position of the sharpest temperature gradients and latitudinal changes in the land-ocean temperature contrast might play a role as well.

While the underlying mechanisms have been explored in depth elsewhere^{1–4}, the essence of the argument involves the relationship between changing zonal mean temperatures and the strength and position of maxima in the mid-latitude westerly jet. The main condition for resonance is the formation of a zonally-directed waveguide for a particular zonal wavenumber k , which depends only on the wavenumber and the shape of the zonal-mean zonal wind (U) profile. Such a waveguide is present when a mid-latitude region of positive squared meridional wavenumber l^2 is bounded by latitudes both north and south where l^2 vanishes, inhibiting the dispersion of wave energy and trapping excited planetary waves in the upper troposphere (300–500 mb). This can occur for zonal wavenumbers $k = 6–8^2$, with the waveguide found at the equatorward flank of the subtropical jet at latitudes around 30–45°N.

Such conditions are typically associated with a profile for U characterized by two maxima in the Northern Hemisphere, i.e. a double jet latitudinal structure. In contrast to a single jet, a double jet regime associated with a profile for U is characterized by a confined sub-tropical jet with sharp edges wherein wind speeds change rapidly with latitude⁵. Such sharp sub-tropical jets are highly effective waveguides^{30,31}, a central requirement for QRA. Especially long-duration resonance events (as e.g. seen during the European and Russian heat waves in 2003 and 2010) have such double jet structures which in turn, through the thermal wind relationships, are characterized by a particular pattern of latitudinal variation in zonal-mean surface and lower tropospheric temperatures⁷. Recent work has reported a clustering of resonance events since 2000 during the satellite reanalysis era (1979–present) that coincides with rapid warming of Arctic surface temperatures, which is suggestive of a possible climate change connection⁸.

Here, we build on recent work by developing an observational temperature-based fingerprint for QRA conditions. We examine, both in long-term historical observations and state-of-the-art (“CMIP5”) climate model simulations, the changes over time in the projection of this fingerprint. Our study focuses on hemispheric-scale trends as it has been shown¹² that many recently observed QRA events were hemispheric in nature. A worthwhile extension of the study might focus separately on different (e.g. Atlantic vs. Pacific) sectors of the Northern Hemisphere.

Our approach is conceptually similar^{32,33} to statistical downscaling of climate model simulations: We utilize large-scale features of the climate model simulations considered reliable (in this case, meridional temperature gradients) and then exploit a robust empirical relationship that exists between that feature and the response of interest (planetary wave dynamics related to QRA). It is well-documented that climate models reasonably well capture changes in global patterns of surface temperature, which are primarily thermodynamically controlled. In contrast, there is much less confidence in circulation aspects of climate change, which are primarily controlled by dynamics^{34–36}. We assume here that even models that don’t correctly simulate certain details of planetary wave dynamics responses³⁷—an issue we will examine later—are still likely to get the QRA fingerprint right, allowing us to draw reliable real-world conclusions about how climate change may impact the phenomenon of QRA.

Meridional gradients in lower tropospheric temperatures, as discussed above, imply changes in mid and upper tropospheric zonal wind (U) through the thermal wind relationship. Advantages in using the former, rather than latter, as a measure of QRA-favorable conditions are that (a) long-term historical observations of surface temperature are available back through the late 19th century (this is not the case with upper level atmospheric variables) and (b) there is a fairly straightforward and robust impact of anthropogenic climate change on changes in the structure of lower tropospheric temperatures (e.g. via the mechanism of Arctic amplification and/or the enhanced land-ocean temperature contrast).

Using ERA interim reanalysis data and the QRA detection scheme presented in Kornhuber⁸ (see Methods for details) we produced a composite of boreal summer (JJA) zonal mean near-surface (1000 mb) temperature profiles during QRA-favorable time intervals (Fig. 1a). Differencing the QRA-favorable and climatological mean profiles, we define an anomalous zonal mean temperature profile associated with QRA conditions (Fig. 1b). We restrict the profile to the mid-latitude (25–75°N) region of interest and center the profile on zero, yielding a “fingerprint” (Fig. 1c) in the zonal mean temperature field associated with QRA-favorable conditions. The fingerprint exhibits negative values in the subtropics, increases to near-neutral values at 40°N, a decline toward more negative values through 50°N, and pronounced positive values again at higher sub-polar latitudes. While Arctic-amplified warming projects onto this latitudinal anomaly pattern, the fingerprint has considerably more latitudinal structure (including the contribution from an enhanced land/ocean contrast along the Arctic Ocean shore) than is characterized simply by polar amplification alone.

The anomalous meridional temperature gradient associated with the fingerprint (Fig. 1d) is characterized by a large positive peak in the mid-latitude zone of 50–65°N, which, via thermal wind, implies a more-pronounced minimum in the zonal mean zonal wind and thus promotes the formation of a double jet. More poleward (i.e. beyond 65°N) the reduction in the temperature gradient (and thus a stronger negative gradient) implies stronger westerlies in sub-polar regions. These are precisely the conditions that Pethoukov *et al.*¹ identify as QRA-favorable.

Having defined a fingerprint for QRA-favorable conditions, we next examined mid-latitude (25–75°N) zonal mean temperatures from the historical simulations of the Coupled Model Intercomparison Project Phase 5 (CMIP5) experiments³⁸ (see Supp. Info for details) which comprise $N = 164$ distinct simulations (Table 1) in the anthropogenic+ natural “all-forcing” case and $N = 40$ simulations for the “anthropogenic-only” forcing experiments (see Supp. Info).

The multimodel ensemble zonal mean surface temperatures for the relevant (JJA) season (Fig. 2) show the expected polar amplification of warming, with higher-latitude regions tending to warm more than lower-latitude regions (Fig. 2a). This pattern is expected from the warm-season ice-albedo feedback associated with anthropogenic greenhouse warming, and it is considerably more pronounced in the anthropogenic-only forcing

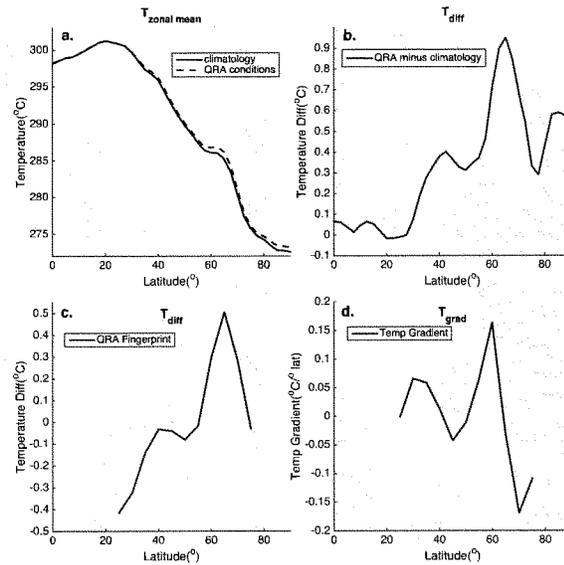


Figure 1. Boreal Summer (JJA) Zonal Mean Temperature Profiles. Shown are (a) JJA 1000 mb temperatures from ERA reanalysis data (1979–2015) for both climatological mean and QRA-favorable conditions (at 2.5° latitudinal resolution), (b) the difference between the two i.e. the anomalous zonal mean temperature profile associated with QRA-favorable conditions, (c) The QRA fingerprint defined as the former quantity, confined to the extratropical region $25\text{--}75\text{N}$, centered on zero, and interpolated onto 5° latitudinal grid commensurate with model simulations, and (d) the associated meridional temperature gradient.

experiments (Fig. 2b) where the complicating effects of volcanic forcing are absent. The full distribution of trends among the multimodel ensemble is shown for the mean extratropical ($25\text{--}75\text{N}$ average) temperature series (Fig. 2c,d). The series show considerable variability, emphasizing the potentially confounding role of internal variability in identifying clear trends in the zonal mean profiles in individual historical realizations (including the actual observed realization).

The next step in the analysis involves projecting the QRA fingerprint (i.e. Fig. 1c) onto the CMIP5 zonal mean temperature profiles (Fig. 3) using linear regression (see Methods). Examining both the full CMIP5 all-forcing simulations, (Fig. 3a) and anthropogenic-only simulations (Fig. 3b), we observe a large amount of variability among the individual realizations of the multimodel ensemble, again emphasizing the significant role of internal variability. A positive long-term trend is nonetheless evident in most realizations, and is clearly evident in the ensemble means (Fig. 3a,b). This trend is formally independent of global warming, since it reflects a change over time in a relative latitudinal pattern of temperature variation rather than any change in mean hemispheric or global warmth. Comparing the ensemble mean fingerprint series to the ensemble mean extratropical ($25\text{--}75\text{N}$) mean temperature for the all-forcing simulations (Fig. 3c) nonetheless reveals a similar long-term increase consistent with polar amplification from anthropogenic warming.

The post-1970 trend of 0.006 units/year in the multimodel mean fingerprint series (Fig. 3c) is highly significant ($p < 0.0001$). Of greater interest, however, is the behavior of individual ensemble members given that the historical changes observed reflect a single realization of internal natural variability. Examining the distribution of trends from the full multimodel ensemble, the median trend lies close to the mean trend, and 68% of the multimodel realizations exhibit a positive trend, which is highly unlikely to have arisen from chance ($p < 0.0001$).

CMIP5 All-Forcing (1970–2005)	Slope (units/yr)	% > 0	<i>p</i>	
Multimodel Mean	0.006		<0.0001	
Multimodel Ensemble (–1 σ , +1 σ)	(–0.005, 0.017)	68	<0.0001	
CMIP5 Anthropogenic-Only (1970–2005)				
Multimodel Mean	0.019			
Multimodel Ensemble (–1 σ , +1 σ)	(0.0099, 0.029)	88	<0.0001	
Observations (1970–2015)	Slope (units/yr)	t	df	p
GISTEMP	0.022 ± 0.01	2.35	35	0.01
HadCRUT4	0.017 ± 0.01	1.68	34	0.05
Cowan & Way	0.016 ± 0.01	1.68	37	0.05
Observations (1970–2005)	Slope (units/yr)	t	df	p
GISTEMP	0.028 ± 0.014	2.03	22	0.03
HadCRUT4	0.019 ± 0.016	1.16	25	0.13
Cowan & Way	0.018 ± 0.015	1.17	27	0.13

Table 1. Post-1970 Trend in QRA fingerprint series.

based on the null hypothesis of red noise; see Table 1 and Methods). Nonetheless, nearly one third of the realizations thereby do not display a positive trend, suggesting that, if the CMIP5 historical simulations are an accurate representation of the distribution of possible historical scenarios, an anthropogenic increase in QRA-favorable conditions is only *likely* (and not *very likely*) in the IPCC lexicon, to be observed in any specific realization of historical temperature variability, including the unique realization that we have actually observed.

For the anthropogenic-only case (Fig. 3d), the post-1970 trend is greater (0.01 units/year), and an increase is found in 88% of the multimodel ensemble members (also significant at the $p < 0.0001$ level; Table 1), nearly breaching the IPCC “very likely” threshold (Table 1). The more dominant trend in this case appears to be a consequence of the absence of volcanic forcing, particularly the absence of the prominent 1982 El Chichon and 1991 Pinatubo eruptions. It is reasonable to conclude that these volcanic events have likely acted to obscure an anthropogenic signal in the QRA fingerprint.

It is noteworthy that the anthropogenic-only ensemble mean QRA fingerprint series exhibits a more monotonic increase through the 1950s and 1960s than the corresponding extratropical mean temperature series (Fig. 3d), the latter of which shows a more pronounced downturn during the 1950–1970 interval of enhanced negative anthropogenic aerosol forcing. This difference in the temporal evolution of the two series ostensibly arises from the fact that anthropogenic aerosol forcing exhibits a regionally heterogeneous spatial pattern of temperature influence, and projects very weakly onto the meridional structure of QRA fingerprint. Thus, it is the more temporally inhomogeneous anthropogenic greenhouse gas forcing that projects primarily onto the QRA fingerprint, and the fingerprint series continues to increase due to greenhouse warming even during a period of pronounced anthropogenic aerosol forcing.

We next project the QRA fingerprint series onto the zonal mean 300 mb zonal velocity (U) field for each of the CMIP5 simulations. These projections (Fig. 4) show the expected double jet structure, with a substantial negative zonal wind anomaly in the 50–65N mid-latitude zone and a pronounced positive zonal wind anomaly at higher subpolar latitudes. These features are evident in nearly every simulation for both all-forcing and anthropogenic-only experiments. The precise location and magnitude of the mid-latitude negative peak varies among simulations, and a handful of simulations don’t exhibit the feature at all, consistent with previous work²⁴ finding that some models do exhibit biases in upper level winds and especially the bimodality of the jet stream. Such caveats notwithstanding, our results suggest the QRA fingerprint detected in the CMIP5 simulations is indeed associated with a thermal wind-driven anomalous double peak zonal jet structure, consistent with the planetary wave dynamics associated with QRA.

Finally, we apply the QRA fingerprint approach to observational surface temperature data available through 2015 (Fig. 5). As with the CMIP5 historical simulations, we see the expected pattern of polar amplification of warming, regardless of which of three different surface temperature products (GISTEMP, HadCRUT4, and Cowtan & Way) is used (Fig. 5a,b,c). When we project the QRA fingerprint onto the zonal temperature profiles (Fig. 5d,e,f), we observe a significant trend in the QRA fingerprint during the post-1970 interval during which the CMIP5 simulations display a prominent trend. The trend is significant at the $p = 0.05$ level for all three instrumental temperature datasets (Table 1). While the trends in the observational fingerprint series are modestly greater (0.016–0.022 units/year) than those for the CMIP5 multimodel mean series, both are in agreement taking into account respective one sigma ranges (Table 1). The QRA fingerprint series for one of the surface temperature datasets (GISTEMP) exhibits positive values during the early decades of the 20th century that rival recent values. Examining Fig. 5a–c, it is apparent that high-latitude warmth substantially exceeds low-latitude warmth during these decades for GISTEMP, though this is not seen in the other datasets. We suspect that the GISTEMP approach of spatially-interpolating across the Arctic based on what data are available, becomes increasingly susceptible to large sampling uncertainties as data in this region become exceptionally sparse in earlier decades. That could lead to spurious amplification of high-latitude meridional temperature gradients that project substantially onto the QRA fingerprint.

If we restrict the time interval under examination to the period of overlap between the observations and CMIP5 historical simulations that terminates earlier in 2005, we find that the trend in the fingerprint series is

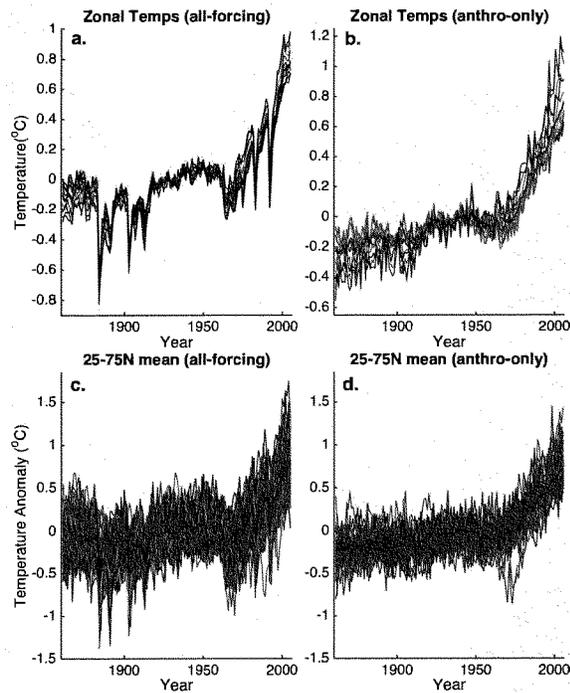


Figure 2. Zonal mean temperatures for 5 degree bands from 25–75N in the CMIP5 historical simulations. Shown are the multimodel means for the (a) all-forcing and (b) anthropogenic-only simulations. Rainbow scale is used to denote increasing latitude from 25N (violet) to 75N (red). The extratropical 25–75N mean series is shown for comparison (black). Shown also for both the (c) all-forcing and (d) anthropogenic-only simulations is the extratropical mean series for each member of the multimodel ensemble (colored curves) along with the multimodel mean (black) series.

statistically significant at the $p = 0.05$ level for only one (GISTEMP) of the three surface temperature datasets (Table 1). Combined with inferences drawn above from the analysis of CMIP5 historical simulations, these observations suggest that the anthropogenic signal in the QRA fingerprint has emerged from the background noise of natural variability only within the past decade or so.

In summary, our analysis of both historical model simulations and observational surface temperature data, strongly suggests that anthropogenic warming is impacting the zonal mean temperature profile in a manner conducive to wave resonance and a consequent increase in persistent weather extremes in the boreal summer. Combined with other additional proposed mechanisms for climate change impacts on extreme weather, this adds to the weight of evidence for a human influence on the occurrence of devastating events such as the 2003 European heat wave, the 2010 Pakistan flood and Russian heat wave, the 2011 Texas heat wave and recent floods in Europe.

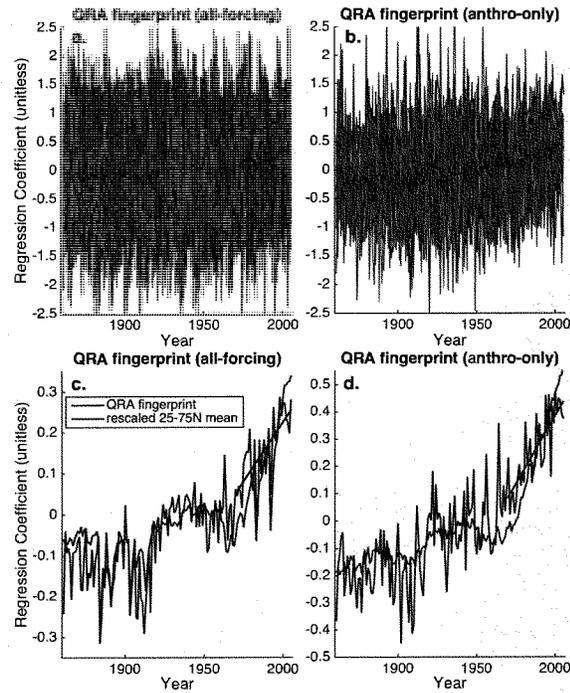


Figure 3. QRA Fingerprint Series. Shown for both the (a) all-forcing and (b) anthropogenic-only simulations is the QRA series for each member of the multimodel ensemble (colored curves) along with the multimodel mean (black) series. The corresponding multimodel mean QRA series are shown along with the extratropical mean temperatures series for the (c) all forcing and (d) anthropogenic-only simulations, along with the linear trend over 1970–2005 (red line).

Methods

QRA Fingerprint. We used the QRA detection scheme of Kornhuber *et al.*³ but in this case applied it to near-surface temperature rather than upper level winds, to develop a zonal mean QRA temperature fingerprint. We used the Jun–Aug (JJA) 1979–2015 ERA interim reanalysis ($2.5^\circ \times 2.5^\circ$). Near-surface atmospheric temperature profiles were calculated using $z = 1000$ mb daily data over the full Northern Hemisphere ($0^\circ\text{N}–90^\circ\text{N}$) in 37 steps (2.5°). We focused on long duration (≥ 10 days) wavenumber 7 events to define QRA-favorable time intervals, and confined zonal-mean profiles to the mid-latitude latitude range ($25\text{N}–75\text{N}$) analyzed in previous work^{1–3}. Such events have been shown to be closely related to Northern Hemisphere JJA heat extremes³⁴. The fingerprint was interpolated to a 5° latitude grid that is consistent with the grid of the model simulations and observational data (see below) and centered on zero. This yields an 11 element zero-centered row vector that defines the QRA fingerprint.

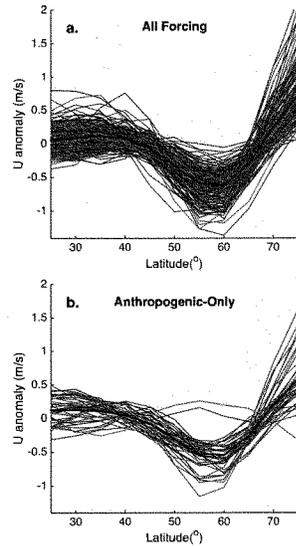


Figure 4. Projection of QRA Fingerprint Series onto 300 mb Zonal Wind (U) in individual CMIP5 historical Simulations (colored curves) and averaged over ensemble (black). Shown are results for (a) all-forcing and (b) anthropogenic-only forcing experiments.

The projection of the fingerprint was estimated in both CMIP5 simulated (see below) and observational (see below) datasets through linear regression of the 11 element row vectors defined by the individual yearly (JJA) model or observational zonal mean surface temperatures onto the QRA fingerprint defined above.

CMIP5 Historical Simulations. We used the Coupled Model Intercomparison Project Phase 5 (CMIP5) historical experiment³⁸ multimodel ensemble simulations, including both the anthropogenic+natural forced simulations ($N = 164$ realizations; $M = 48$ models) and anthropogenic-only forced simulations ($N = 40$ realizations; $M = 10$ models) spanning 1861–2005 (Table S1). Each physics version of a model was considered a separate model. The analysis was limited to the common time period of overlap for all models and realizations (1861–2005). Those with a start year later than 1861 were not included in the analysis. We used a simple area-weighted average to create zonal means at a 5° interval.

Observational Surface Temperatures. We analyzed zonal mean boreal summer (JJA) average temperatures (Surface Air Temperature over land and Sea Surface Temperature over oceans) using each of three alternative datasets: GISTEMP³⁹ (1880–2015), HadCRUT4⁴⁰ (1894–2015) and Cowtan & Way⁴¹ (1894–2015). These three different datasets make alternative assumptions about how to account for historical data gaps, which is particularly important in the Arctic region that is key to this study, due to the large spatial gaps in this region coupled with the amplified high-latitude warming in the Northern Hemisphere in recent decades. The time period of analysis was constrained by continuous data availability for each latitude band. For example, the HadCRUT4 and Cowtan & Way datasets contain at least one grid cell temperature value in each latitude band across the range of interest (25–75°N) from 1894 to present. Accordingly, the grid cell coverage is relatively sparse in the early segments of the records and increases toward present day. As with the model output, we used a simple area-weighted average to create zonal means at a 5° interval.

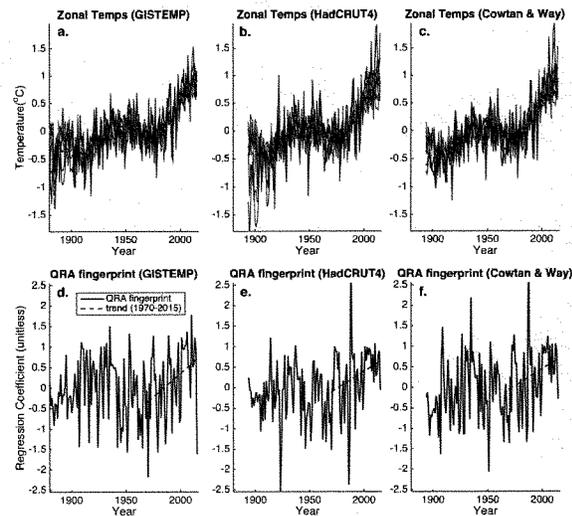


Figure 5. Observational Series. Shown are the zonal mean temperatures for 5 degree bands from 25–75N (colours—same conventions as in Fig. 2a) and the extratropical 2–75N mean series (black) for (a) GISTEMP, (b) HadCRUT4, and (c) Cowtan & Way instrumental temperature series. Shown are the corresponding QRA fingerprint series (d–f) along with linear trend from 1970–2015 (black dashed).

Trend Assessment. Linear trends for both simulations and observations were computed based on ordinary least squares (OLS) using the post-1970 interval of dominant anthropogenic forcing.

For the observational series, trends were calculated both for the 1970–2005 ($N = 36$) interval of overlap with the CMIP5 historical simulations, and for the longer 1970–2015 ($N = 46$ years) updated to include the most recent decade of observations. In both cases, p values were assessed by taking into account reduced degrees of freedom owing to serial correlation of regression residuals via $N = N(1 - \rho)/(1 + \rho)$ where ρ is the lag-one autocorrelation coefficient of the actual series (Table 1).

For the CMIP5 multimodel mean all-forcing and anthropogenic-only series, trends over 1970–2005 ($N = 36$) and statistical significance were assessed as described above.

We also diagnosed trends for the full CMIP5 multimodel ensemble, assessing the ± 1 sigma range (or more precisely, the 16%ile and 84%ile of the distribution, which is slightly asymmetric with respect to the mean) across the ensemble as reported in Table 1. We also calculated, as a measure of robustness across the multi-model ensemble, the percent of ensemble members (“% > 0” in Table 1) with positive trends and performed Monte Carlo simulations (10,000 realizations) modeling each multi-model ensemble member fingerprint series as AR(1) red noise (preserving the standard deviation and lag-one autocorrelation of the series). Using the distribution among the Monte Carlo surrogates of the 1970–2005 trends across the multimodel ensemble, we then assessed p values for the “% > 0” statistic (the minimum possible p value calculable using 10,000 surrogates is 10^{-4}).

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Author Contributions

M.E.M. conceived, designed, and performed the research and wrote the paper. K.K. helped in the design of the research, performed some aspects of the research and co-wrote the paper. B.A.S. and S.K.M. performed some aspects of the research, and co-wrote the paper. D.C. helped in the design of the research and co-wrote the paper. S.R. co-wrote the paper.

Additional Information

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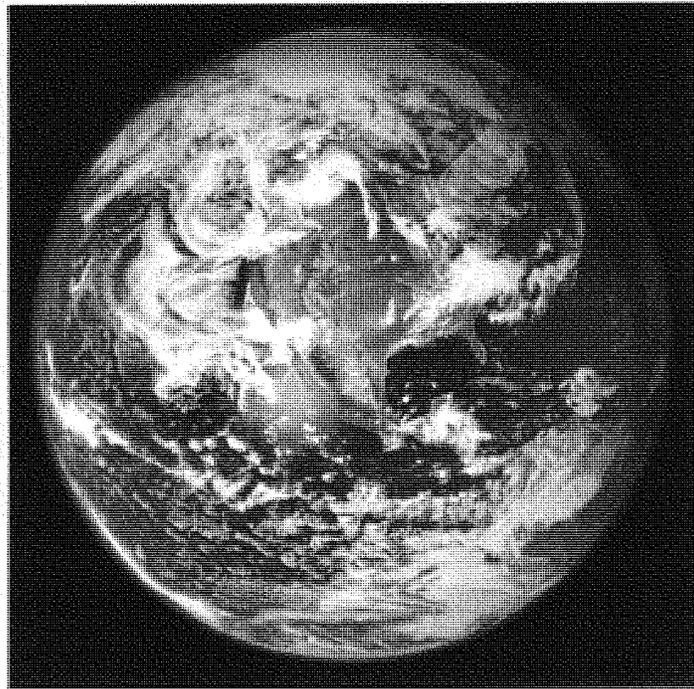
Appendix II

ADDITIONAL MATERIAL FOR THE RECORD

DOCUMENTS SUBMITTED BY RANKING MEMBER

EDDIE BERNICE JOHNSON

“Much Ado About Nothing”
A Minority Review of the Majority’s
Climate Science Investigation



Prepared by Democratic Staff of the House
Committee on Science, Space & Technology for
Democratic Members and Staff

March 2017

“Much Ado About Nothing”
A Minority Review of the Majority’s
Climate Science Investigation



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Purpose - Climate Science Hearing

Science Committee Chairman Lamar Smith has called a Full Committee hearing for Wednesday, March 29, 2017, innocuously titled: “Climate Science: Assumptions, Policy Implications, and the Scientific Method.” This hearing is only the latest example of efforts by the Committee’s Majority over the past two Congresses to provide a forum for fringe science interests, climate change deniers, and oil and gas industry proxies to spread doubt and misinformation about climate science and the scientific process.

At Wednesday’s hearing, the Majority is likely to bring up their investigation of a scientific paper published in the journal *Science* in June 2015 and co-authored by nine scientists from the National Oceanic and Atmospheric Administration (NOAA). The study was led by Thomas Karl, a well-respected climate scientist and then Director of NOAA’s National Centers for Environmental Information (NCEI), headquartered in Ashville, North Carolina. The paper, known as the *Karl study*, was titled “Possible artifacts of data biases in the recent global surface warming hiatus.”¹ The study used new temperature data from 2013 and 2014 and improved methods to correlate the temperature data collected by buoys and ships. With these improved methods and added global temperature data, the study concluded that there had been no “hiatus” or pause in global warming over the preceding 15 years, as previous studies had suggested. Dr. Karl retired last year after a distinguished career at NOAA that lasted more than 40 years.

As this report outlines below, the Majority’s nearly two-year crusade to attempt to undermine and invalidate the Karl study, which underwent two separate peer-reviews over a period of six months by independent reviewers at the journal *Science* before it was published, is really *Much Ado About Nothing*.

The Majority has never provided any evidence that NOAA or its scientists “manipulated” their data for political or other reasons, as they have consistently claimed. Recently, a former NOAA scientist named Dr. John Bates has emerged who has publicly disagreed with the Karl co-authors about how they stored and archived their climate data. However, he never disputed the actual findings of the Karl study and never made any allegations about “data manipulation.” The Majority, however, has misused his statements to suggest Dr. Bates has supported their fictional narrative about intentional manipulation of climate data for political purposes. Dr. Bates recently told the press he feared that his comments would be taken out of context. “I knew people would misuse this,” he said.² That is exactly what the Majority has done.

In fact, on February 5, 2017, the Science Committee Majority released a press release regarding comments made by Dr. Bates, titled: *Former NOAA Scientist Confirms Colleagues Manipulated Climate Records*. The following day, however, Dr. Bates gave two press interviews to both

¹ Thomas R. Karl, et al., “Possible artifacts of data biases in the recent global surface warming hiatus,” *Science*, June 26, 2015, Vol. 348, Issue 6242, pp. 1469-1472, accessed here: <http://science.sciencemag.org/content/348/6242/1469>; Supplemental material accessed here: <http://science.sciencemag.org/content/sci/suppl/2015/06/03/science.aaa5632.DC1/Karl-SM.pdf>

² Warren Cornwall and Paul Voosen, “How a culture clash at NOAA led to a flap over a high-profile warming pause study,” *ScienceInsider*, February 8, 2017, accessed here: www.sciencemag.org/news/2017/02/how-culture-clash-noaa-led-flap-over-high-profile-warming-pause-study

E&E News and the *AP* clearly stating that there was no data ‘manipulation.’³ He told the *AP* that there was “no data tampering, no data changing, nothing malicious” involved with the Karl study. “It’s not trumped up data in any way shape or form,” said Bates.⁴ Dr. Bates did have disagreements with the Karl study authors about how they archived and stored the climate data related to their study. This portion of Dr. Bates’s claims has been widely described as an internal dispute between scientists at NOAA in multiple press stories.⁵

Dr. Bates also suggested the study was “rushed” to press for political reasons. That claim is simply not supported by any of the facts. The journal *Science* put the Karl study through two separate rounds of peer-review over a period of six months, hardly a “rushed” effort. In addition, the *AP* reported that on average a review of a paper at *Science* takes 109 days. In the case of the Karl study it took *Science* 185 days to review it before publication.⁶

The Science Committee Majority, however, has concocted their own politically useful tale about the Karl study, claiming repeatedly that NOAA scientists had “manipulated” data in the Karl study for political purposes. They have never provided any evidence supporting these claims and they have mangled Dr. Bates’s concerns about data archiving issues to support their unfounded allegations of data manipulation that Dr. Bates himself has clearly and strongly refuted.

This report provides background on the Majority’s unsubstantiated claims about the Karl study and their lengthy, politically motivated, investigation into this climate science paper. It also includes summaries and links to other scientific papers that have supported the methodologies used in the Karl study and corroborated the study’s findings that the global warming “hiatus” never actually occurred. Those findings were published in eight separate articles, in seven different scientific journals, co-authored by 35 individual scientists from six countries (including the United States, United Kingdom, Australia, Canada, Norway, and Switzerland). These climate scientists reached the same basic conclusion of the Karl study’s co-authors that the planet has continued to warm over the past few decades unabated. The investigations launched by the Majority, no matter how aggressive, forceful or persistent, will not change the scientific reality of climate change.

³ See: Scott Waldman, “‘Whistleblower’ says protocol was breached but no data fraud,” *E&E News*, February 7, 2017, accessed here: www.eenews.net/stories/1060049630 (Hereafter, “*E&E News* story”) and Seth Borenstein and Michael Biesecker, “Major global warming study again questioned, again defended,” *Associated Press (AP)*, February 7, 2017, accessed here: <http://bigstory.ap.org/article/3fc5d49a349344f1967aadc4950e1a91/major-global-warming-study-again-questioned-again-defended> (Hereafter, *Associated Press* story)

⁴ *Associated Press* story.

⁵ See, Hiroko Tabuchi, “How an Interoffice Spat Erupted Into a Climate-Change Furor,” *New York Times*, February 20, 2017, accessed here: www.nytimes.com/2017/02/20/business/energy-environment/climate-change-dispute-john-bates.html?_r=0; Scott Waldman, “‘Whistleblower’ says protocol was breached but no data fraud,” *E&E News*, February 7, 2017, accessed here: www.eenews.net/stories/1060049630; Warren Cornwall and Paul Voosen, “How a culture clash at NOAA led to a flap over a high-profile warming pause study,” *ScienceInsider*, February 8, 2017, accessed here: www.sciencemag.org/news/2017/02/how-culture-clash-noaa-led-flap-over-high-profile-warming-pause-study; Seth Borenstein and Michael Biesecker, “Major global warming study again questioned, again defended,” *Associated Press (AP)*, February 7, 2017, accessed here: <http://bigstory.ap.org/article/3fc5d49a349344f1967aadc4950e1a91/major-global-warming-study-again-questioned-again-defended>

⁶ *Associated Press* story.

Key Points to Keep in Mind:

- **The NOAA data in the Karl study was not “manipulated.”** The Majority has grossly distorted the facts of their unsubstantiated allegations about the Karl study, repeatedly claiming, with zero evidence, that NOAA’s scientists “manipulated” data used in the journal *Science*. Even Dr. John Bates, the former NOAA whose comments the Majority has recently relied on to re-energize their stalled investigation launched nearly two years ago has denied that data was manipulated, telling the *Associated Press* that there was “no data tampering, no data changing, nothing malicious” involved with his colleagues’ study.⁷
- **The Karl study was not “rushed” to publication.** The Majority has claimed the study was “rushed” to publication. In reality, the Karl study went through two separate, independent rounds of peer review by the journal *Science* that were conducted over a six-month period prior to publication. Calling the study “rushed” does not correspond with the actual facts.
- **Dr. Bates reportedly signed off on the Karl paper when he was at NOAA.** Dr. Bates was apparently in charge of reviewing the scientific integrity of the Karl study at NOAA and signed off on the original manuscript before it was submitted to *Science* in December 2014.
- **Dr. Bates was demoted by Tom Karl in 2012.** According to multiple media reports and former NOAA officials, Dr. Bates was removed from his supervisory position at NOAA in 2012 by Tom Karl because of personnel management issues and was given the position of Principal Scientist that included no supervisory responsibilities.⁸
- **Multiple scientific papers have confirmed the Karl study’s conclusions.** In their continuing efforts to undermine the mainstream consensus that climate change is a scientific reality, the Majority has attempted to paint the Karl paper as being politically motivated and scientifically manipulated. However, at least six scientific papers published since the Karl study appeared in *Science* in June 2015 have supported the study’s conclusions. At a previous Science Committee hearing last year, Chairman Smith also misconstrued a paper co-authored by Dr. Michael Mann in *Nature Climate Change* to suggest it is at odds with the Karl study and inaccurately said this paper found there had been a “halt in global warming” over the previous 18 years.⁹ The paper by Dr. Mann, lead author Dr. John Fyfe, and others, however, actually found that there has not been a global warming “hiatus,” or “pause” in global temperatures. They described the most recent 15-year period ending in 2014 as a “warming slowdown,” not a “halt” as described by the Chairman of the Science Committee.

⁷ Ibid.

⁸ See, Seth Borenstein and Michael Biesecker, “Major global warming study again questioned, again defended,” *Associated Press*, Feb. 7, 2017: <http://bigstory.ap.org/article/3fc5d49a349344f1967aadc4950e1a91/major-global-warming-study-again-questioned-again-defended> and Warren Cornwall and Paul Voosen, “How a culture clash at NOAA led to a flap over a high-profile warming pause study,” *ScienceInsider*, Feb. 8, 2017,

www.sciencemag.org/news/2017/02/how-culture-clash-noaa-led-flap-over-high-profile-warming-pause-study

⁹ “An Overview of the Budget Proposal for the National Oceanic and Atmospheric Administration for Fiscal Year 2017,” Hearing Before the Subcommittee on Environment, Committee on Science, Space, and Technology, U.S. House of Representatives, March 16, 2016, accessed here: <https://www.gpo.gov/fdsys/pkg/CHRG-114hhrg20837/pdf/CHRG-114hhrg20837.pdf>

“We do not believe that warming has ceased,” the authors wrote.¹⁰ Bates also misrepresented what this study concluded, writing “The [Karl] study drew criticism from other climate scientists, who disagreed with [the Karl paper’s] conclusion about the ‘hiatus,’” citing the *Nature* article by Dr. Mann and his co-authors.¹¹ That was inaccurate.

Background

The Majority is long running investigation into the Karl study has been sown with falsehoods and fact-fewer accusations, almost from the moment the study was published in June 2015. The response to the Karl study from the Science Committee Majority was swift, sweeping and caustic in tone from the start, questioning the integrity of the NOAA scientists and eventually suggesting they had “manipulated” the data in the study for political purposes at the behest of President Obama’s administration. In his first letter to NOAA on July 14, 2015, Chairman Smith berated Dr. Kathryn Sullivan, a former astronaut and the NOAA Administrator under the Obama Administration, for not making the data used in the Karl study public, for instance, only to learn from NOAA that the data had been public for one year prior to publication of the Karl study.

Chairman Smith issued a subpoena to the Department of Commerce requesting internal communications between NOAA scientists regarding global temperature data on October 13, 2015. Dr. Sullivan pushed back on the subpoena. She said the Majority’s demands could chill communications between scientists and endanger the scientific process as a result. Although NOAA eventually did provide document productions in December 2015 and March 2016.

Science Committee Ranking Member Eddie Bernice Johnson also objected to the subpoena, but on different grounds. On October 23, 2017, Ms. Johnson sent a letter to Chairman Smith, writing, “This subpoena appears to be furthering a fishing expedition, rather than engaging in focused oversight with a legitimate goal in mind. Unfortunately, this is reflective of much of the Committee on Science, Space, and Technology’s oversight work this Congress, and it is a disturbing trend for the legitimacy of this Committee,” she wrote.¹² Nearly 18 months since the subpoena was issued the Majority still has no fish to show for their fishing expedition.

One month after the Majority issued this subpoena, on November 18, 2015, during a Science Committee hearing on the Paris climate talks (which took place from Nov. 30th to Dec. 1st 2015), Chairman Smith alleged that NOAA’s scientists involved in the Karl study “altered historical climate data to get politically correct results in an attempt to disprove the hiatus in global temperature increases.” Chairman Smith went even further, suggesting that the very timing of the release of the Karl study was somehow part of a grand government conspiracy. “NOAA

¹⁰ John C. Fyfe, et al., “Making sense of the early-2000s warming slowdown,” *Nature Climate Change*, Vol. 6, March 2016, accessed here: <http://www.nature.com/nclimate/journal/v6/n3/full/nclimate2938.html>

¹¹ John Bates, “Climate scientists versus climate data,” *Climate Etc.*, posted on February 4, 2017, accessed here: <https://judithcurry.com/2017/02/04/climate-scientists-versus-climate-data/>

¹² Letter from Science Committee Ranking Member Eddie Bernice Johnson to Science Committee Chairman Lamar Smith regarding the Majority’s NOAA subpoena, October 23, 2015, accessed here: <http://democrats.science.house.gov/sites/democrats.science.house.gov/files/Ranking%20Member%20Johnson%20Letter%20to%20Chairman%20Smith%20on%20NOAA%20Subpoena.pdf>

conveniently issues its news release promoting this report just as the Obama administration was about to announce its extensive climate change regulations,” Chairman Smith asserted.¹³

On the same day as this hearing Chairman Smith sent his seventh (7) letter to the Administration about the Karl study, this one addressed to Secretary of Commerce Penny Pritzker. The investigative narrative from the Majority, however, began to shift. Rather than suggesting the data in the Karl paper had been “manipulated” the Chairman suggested that NOAA “rushed to publish” the study. The Majority also claimed, for the very first time, that the Committee had “whistleblowers” who allegedly raised concerns in e-mails about the study in April, May and June 2015. The very timing of these allegations raise questions. Dr. Karl and NOAA submitted its manuscript to the journal *Science* in December 2014, four months before these concerns from whistleblowers were apparently raised. The notion that the Karl study was “rushed” to publication also seems to be at odds with the facts. The manuscript was submitted to *Science* in December 2014 and underwent two separate rounds of peer-review. It was finally published more than six months after it was received, hardly a “rushed” effort in most people’s minds. In addition, the *AP* reported that on average a review of a paper at *Science* takes 109 days. In the case of the Karl study, it took 185 days to review it before publication.¹⁴

In December 2015, one month after the Majority sent this letter to Secretary of Commerce Penny Pritzker, Chairman Smith went further still in his allegations during an interview on *National Public Radio*.¹⁵ Asked during his interview if the normal peer review process conducted at a major scientific journal like *Science* would have flagged any missing information or cherry picking of data, Chairman Smith said: “I don’t think *Science* magazine had access to a whistleblower like we did, saying it had been rushed and had not been sufficiently peer-reviewed.” He continued: “And, you know, *Science* magazine may have its own bias. I don’t know, maybe they wanted to rush it out before the Paris [climate change] summit as well.”¹⁶

The Chairman of the House Science Committee had just accused the well-respected publication *Science*, founded in 1880 with seed money from Thomas Edison and today published by the American Association for the Advancement of Science (AAAS), the world’s oldest and largest general science organization serving 10 million people, of potentially conspiring with NOAA and the Obama Administration to intentionally alter a climate change study for political purposes. These accusations were made with zero public evidence to support these bold and brazen claims. The Majority has never shared the e-mails they reportedly have that they believe justifies these claims with Democratic Members or staff, NOAA, or with the public.

¹³ “Smith Statement on Paris Climate Conference,” Majority Press Release, Committee on Science, Space and Technology, November 18, 2015, accessed here: <https://science.house.gov/news/press-releases/smith-statement-paris-climate-conference>

¹⁴ Ibid.

¹⁵ Nell Greenfieldboyce, “Is This Congressman’s Oversight An Effort To Hobble Climate Science?” Morning Edition, *National Public Radio*, December 7, 2015, accessed here: <http://www.npr.org/2015/12/07/458476435/is-this-congressmans-oversight-an-effort-to-hobble-climate-science>

¹⁶ Ibid.

In December 2015 and January 2016, the Editorial Boards of three newspapers including *The Washington Post*, *Des Moines Register* and *New York Times* issued blistering editorials condemning the Majority's investigation of NOAA and the Karl study.¹⁷

The New York Times wrote that the Majority's "focus on a single study threatens to obscure a larger issue: The overwhelming majority of scientific evidence shows that the world climate is changing because of human activity. ... What is needed is action to mitigate climate change, not baseless criticisms of the scientific process."¹⁸

The Des Moines Register pointed out how the actions of the Republican Chairman appear to have been intended to intimidate climate scientists. The paper's editorial, titled: "*Lawmaker fights science with intimidation*," said "Smith doesn't have any reason to question the new findings [of NOAA's Karl study] or the process by which the scientists reached their conclusions, all of which has been made public. He's just looking for dirt that might call into question the scientists' professionalism, or lend support to his unsubstantiated claim that they are distorting data to advance the political agenda of the president," wrote the paper's Editorial Board.¹⁹

Just last month, the *Boston Globe's* Editorial Board also addressed the Majority's investigation of the Karl study in its editorial titled, "*Pushing back against science deniers*." The editorial focused on the Trump Administration's war on science and observed, "In Congress, the House Committee on Science, Space, and Technology — which could theoretically be a check on any White House excess — is led by Representative Lamar Smith, a climate-change-denying Republican from Texas. Smith has used the panel's subpoena power to try to obtain internal e-mails from government scientists about a global warming study he didn't like in the journal *Science* — leading to a chill that has nothing to do with the weather."²⁰

Many major U.S science organizations, representing hundreds of thousands of scientists and engineers, including the American Association for the Advancement of Science (AAAS), American Chemical Society (ACS), American Geophysical Union (AGU), American Meteorological Society (AMS), American Statistical Association (ASA), Ecological Society of America (ESA), and Geological Society of America (GSA) also voiced their condemnation of the Majority's investigation. In a letter to Chairman Smith signed by all seven of these organizations in November 2015, they said they had grave concerns about the Majority's investigation into the Karl paper, describing it as an "inquest," "despite a lack of public evidence

¹⁷ See, "2015-A year of progress and buffoonery on climate change," Editorial, *Washington Post*, January 2, 2016, accessed here: https://www.washingtonpost.com/opinions/2015-a-year-of-progress-and-buffoonery-on-climate-change/2016/01/02/9ad6955c-af33-11e5-9ab0-884d1cc4b33e_story.html?utm_term=.cd34bb37fbc0; "The Latest Attack on Climate Science," Editorial, *New York Times*, December 4, 2015, accessed here: <http://www.nytimes.com/2015/12/04/opinion/the-latest-attack-on-climate-science.html>; "Editorial: Lawmaker fights science with intimidation," Editorial, *The Des Moines Register*, December 2, 2015, accessed here: <http://www.desmoinesregister.com/story/opinion/editorials/2015/12/02/editorial-lawmaker-fights-science-intimidation/76581828/>

¹⁸ "The Latest Attack on Climate Science," Editorial, *New York Times*, December 4, 2015

¹⁹ "Lawmaker fights science with intimidation," *The Des Moines Register*, December 2, 2015

²⁰ "Pushing back against science deniers," *The Boston Globe*, February 13, 2017, accessed here: <https://www.bostonglobe.com/opinion/editorials/2017/02/13/pushing-back-against-science-deniers/veuxtRZSY1Qa1S1hjNDjIN/story.html>

of scientific misconduct.” They also noted that the data and methodologies used in the Karl paper “have been publicly shared and discussed directly with the committee staff.”²¹

The letter went on to say: “Scientists and policymakers may disagree over the implications of scientific conclusions on climate change and other policy-relevant topics.

Disagreements about the interpretation of data, the methodology, and findings are part of daily scientific discourse. Scientists should not be subjected to fraud investigations or harassment simply for providing scientific results that some may see as politically controversial. Science cannot thrive when policymakers—regardless of party affiliation—use policy disagreements as a pretext to attack scientific conclusions without public evidence.”²²

Eventually, the Majority’s investigation into NOAA and the Karl paper appeared to peter out in the spring of 2016 until the Majority’s interest in it was restarted again earlier this year.

For a more detailed time-line of the Majority’s investigation of the Karl study see below.

**Letter to Chairman Smith from
Major U.S. Science Organizations,
November 24, 2015**

“Disagreements about the interpretation of data, the methodology, and findings are part of daily scientific discourse. Scientists should not be subjected to fraud investigations or harassment simply for providing scientific results that some may see as politically controversial.”

²¹ Letter to Chairman Lamar Smith, Committee on Science, Space, and Technology, from American Association for the Advancement of Science (AAAS), American Chemical Society (ACS), American Geophysical Union (AGU), American Meteorological Society (AMS), American Statistical Association (ASA), Ecological Society of America (ESA), and Geological Society of America (GSA), November 24, 2015, accessed here: <https://sciencepolicy.agu.org/files/2013/07/Intersociety-NOAA-letter-11-24-2015.pdf>

²² Ibid.

Majority's NOAA Climate Investigation Timeline

<p>June 2014 NOAA Staff Briefing</p>	<ul style="list-style-type: none"> • NOAA provides a bipartisan briefing on the Karl study, explaining the datasets and methodologies in the Karl paper.
<p>July 14, 2014 Chairman Smith sends letter to NOAA Administrator Sullivan</p>	<ul style="list-style-type: none"> • One month after Karl study published, Majority sends letter to NOAA requesting data used in study be made public. NOAA responds explaining data has been public since July 2014.
<p>August 2014 Chairman Smith sends letter to NOAA Administrator Sullivan</p>	<ul style="list-style-type: none"> • Majority reiterates previous request for data and says data not available in format the Chairman requested.
<p>September 25, 2014 Chairman Smith sends letter to NOAA Administrator Sullivan</p>	<ul style="list-style-type: none"> • Chairman repeats previous requests, accuses NOAA of withholding data and threatens subpoena. NOAA responds Oct. 2, linking to public datasets, citing methodology in Karl study and lists seven other papers that used similar methods.
<p>October 2014 Chairman Smith Issues Subpoena to NOAA</p>	<ul style="list-style-type: none"> • Subpoena for all communication between NOAA employees regarding (publicly available) global temperature datasets used in Karl paper. NOAA provides 2nd briefing to Committee staff Oct. 15th and letter Oct. 27th reiterating NOAA has cooperated.
<p>November 2014 Chairman Smith sends letter to NOAA Administrator Sullivan</p>	<ul style="list-style-type: none"> • Letter requests documents, communications and datasets, as well as transcribed interviews with Dr. Karl and three other NOAA employees, including NOAA's Chief Scientist.
<p>November 13, 2015 Chairman Smith sends letter to Commerce Secretary Pritzker</p>	<ul style="list-style-type: none"> • Chairman Smith accuses NOAA of a "public relations effort better suited to an advertising campaign," referring to a tweet sent by NOAA informing the public of the Karl study.
<p>November 18, 2015 Chairman Smith sends letter to Commerce Secretary Pritzker</p>	<ul style="list-style-type: none"> • In this seventh letter the Majority says "whistleblowers" claim the Karl study was "rushed" to publication, although the timing does not make sense. Chairman also postpones the transcribed interviews. NOAA sends documents in Dec. and March.
<p>January 2016 Chairman Smith sends letter to NOAA Administrator Sullivan</p>	<ul style="list-style-type: none"> • The Majority demands additional search terms be used saying previous document production not adequate and claims Karl paper did not comply with Data Quality Act. NOAA provides more documents March 15th that refutes these accusations.
<p>March 2016 Chairman Smith sends letter to NOAA Administrator Sullivan</p>	<ul style="list-style-type: none"> • NOAA sends response letter to February 22nd letter on same day. Chairman sends NOAA letter chastising them for missing the deadline in their response to the Feb. 22nd letter.
<p>February 2017 Chairman Smith sends letter to Acting NOAA Administrator</p>	<ul style="list-style-type: none"> • Reinvigorated by the Bases allegations about the Karl study Chairman Smith sends a new request for all documents and communications related to the Karl study. NOAA responds with a production of documents on February 18th.

The Bates Allegations and the Majority's Manipulation of Facts

Despite the long lull in the Majority's NOAA investigation, last month the Majority's interest in the Karl study was reignited. On Saturday, February 4, 2017, the blog *Climate Etc.* run by Majority hearing witness and climate skeptic Dr. Judith Curry, published a blog-post by former NOAA scientist, Dr. John Bates.²³ The post alleged that the Karl paper violated scientific integrity guidelines and publishing standards related to how its data was stored and archived.

Importantly, Dr. Bates reportedly was in charge of the Karl manuscript's review at NOAA and signed off on the scientific integrity of the paper before it was submitted to *Science*. He has not questioned the scientific integrity of the paper but did reportedly raise issues internally at NOAA after the paper was published regarding the format and accessibility of the study's climate data, although this data was publicly available a year before the Karl study was published in *Science*.

The controversial British reporter David Rose also published a story in the British tabloid, *The Mail on Sunday* (a sister publication of *The Daily Mail*), on the evening of February 4th that was updated on Sunday, February 5th, with an explosive headline: "**Exposed: How world leaders were duped into investing billions over manipulated global warming data.**" The story was based around an interview with Dr. Bates and focused on the Karl study.²⁴ In neither Judith Curry's blog-post or *The Mail on Sunday* story did Dr. Bates question the conclusions of the Karl study or suggest that data had been "manipulated." But that is the narrative that took hold and spread amongst the climate denial network. It was also touted by the Science Committee Majority as justification for their nearly two-year long investigation of the Karl study.

David Rose, the author of *The Mail on Sunday* story has been repeatedly criticized by climate scientists for relying on questionable data and misinterpreting scientific findings. He has also peddled some unconventional scientific views, writing in 2010, for instance, that the world was about to enter a mini ice age.²⁵ The United Kingdom's National Weather Service, known as the Met Office, has issued public responses to erroneous information provided by Mr. Rose in his reporting regarding climate change issues on at least four separate occasions in 2012, 2013 and 2014.²⁶ Responding to a story written by David Rose in a January 29, 2012 press release the Met Office wrote: "This article includes numerous errors in the reporting of published peer reviewed

²³ John Bates, "Climate scientists versus climate data," *Climate Etc.*, posted on February 4, 2017, accessed here: <https://judithcurry.com/2017/02/04/climate-scientists-versus-climate-data/>

²⁴ David Rose, "Exposed: How world leaders were duped into investing billions over manipulated global warming data," *The Mail on Sunday*, February 4, 2017, (Hereafter, *The Mail on Sunday* story), accessed here: www.dailymail.co.uk/sciencetech/article-4192182/World-leaders-duped-manipulated-global-warming-data.html

²⁵ David Rose, "The mini ice age starts here," *The Mail on Sunday*, January 9, 2010, accessed here: <http://www.dailymail.co.uk/sciencetech/article-1242011/DAVID-ROSE-The-mini-ice-age-starts-here.html>

²⁶ See: "Met Office in the Media: 29 January 2012," Met Office Press Office, accessed here: <https://blog.metoffice.gov.uk/2012/01/29/met-office-in-the-media-29-january-2012/>;

"Met Office in the Media: 14 October 2012," Met Office Press Office, accessed here: <https://blog.metoffice.gov.uk/2012/10/14/met-office-in-the-media-14-october-2012/>;

"Met Office in the Mail on Sunday," posted on 15 September, 2013 by Met Office Press Office, accessed here:

<https://blog.metoffice.gov.uk/2013/09/15/met-office-in-the-mail-on-sunday/>; and

"Met Office in the Media: 16 February 2014, response by Professor Mat Collins and the Met Office," Posted on 17 February, 2014 by Met Office Press Office, accessed here: <https://blog.metoffice.gov.uk/2014/02/17/met-office-in-the-media-16-february-2014-response-by-professor-mat-collins-and-the-met-office/>

science undertaken by the Met Office Hadley Centre and for Mr. Rose to suggest that the latest global temperatures available show no warming in the last 15 years is entirely misleading.”²⁷

In his blog post and *The Mail on Sunday* story, Dr. Bates claimed the *Science* article was “rushed” to publication, primarily by Dr. Karl, that the Obama Administration wanted it released prior to the U.N. sponsored Paris Climate Conference, and he suggested that Dr. Karl cut corners to push the paper out. These allegations have been examined by multiple media outlets who have seen documents provided by Dr. Bates reportedly supporting his claims and they have suggested these critiques of the Karl paper amount to nothing more than an inter-office spat.²⁸ Multiple scientists, some associated with NOAA, and others not, have also suggested to the media that some of Dr. Bates’ criticisms are simply inaccurate and others grossly overstated.

Who’s Manipulating Whom?

The Science Committee Majority was quick to seize on this new flurry of media attention to the



COMMITTEE ON
**SCIENCE, SPACE, &
TECHNOLOGY**
Lamar Smith, Chairman

Former NOAA Scientist Confirms Colleagues Manipulated Climate Records

Feb 5, 2017 | Press Release

earlier. They wasted no time. One day after Dr. Bates was featured in *The Daily Mail* story and wrote his own blog on Judith Curry’s blog-post, the Science Committee Majority sent out a press release, on February 5, 2017, with the headline: “Former NOAA Scientist Confirms Colleagues Manipulated Climate Records.”²⁹ However, the following day, on February 6, 2017, Dr. Bates gave two interviews to *E&E News* and the *Associated Press*. Perhaps not surprisingly, in both interviews Dr. Bates strongly denied the

NOAA study. Finally, perhaps, this new media attention could provide the Majority with some sort of justification for the sweeping and unsubstantiated claims they had been making against NOAA and the NOAA-scientists involved in the publication of the Karl study that began more than 18 months

Dr. John Bates, former NOAA scientist

“It’s not trumped up data in
any way shape or form.”

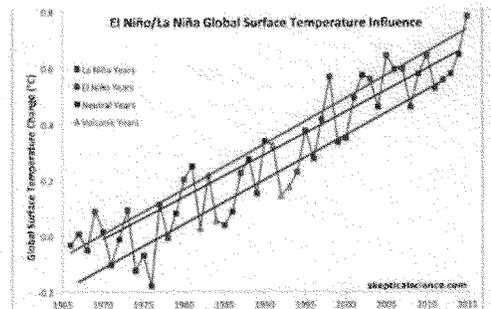
²⁷ “Met Office in the Media: 29 January 2012,” Official blog of the Met Office news team, January 29, 2012, accessed here: <https://blog.metoffice.gov.uk/2012/01/29/met-office-in-the-media-29-january-2012/>;

²⁸ See, Hiroko Tabuchi, “How an Interoffice Spat Erupted Into a Climate-Change Furor,” *New York Times*, February 20, 2017, accessed here: https://www.nytimes.com/2017/02/20/business/energy-environment/climate-change-dispute-john-bates.html?_r=0; Scott Waldman, “‘Whistleblower’ says protocol was breached but no data fraud,” *E&E News*, February 7, 2017, accessed here: <http://www.eenews.net/stories/1060049630>; Warren Cornwall and Paul Voosen, “How a culture clast at NOAA led to a flap over a high-profile warming pause study,” *ScienceInsider*, February 8, 2017, accessed here: <http://www.sciencemag.org/news/2017/02/how-culture-clash-noaa-led-flap-over-high-profile-warming-pause-study>; Seth Borenstein and Michael Biesecker, “Major global warming study again questioned, again defended,” *Associated Press (AP)*, February 7, 2017, accessed here: <http://bigstory.ap.org/article/3fc5d49a349344f1967aad4950e1a91/major-global-warming-study-again-questioned-again-defended>;

²⁹ “Former NOAA Scientist Confirms Colleagues Manipulated Climate Records,” (Republican) Press Release, Committee on Science, Space & Technology, February 5, 2017, accessed here: <https://science.house.gov/news/press-releases/former-noaa-scientist-confirms-colleagues-manipulated-climate-records>

claims of data “manipulation” being touted by the Science Committee Majority. “The issue here is not an issue of tampering with data,” Bates told *E&E News*, “but rather really of timing of a release of a paper that had not properly disclosed everything it was,” he said. Bates did suggest the Karl paper was “rushed” to publication and that NOAA data was not properly archived.³⁰ Bates had stronger words for the *Associated Press* regarding the lack of manipulation, however. He told the *AP* his concerns centered on the way the data was handled, documented and stored. Bates, who acknowledged to the *AP* that man-made carbon dioxide emissions are contributing to global warming, said that there was “no data tampering, no data changing, nothing malicious,” regarding the Karl study. “It’s really a story of not disclosing what you did,” Bates said in the interview. “It’s not trumped up data in any way shape or form,” he said.³¹ No wonder the Majority did not invite Dr. Bates as a witness to the March 29th Climate Science hearing.

Interestingly, although there is no specific connection to the publishing of the Bates story, on February 8, 2017, four days after *The Daily Mail* published its story on Bates’ criticisms of the Karl study, the editors of Wikipedia voted to bar *The Daily Mail* as a source of reference in its entries. They said the media outlet was “generally unreliable” and had a “reputation for poor fact checking, sensationalism and flat-out fabrication,” according to a story published by *Fox News*.³² Wikipedia also notes that *The Daily Mail* “has been accused of racism, and printing sensationalist and inaccurate scare stories of science and medical research.”³³



Note to @BreitbartNews: Earth Is Not Cooling. Climate Change Is Real and Stop Using Our Video to Mislead Americans
wxch n/2gzJpQG
2:38 PM - 6 Dec 2016

The Majority, however, seems consistently unperturbed by the sources they rely upon to justify their “investigations” or to attempt to validate their political positions. They often go to great lengths to cling onto stories, regardless of the source or the validity of the contents, that appear to align with their political viewpoints, regardless of how unscientific or fraught with falsehoods they may be. One example of this occurred last December when *Breitbart News* published a story with the misleading headline, “Global Temperatures Plunge. Icy Silence from Climate

³⁰ Scott Waldman, “‘Whistleblower’ says protocol was breached but no data fraud,” *E&E News*, February 7, 2017, accessed here: <http://www.eenews.net/stories/1060049630>

³¹ Seth Borenstein and Michael Biesecker, “Major global warming study again questioned, again defended,” *Associated Press*, February 7, 2017, accessed here: <http://bigstory.ap.org/article/3fc5d49a349344f1967aad4950e1a91/major-global-warming-study-again-questioned-again-defended>

³² “Wikipedia bans editors from citing Daily Mail as source,” *Fox News*, February 9, 2017, accessed here: <http://www.foxnews.com/tech/2017/02/09/wikipedia-bans-editors-from-citing-daily-mail-as-source.html>

³³ https://en.wikipedia.org/wiki/Daily_Mail

Alarmists.”³⁴ Even the staid Weather Channel weighed in on the misleading *Breitbart News* article tweeting, “Note to @BreitbartNews: Earth is Not Cooling, Climate Change is Real and Stop Using Our Video to Mislead Americans.”³⁵ The Weather Channel’s response, including a video response, was to point out how those that deny climate change often use misleading or simply false information in an attempt to validate their opinions. Indeed, it is well established that the vast majority of climate scientists (97% or more) agree that global warming is real and largely the result of human caused fossil fuel production. These scientists may disagree on specific analyses or conclusions, but they agree that there is a solid scientific consensus regarding the reality of climate change and its causes.³⁶

The tweet condemning the *Breitbart News* story could have easily been directed to the Science Committee Majority, who re-tweeted the misleading *Breitbart News* story multiple times. The irony of the Science Committee re-tweeting misleading scientific information from *Breitbart News* was not lost on the media, including *Scientific American*, *The Boston Globe*, *New York Times*, and *NBC News*.³⁷

The *Breitbart News* story had in fact been repackaged from a story originally reported by David Rose of *The Daily Mail*. The author of the *Breitbart* story, however, James Delingpole, had his own shoddy climate change history, according to a story in *Ars Technica* by Scott Johnson titled: “US House Science Committee tweets *Breitbart* climate misinformation. “Global temperatures plunge,” the article falsely exclaims.” Johnson wrote that “Delingpole famously admitted” in an

³⁴ James Delingpole, “Global Temperatures Plunge. Icy Silence from Climate Alarmists,” November 30, 2016, accessed here: <http://www.breitbart.com/london/2016/11/30/global-temperatures-plunge-icy-silence-climate-alarmists/>

³⁵ The Weather Channel’s print and video response to *Breitbart News* story and re-tweeting of the story by the Committee on Science, Space & Technology, December 6, 2016, accessed here:

https://weather.com/news/news/breitbart-misleads-americans-climate-change?cm_ven=T_WX_CD_120616_2

³⁶ See, for example: The Consensus Project, accessed here: <http://theconsensusproject.com> and James Lawrence Powell, Science and Global Warming, accessed here: www.jamespowell.org/methodology/newmethodology.html

³⁷ See, Ryan F. Mandelbaum, “The 9 Best Reactions to the House Science Committee’s *Breitbart* Tweet; Experts condemn lawmakers’ decision to promote fallacious article from conservative news site,” *Scientific American*, December 2, 2016, accessed here: <https://www.scientificamerican.com/article/the-9-best-reactions-to-the-house-science-committees-breitbart-tweet/>; Aimee Ortiz and Nicole Hernandez, “House committee feels the heat after *Breitbart* tweet,” *The Boston Globe*, December 2, 2016, accessed here: <https://www.bostonglobe.com/news/nation/2016/12/02/house-science-committee-feeling-heat-after-breitbart-tweet/vnFgs7BvZdQMTMzqiSQU5N/story.html>; Henry Fountain, “News Report on Global Temperatures is Wrong, Scientists Say,” *The New York Times*, December 2, 2012, accessed here: <https://www.nytimes.com/2016/12/02/science/global-warming-daily-mail-breitbart.html>; Phil McCausland, “House Science Committee Tweets Climate-Change Denying *Breitbart* Article,” *NBC News*, December 2, 2016, accessed here: <http://www.nbcnews.com/news/us-news/house-science-committee-tweets-climate-change-denying-breitbart-article-debunked-n690986>

interview with the *BBC* show *Horizon* “that he never reads scientific papers and called himself “an interpreter of interpretations.”³⁸

None of this should be surprising. One week before *The Daily Mail* ran its February 4th story on the Karl study the Chairman of the House Science Committee, Lamar Smith, walked onto the House floor and berated the “national liberal media” and suggested to Americans that it is better to “get your news directly from the President” if they wanted “to get the unvarnished truth.”³⁹ The notion that the Chairman of the House Science Committee believes that Donald Trump is more ‘truthful’ than the mainstream media is deeply disturbing, but is important to understand in evaluating the Majority’s positions regarding important scientific issues, such as climate change.

Meanwhile, the criticisms by Dr. Bates of the Karl study are problematic not just because they have been so contorted by the Majority and renounced by many independent scientists. But there are other reasons to assess these claims cautiously. In 2012, when Dr. Bates was the Director of the Remote Sensing and Applications Division at NOAA’s National Climatic Data Center (NCDC) and was in charge of about one dozen other scientists and staff, there were multiple complaints against him regarding his demeanor to his colleagues and subordinates. In one case he was reportedly barred from entering another employee’s office because she felt threatened by him. Dr. Karl was the Director of NCDC at the time and Dr. Bates’ second line supervisor, but made the decision based on these complaints to remove Dr. Bates’ from his supervisory management position.⁴⁰ Dr. Bates became one of two Principal Scientists at the center and, according to some former NOAA scientists, Dr. Bates was bitter about this demotion and told some colleagues that he believed he was demoted because Dr. Karl was “jealous” of him. He also reportedly said that he, not Dr. Karl, should be the one running the center. It is unclear if any of these issues played any role in Dr. Bates comments about the Karl paper or not.

In addition, according to several former NOAA scientists, at the time the Karl paper was being produced for publication, in 2014, as Principal Scientist Dr. Bates was in charge of reviewing the scientific integrity of the actual manuscript that would be submitted to the journal *Science*. Dr. Bates, according to these former NOAA employees, never raised issues with the paper and did not suggest that data was being manipulated or the publication rushed. After the study’s publication, however, he did raise concerns about the type of format the climate data in the study

³⁸ Scott Johnson, “US House Science Committee tweets Breitbart climate misinformation. “Global temperatures plunge,” the article falsely exclaims,” *Ars Technica*, December 2, 2016, accessed here:

<https://arstechnica.com/science/2016/12/us-house-science-committee-tweets-breitbart-climate-misinformation/>

³⁹ See, David Weigel, “House Science Committee Chairman: Americans Should Get News From Trump Not Media,” *The Washington Post*, January 25, 2017, accessed here:

https://www.washingtonpost.com/news/powerpost/wp/2017/01/25/house-science-committee-chairman-americans-should-get-news-from-trump-not-media/?utm_term=.1ef0b9a17314;

Theodore Schleifer, “House science chairman: ‘Get your news directly from the president,’” *CNN*, January 25, 2017, accessed here:

<http://www.cnn.com/2017/01/25/politics/lamar-smith-donald-trump-news/>;

Kevin Freking, “Texas Rep. Lamar Smith: Get news from Donald Trump, not media,” Associated Press, January 26, 2017, accessed here:

<http://www.chron.com/news/politics/article/House-Science-chairman-Get-news-from-Trump-not-10886187.php>

⁴⁰ See, Hiroko Tabuchi, “How an Interoffice Spat Erupted Into a Climate-Change Furor,” *New York Times*, February 20, 2017, accessed here: www.nytimes.com/2017/02/20/business/energy-environment/climate-change-dispute-john-bates.html?_r=0; and Warren Cornwall and Paul Voosen, “How a culture clash at NOAA led to a flap over a high-profile warming pause study,” *ScienceInsider*, February 8, 2017, accessed here:

www.sciencemag.org/news/2017/02/how-culture-clash-noaa-led-flap-over-high-profile-warming-pause-study

was in and how accessible it was, although the data had been publicly available for one year prior to the Karl study being published in *Science*.

Dr. Bates retired from NOAA in November 2016. In February 2017, just before he posted his blog-post on Judith Curry's website and *The Mail on Sunday* story came out Dr. Bates apparently ran into Dr. Tom Peterson, one of the co-authors of the Karl study, who was also a Principal Scientist at NOAA before he retired in 2015, at a play in Asheville, North Carolina. The two chatted during intermission and Dr. Peterson asked Dr. Bates how retirement was going. "It's about to get interesting," Dr. Bates reportedly replied. Soon after he returned to his seat Dr. Peterson began getting e-mails about Dr. Bates' blog-post on Judith Curry's website and *The Mail on Sunday* story. The play that Dr. Bates and Dr. Peterson attended that evening was William Shakespeare's *Much Ado About Nothing*. "That just strikes me as perfect," Dr. Peterson told *ScienceInsider*.⁴¹

Scientific Support for The Karl Study

The Science Committee has come a long way in the past decade. It was once viewed as a bastion of nonpartisan support for science, and science-related issues. Back in 2005, the Chairman of the Energy and Commerce Committee, Joe Barton, had launched an investigation into climate

scientist Michael Mann, not because of evidence of wrong doing, apparently because the Chairman appeared to disagree politically with Dr. Mann's conclusions regarding the reality of climate change. The Republican Chairman of the Science Committee at the time Sherwood Boehlert came to Dr. Mann's defense. On July 14, 2005, he wrote to Chairman Barton saying: "I am writing to express my strenuous objections to what I see as the misguided and illegitimate investigation you have launched concerning Dr. Michael Mann, his co-authors and sponsors." He went on, "My primary concern about your investigation is that its purpose seems to be to intimidate scientists rather than to learn from them, and to substitute Congressional political review

Former Republican Chairman of the Science Committee, Sherwood Boehlert in a 2005 letter to Joe Barton, Chairman of the Energy & Commerce Committee

"The precedent your investigation sets is truly chilling. There are numerous scientific debates ongoing about climate change. Data and conclusions get challenged all the time. Are we going to launch biased investigations each time a difference appears in the literature?"

⁴¹ Warren Cornwall and Paul Voosen, "How a culture clash at NOAA led to a flap over a high-profile warming pause study," *ScienceInsider*, February 8, 2017, accessed here: www.sciencemag.org/news/2017/02/how-culture-clash-noaa-led-flap-over-high-profile-warming-pause-study

for scientific peer review,” wrote Chairman Boehlert. “The precedent your investigation sets is truly chilling. There are numerous scientific debates ongoing about climate change. Data and conclusions get challenged all the time. Are we going to launch biased investigations each time a difference appears in the literature?” Boehlert asked.⁴²

Chairman Boehlert’s letter was written twelve years ago this coming July and he probably never thought his words would so aptly apply to his own Committee.

More than anything, the Majority’s prolonged and tenuous investigation of the Karl study demonstrates not just a willingness to use their oversight authority to pursue a clearly political agenda, but also a fundamental misunderstanding of the scientific process. Legitimate disputes about scientific findings happen all the time among scientists. Divergent scientific conclusions do not point to some sort of conspiratorial plot or intentional efforts to mislead one’s peers or the public. Making those sorts of serious allegations, as the Majority has done about the Karl study, should be based on substantial facts and not idle speculation, preconceived personal beliefs, or vague accusations of unsupported misconduct.

The *Associated Press* interviewed the former editor of *Science* at the time the Karl paper went through the peer-review process and was published, Marica McNutt, who is now president of the National Academy of Sciences. She “praised Bates for wanting to highlight the importance of data archiving, but said his criticisms have little to do with the main part of the paper and chastised the House [Science Committee] for using issues of data archiving to try to discredit the 2015 study,” the *AP* reported. “The study has been reproduced independently of Karl et. al. — that’s the ultimate platinum test of whether a study is to be believed or not,” McNutt said. “And this study has passed.”⁴³

The Karl study is based on verifiable data, and its well-respected scientist co-authors are not part of a nefarious conspiracy to deceive the world and trick them into believing in the reality of climate change. The Karl paper is a twice peer-reviewed scientific study that underwent six months of review by one of the world’s oldest and well-established scientific publications, the prominent journal *Science*. Its findings have been confirmed by at least six independent studies.

It is troubling that the Majority appears unable or unwilling to distinguish between politically motivated falsehoods supported by no factual evidence and legitimate scientific studies that may run counter to their political narrative about climate change. In the end, the Majority’s inquiry into the various allegations they have espoused about the Karl paper should be named after that Shakespeare play Dr. Bates attended, *Much Ado About Nothing*.

A summary and links to some of the papers that have both used similar methodologies as the Karl study, which was criticized by the Majority, and to studies that have corroborated the study’s key finding that the global warming hiatus never actually occurred, are provided on the following pages.

⁴² Letter from former Science Committee Chairman Sherwood Boehlert (R-NY) to Energy & Commerce Committee Chairman Joe Barton (R-TX), July 14, 2005, accessed here: <https://www.geo.umass.edu/climate/Boehlert.pdf>

⁴³ *Associated Press* story.

**nature
climate change**

Sonia I. Seneviratne, Markus G. Donat, Brigitte Mueller & Lisa V. Alexander, "No pause in the increase of hot temperature extremes," *Nature Climate Change - Commentary*, Vol. 4., March 2014, p. 161-163, (Published online 26 February 2014) (Corrected Footnote 25 April 2014, accessed here:

<http://www.nature.com/nclimate/journal/v4/n3/full/nclimate2145.html>

ABSTRACT	HIGHLIGHTS
<p>Observational data show a continued increase of hot extremes over land during the so-called global warming hiatus. This tendency is greater for the most extreme events and thus more relevant for impacts than changes in global mean temperature.</p>	<p>Based on existing observational evidence, we highlight that the term pause, as applied to the recent evolution of global annual mean temperatures, is ill-chosen and even misleading in the context of climate change. Indeed, an apparently static global mean temperature can mask large trends in temperatures at both regional and seasonal scales. More importantly, it is land-based changes in extreme temperatures, particularly those in hot extremes in inhabited areas, that have the most relevance for impacts. It seems only justifiable to discuss a possible pause in the Earth's temperature increase if this term applies to a general behaviour of the climate system, and thus also to temperature extremes.</p> <p style="text-align: center;">*****</p> <p>However, we show that analyses based on observational data reveal no pause in the evolution of hot extremes over land since 1997.</p>



Boyin Huang, Viva F. Banzon, Eric Freeman, Jay Lawrimore, Wei Liu, Thomas C. Peterson, Thomas M. Smith, Peter W. Thorne, Scott D. Woodruff, Huai-Min Zhang, "Extended Reconstructed Sea Surface Temperature Version 4 (ERSST.v4). Part I: Upgrades and Intercomparisons," *Journal of Climate*, American Meteorological Society, February 1, 2015, p. 911-930, accessed here:

<http://journals.ametsoc.org/doi/pdf/10.1175/JCLI-D-14-00006.1>

ABSTRACT	HIGHLIGHTS
<p>The monthly Extended Reconstructed Sea Surface Temperature (ERSST) dataset, available on global grids, has been revised from version 3 (v3) to version 4 (v4). Major revisions include updated and substantially more complete input data from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) release 2.5; revised empirical orthogonal teleconnections (EOTs) and EOT acceptance criterion; updated sea surface temperature (SST) quality control procedures; revised SST anomaly (SSTA) evaluation methods; updated bias adjustments of ship SSTs using the Hadley Centre Nighttime Marine Air Temperature dataset version 2 (HadNMT2), and buoy SST bias adjustment not previously made in v3. Tests show that the impacts of the revisions to ship SST bias adjustment in ERSST.v4 are dominant among all revisions and updates. The effect is to make SST 0.18–0.28C cooler north of 30S but 0.18–0.28C warmer south of 30S in ERSST.v4 than in ERSST.v3 before 1940. In comparison with the Met Office SST product [the Hadley Centre Sea Surface Temperature dataset, version 3 (HadSST3)], the ship SST bias adjustment in ERSST.v4 is 0.18–0.28C cooler in the tropics but 0.18–0.28C warmer in the midlatitude oceans both before 1940 and from 1945 to 1970.</p> <p>*****</p> <p>Comparisons indicate that SSTs in ERSST.v4 are as close to satellite-based observations as other similar SST analyses.</p>	<p>Sea surface temperature (SST) is one of the most important indicators of climate variability and long-term climate change.</p> <p>*****</p> <p>Large-scale multidecadal variations in the SST products are critically dependent on the bias adjustment of historical ship-based SST observations, since buoys and other automated platforms measuring SST were not introduced widely until the 1970s. The historical ship SST data were measured by a range of methods that have changed through time.</p> <p>*****</p> <p>To bias adjust for the changing measurement methodologies, quantitative estimates have been made of these various biases by different groups.</p>

Science

AAAS

Thomas R. Karl, Anthony Arguez, Boyin Huang, Jay H. Lawrimore, James R. McMahon, Matthew J. Menne, Thomas C. Peterson, Russell S. Vose, Huai-Min Zhang, "Possible artifacts of data biases in the recent global surface warming hiatus," *Science*, 26 Jun 2015, Vol. 348, Issue 6242, pp. 1469-1472, accessed here:

<http://science.sciencemag.org/content/348/6242/1469>; Supplemental material accessed here: <http://science.sciencemag.org/content/sci/suppl/2015/06/03/science.aaa5632.DC1/Karl-SM.pdf>

ABSTRACT	HIGHLIGHTS
<p>Much study has been devoted to the possible causes of an apparent decrease in the upward trend of global surface temperatures since 1998, a phenomenon that has been dubbed the global warming "hiatus." Here, we present an updated global surface temperature analysis that reveals that global trends are higher than those reported by the Intergovernmental Panel on Climate Change, especially in recent decades, and that the central estimate for the rate of warming during the first 15 years of the 21st century is at least as great as the last half of the 20th century. These results do not support the notion of a "slowdown" in the increase of global surface temperature.</p> <p>*****</p> <p>Editor's Summary</p> <p>Walking back talk of the end of warming</p> <p>Previous analyses of global temperature trends during the first decade of the 21st century seemed to indicate that warming had stalled. This allowed critics of the idea of global warming to claim that concern about climate change was misplaced. Karl et al. now show that temperatures did not plateau as thought and that the supposed warming "hiatus" is just an artifact of earlier analyses. Warming has continued at a pace similar to that of the last half of the 20th century, and the slowdown was just an illusion.</p>	<p>"Newly corrected and updated global surface temperature data from NOAA's NCEI do not support the notion of a global warming "hiatus." As shown in Fig. 1, there is no discernable (statistical or otherwise) decrease in the rate of warming between the second half of the 20th century and the first 15 years of the 21st century. Our new analysis now shows that the trend over the period 1950–1999, a time widely agreed as having significant anthropogenic global warming, is 0.113°C decade, which is virtually indistinguishable from the trend over the period 2000–2014 (0.116°C decade). Even starting a trend calculation with 1998, the extremely warm El Niño year that is often used as the beginning of the "hiatus," our global temperature trend (1998–2014) is 0.106°C decade—and we know that is an underestimate because of incomplete coverage over the Arctic. Indeed, according to our new analysis, the IPCC's statement of 2 years ago—that the global surface temperature "has shown a much smaller increasing linear trend over the past 15 years than over the past 30 to 60 years"—is no longer valid."</p>



Kevin Cowtan¹, Zeke Hausfather, Ed Hawkins, Peter Jacobs, Michael E. Mann, Sonya K. Miller, Byron A. Steinman, Martin B. Stolpe, Robert G. Way, "Robust comparison of climate models with observations using blended land air and ocean sea surface temperatures," August 2015, *American Geophysical Union*, accessed here:

https://www.researchgate.net/publication/280571227_Robust_comparison_of_climate_models_with_observations_using_blended_land_air_and_ocean_sea_surface_temperatures

ABSTRACT	HIGHLIGHTS
<p>The level of agreement between climate model simulations and observed surface temperature change is a topic of scientific and policy concern. While the Earth system continues to accumulate energy due to anthropogenic and other radiative forcings, estimates of recent surface temperature excitation fall at the lower end of climate model projections. Global mean temperatures from climate model simulations are typically calculated using surface air temperatures, while the corresponding observations are based on a blend of air and sea surface temperatures. This work quantifies a systematic bias in model-observation comparisons arising from differential warming rates between sea surface temperatures and surface air temperatures over oceans. A further bias arises from the treatment of temperatures in regions where the sea ice boundary has changed. Applying the methodology of the HadCRUT4 record to climate model temperature fields accounts for 58% of the discrepancy in trend between models and observations over the period 1971-2014.</p>	<p>The new dataset of Karl et al. [2015] incorporates adjustments to SSTs to match nighttime marine air temperatures [Huang et al., 2015] and so may be more comparable to model air temperatures. The difference between air and sea surface temperature trends diagnosed here provides support for an increase in temperature trends when using marine air temperatures, as reported in Karl et al. [2015].</p>



Foster, G. and Abraham, J. "Lack of evidence for a slowdown in global temperature," *US Climate Variability and Predictability (CLIVAR) Variations, Vol. 13, No. 3, page 6-9, Summer 2015, accessed here:*
https://usclivar.org/sites/default/files/documents/2015/Variations2015Summer-1_0.pdf

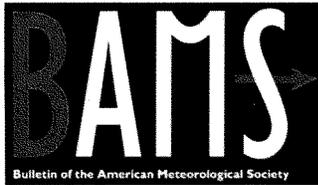
ABSTRACT	HIGHLIGHTS
<p>The climate science community has reached a near consensus that the warming rate of global surface temperature has exhibited a slowdown over the last decade to decade and a half. However, genuine robust statistical evidence of its existence is lacking. We test the hypothesis by numerous statistical tests applied to global temperature time series and find no evidence to support claims of a slowdown in the trend.</p>	<p>"Our results show that the widespread acceptance of the idea of a recent slowdown in the increase of global average surface temperature is not supported by analytical evidence."</p> <p>*****</p> <p>"... those who deny that manmade global warming is a danger have actively engaged in a public campaign to proclaim not just a slowdown in surface temperature increase, but a complete halt to global warming. Their efforts have been pervasive, so that in spite of lack of evidence to back up such claims, they have effectively sown the seeds of doubt in the public, the community of journalists, and even elected officials."</p>



Rajaratnam, B., Romano, J., Tsiang, M. et al., “*Debunking the climate hiatus,*” *Climatic Change*. Vol. 133, Issue 2, pp 129 – 140, November 2015, accessed here: <http://link.springer.com/article/10.1007/s10584-015-1495-y>

ABSTRACT	HIGHLIGHTS
<p>The reported “hiatus” in the warming of the global climate system during this century has been the subject of intense scientific and public debate, with implications ranging from scientific understanding of the global climate sensitivity to the rate in which greenhouse gas emissions would need to be curbed in order to meet the United Nations global warming target. A number of scientific hypotheses have been put forward to explain the hiatus, including both physical climate processes and data artifacts. However, despite the intense focus on the hiatus in both the scientific and public arenas, rigorous statistical assessment of the uniqueness of the recent temperature time-series within the context of the long-term record has been limited. We apply a rigorous, comprehensive statistical analysis of global temperature data that goes beyond simple linear models to account for temporal dependence and selection effects. We use this framework to test whether the recent period has demonstrated i) a hiatus in the trend in global temperatures, ii) a temperature trend that is statistically distinct from trends prior to the hiatus period, iii) a “stalling” of the global mean temperature, and iv) a change in the distribution of the year-to-year temperature increases. We find compelling evidence that recent claims of a “hiatus” in global warming lack sound scientific basis. Our analysis reveals that there is no hiatus in the increase in the global mean temperature, no statistically significant difference in trends, no stalling of the global mean temperature, and no change in year-to-year temperature increases.</p>	<p>“We find compelling evidence that recent claims of a “hiatus” in global warming lack sound scientific basis. Our analysis reveals that there is no hiatus in the increase in the global mean temperature, no statistically significant difference in trends, no stalling of the global mean temperature, and no change in year-to-year temperature increases.”</p> <p>*****</p> <p>“Our rigorous statistical framework yields strong evidence against the presence of a global warming hiatus.”</p>

ABSTRACT	HIGHLIGHTS
<p>Recent public debate and the scientific literature have frequently cited a "pause" or "hiatus" in global warming. Yet, multiple analyses of evidence show that climate change continues unabated, raising questions about the status of the "hiatus". To examine whether the notion of a "hiatus" is justified by the available data, we first document that there are multiple definitions of the "hiatus" in the literature, with its presumed onset spanning a decade. For each of these definitions we compare the associated temperature trend against trends of equivalent length in the entire record of modern global warming. The analysis shows that the "hiatus" trends are encompassed within the overall distribution of observed trends. We next assess the magnitude and significance of all possible trends up to 25 years duration looking backwards from each year over the past 30 years. At every year during the past 30 years, the immediately preceding warming trend was always significant when 17 years (or more) were included in the calculation, alleged "hiatus" periods notwithstanding. If current definitions of the "pause" used in the literature are applied to the historical record, then the climate system "paused" for more than 1/3 of the period during which temperatures rose 0.6K.</p>	<p>"In this article, we show that even putting aside possible artifacts in the temperature record, there is no substantive evidence for a "pause" or "hiatus" in warming. We suggest that the use of those terms is therefore inaccurate."</p> <p>*****</p> <p>"When one extends the period looking backwards in time, the warming trend is always significant, and the most recent vantage point(s) do not differ systematically from earlier vantage points. It follows that the data do not permit identification of a "pause" or "hiatus" during the last 10–20 years."</p> <p>*****</p> <p>"We conclude that the evidence does not support the notion of a "pause" or "hiatus" as an identifiable phenomenon...."</p>



Lewandowsky, S., Risbey, J.S., and Oreskes, N. "The "pause" in global warming – turning a routine fluctuation into a problem for science," *Bulletin of the American Meteorological Society (BAMS)*, May 2016, Vol. 97, No. 5. (in final form on August 27, 2015), published online on June 3, 2016, accessed here: <http://dx.doi.org/10.1175/BAMS-D-14-00106.1>

ABSTRACT	HIGHLIGHTS
<p>There has been much recent published research about a putative "pause" or "hiatus" in global warming. We show that there are frequent fluctuations in the rate of warming around a longer-term warming trend, and that there is no evidence that identifies the recent period as unique or particularly unusual. In confirmation, we show that the notion of a pause in warming is considered to be misleading in a blind expert test. Nonetheless, the most recent fluctuation about the longer-term trend has been regarded by many as an explanatory challenge that climate science must resolve. This departs from long-standing practice, insofar as scientists have long recognized that the climate fluctuates, that linear increases in CO₂ do not produce linear trends in global warming, and that 15-yr (or shorter) periods are not diagnostic of long-term trends. We suggest that the repetition of the "warming has paused" message by creatarians was adopted by the scientific community in its problem-solving and answer-seeking role and has led to undue focus on, and mislabeling of, a recent fluctuation. We present an alternative framing that could have avoided inadvertently reinforcing a misleading claim.</p>	<p>"Concerning the recent fluctuation, we have shown that its framing as a pause or hiatus that constitutes a problem for greenhouse warming is incorrect, because it is not meaningfully different from other fluctuations in warming rate."</p> <p>*****</p> <p>"The claim that global warming uniquely "stopped" during any recent 15-yr period is therefore not sustainable."</p>

Science Advances



Hausfather, Z. et al, "Assessing recent warming using instrumentally homogenous sea surface temperature records," *Science Advances*, Vol. 3, no. 1, January 4, 2017, accessed here: <http://advances.sciencemag.org/content/3/1/e1601207.full>

ABSTRACT	HIGHLIGHTS
<p>Sea surface temperature (SST) records are subject to potential biases due to changing instrumentation and reanalysis practices. Significant differences exist between commonly used composite SST reconstructions from the National Oceanic and Atmospheric Administration's Extended Reconstruction Sea Surface Temperature (ERSST), the Hadley Centre SST data set (HadSST3), and the Japanese Meteorological Agency's Centennial Observation-Based Estimates of SSTs (COBE-SST) from 2003 to the present. The update from ERSST version 3b to version 4 resulted in an increase in the operational SST trend estimate during the last 10 years from 0.075 to 0.12°C per decade, indicating a higher rate of warming in recent years. We show that ERSST version 4 trends generally agree with largely independent, near-global, and instrumentally homogeneous SST measurements from floating buoys, Argo floats, and radiometer-based satellite measurements that have been developed and deployed during the past two decades. We find a large cooling bias in ERSST version 3b and smaller but significant cooling biases in HadSST3 and COBE-SST from 2003 to the present, with respect to most series examined. These results suggest that reported rates of SST warming in recent years have been underestimated in these three data sets.</p>	<p>“We find a large cooling bias in ERSST version 3b and smaller but significant cooling biases in HadSST3 and COBE-SST from 2003 to the present, with respect to most series examined. These results suggest that reported rates of SST warming in recent years have been underestimated in these three data sets.</p> <p>Overall, these results suggest that the new ERSSTv4 record represents the most accurate composite estimate of global SST trends during the past two decades and thus support the finding that previously reported rates of surface warming in recent years have been underestimated.”</p>

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE

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July 14, 2005

The Honorable Joe Barton
Chairman
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Chairman:

I am writing to express my strenuous objections to what I see as the misguided and illegitimate investigation you have launched concerning Dr. Michael Mann, his co-authors and sponsors.

First, your Committee lacks jurisdiction over this matter. Both the National Science Foundation and climate change research are under the purview of the House Committee on Science. This is in no way my central concern about your investigation, but I raise it at the outset because it may have legal implications as you proceed. Jurisdiction is also relevant because the insensitivity toward the workings of science demonstrated in your investigative letters may reflect your Committee's inexperience in the areas you are investigating.

My primary concern about your investigation is that its purpose seems to be to intimidate scientists rather than to learn from them, and to substitute Congressional political review for scientific peer review. This would be pernicious.

It is certainly appropriate for Congress to try to understand scientific disputes that impinge on public policy. There are many ways for us to do that, including hearings with a balanced set of witnesses, briefings with scientists, and requests for reviews by the National Academy of Sciences or other experts.

But you have taken a decidedly different approach – one that breaks with precedent and raises the specter of politicians opening investigations against any scientist who reaches a conclusion that makes the political elite uncomfortable.

Rather than bringing Dr. Mann and his antagonists together in a public forum to explain their differences, you have sent an investigative letter to Dr. Mann and his colleagues that raises charges that the scientific community has put to rest, and ask for detailed scientific explanations that your Committee undoubtedly lacks the expertise to review.

This is utterly unnecessary given that Dr. Mann's articles have prompted a spirited and appropriate (and often technically complex) debate in the scientific community that has played out in readily available journals. Moreover, the only "charge" that has been leveled against Dr. Mann that might prompt Congressional notice – that he was refusing to share data – has been soundly rejected by the National Science Foundation, and those who continue to raise the charge are well aware of that.

Therefore, one has to conclude that there is no legitimate reason for your investigation. The investigation is not needed to gain access to data. The investigation is not needed to get balanced information on a scientific debate. The investigation is not needed to prompt scientific discussion of an important issue.

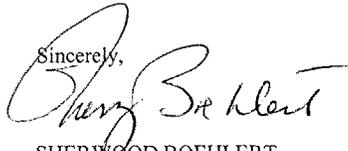
The only conceivable explanation for the investigation is to attempt to intimidate a prominent scientist and to have Congress put its thumbs on the scales of a scientific debate. This is at best foolhardy; when it comes to scientific debates, Congress is "all thumbs."

The precedent your investigation sets is truly chilling. Are scientists now supposed to look over their shoulders to determine if their conclusions might prompt a Congressional inquiry no matter how legitimate their work? If Congress wants public policy to be informed by scientific research, then it has to allow that research to operate outside the political realm. Your inquiry seeks to erase that line between science and politics.

There are numerous scientific debates ongoing about climate change. Data and conclusions get challenged all the time. Are we going to launch biased investigations each time a difference appears in the literature?

I hope you will reconsider the investigation you have launched and allow the scientific community to debate its work as it always has. Seeking scientific truth is too important to be impeded by political expediency. That's a position that Members on all sides of the climate change debate should share.

Sincerely,

A handwritten signature in cursive script that reads "Sherwood Boehlert". The signature is written in black ink and is positioned above the printed name.

SHERWOOD BOEHLERT
Chairman

Drought and Global Climate Change: An Analysis of Statements by Roger Pielke Jr
John P. Holdren, 28 February 2014

Introduction

In the question and answer period following my February 25 testimony on the Administration's Climate Action Plan before the Oversight Subcommittee of the U.S. Senate's Committee on Environment and Public Works, Senator Jeff Sessions (R-AL) suggested that I had misled the American people with comments I made to reporters on February 13, linking recent severe droughts in the American West to global climate change. To support this proposition, Senator Sessions quoted from testimony before the Environment and Public Works Committee the previous July by Dr. Roger Pielke, Jr., a University of Colorado political scientist. Specifically, the Senator read the following passages from Dr. Pielke's written testimony:

It is misleading, and just plain incorrect, to claim that disasters associated with hurricanes, tornadoes, floods or droughts have increased on climate timescales either in the United States or globally.

Drought has "for the most part, become shorter, less, frequent, and cover a smaller portion of the U.S. over the last century". Globally, "there has been little change in drought over the past 60 years."

Footnotes in the testimony attribute the two statements in quotation marks within the second passage to the US Climate Change Science Program's 2008 report on extremes in North America and a 2012 paper by Sheffield *et al.* in the journal Nature, respectively.

I replied that the indicated comments by Dr. Pielke, and similar ones attributed by Senator Sessions to Dr. Roy Spencer of the University of Alabama, were not representative of mainstream views on this topic in the climate-science community; and I promised to provide for the record a more complete response with relevant scientific references.

Dr. Pielke also commented directly, in a number of tweets on February 14 and thereafter, on my February 13 statements to reporters about the California drought, and he elaborated on the tweets for a blog post on The Daily Caller site (also on February 14). In what follows, I will address the relevant statements in those venues, as well. He argued there, specifically, that my statements on drought "directly contradicted scientific reports", and in support of that assertion, he offered the same statements from his July testimony that were quoted by Senator Sessions (see above). He also added this:

The United Nations Intergovernmental Panel on Climate Change found that there is "not enough evidence at present to suggest more than low confidence in a global-scale observed trend in drought."

In the rest of this response, I will show, first, that the indicated quote from the US Climate Change Science Program (CCSP) about U.S. droughts is missing a crucial adjacent sentence in the CCSP report, which supports my position about drought in the American West. I will also show that Dr. Pielke's statements about global drought trends, while irrelevant to my comments about drought in California and the Colorado River Basin, are seriously misleading, as well, concerning what is actually in the UN Panel's latest report and what is in the current scientific literature.

Drought trends in the American West

My comments to reporters on February 13, to which Dr. Pielke referred in his February 14 tweet and to which Senator Sessions referred in the February 25 hearing, were provided just ahead of President Obama's visit to the drought-stricken California Central Valley and were explicitly about the drought situation in California and elsewhere in the West.

That being so, any reference to the CCSP 2008 report in this context should include not just the sentence highlighted in Dr. Pielke's testimony but also the sentence that follows immediately in the relevant passage from that document and which relates specifically to the American West. Here are the two sentences in their entirety (<http://downloads.globalchange.gov/sap/sap3-3/Brochure-CCSP-3-3.pdf>):

Similarly, long-term trends (1925-2003) of hydrologic droughts based on model derived soil moisture and runoff show that droughts have, for the most part, become shorter, less frequent, and cover a smaller portion of the U.S. over the last century (Andreadis and Lettenmaier, 2006). The main exception is the Southwest and parts of the interior of the West, where increased temperature has led to rising drought trends (Groisman et al., 2004; Andreadis and Lettenmaier, 2006).

Linking Drought to Climate Change

In my recent comments about observed and projected increases in drought in the American West, I mentioned four relatively well understood mechanisms by which climate change can play a role in drought. (I have always been careful to note that, scientifically, we cannot say that climate change caused a particular drought, but only that it is expected to increase the frequency, intensity, and duration of drought in some regions—and that such changes are being observed.)

The four mechanisms are:

1. In a warming world, a larger fraction of total precipitation falls in downpours, which means a larger fraction is lost to storm runoff (as opposed to being absorbed in soil).
2. In mountain regions that are warming, as most are, a larger fraction of precipitation falls as rain rather than as snow, which means lower stream flows in spring and summer.
3. What snowpack there is melts earlier in a warming world, further reducing flows later in the year.
4. Where temperatures are higher, losses of water from soil and reservoirs due to evaporation are likewise higher than they would otherwise be.

Regarding the first mechanism, the 2013 report of the IPCC's Working Group I, *The Science Basis* (http://www.climatechange2013.org/images/report/WG1AR5_TS_FINAL.pdf, p 110), deems it "likely" (probability greater than 66%) that an increase in heavy precipitation events is already detectable in observational records since 1950 for more land areas than not, and that further changes in this direction are "likely over many land areas" in the early 21st century and "very likely over most of the mid-latitude land masses" by the late 21st century. The second, third, and fourth mechanisms reflect elementary physics and are hardly subject to dispute (but see also additional references provided at the end of this comment).

As I have also noted in recent public comments, additional mechanisms have been identified by which changes in atmospheric circulation patterns that may be a result of global warming could be affecting droughts in the American West. There are some measurements and some analyses

suggesting that these mechanisms are operating, but the evidence is less than conclusive, and some respectable analysts attribute the indicated circulation changes to natural variability. The uncertainty about these mechanisms should not be allowed to become a distraction obscuring the more robust understandings about climate change and regional drought summarized above.

Global Drought Patterns

Drought is by nature a regional phenomenon. In a world that is warming on the average, there will be more evaporation and therefore more precipitation; that is, a warming world will also get wetter, on the average. In speaking of global trends in drought, then, the meaningful questions are (a) whether the frequency, intensity, and duration of droughts are changing in most or all of the regions historically prone to drought and (b) whether the total area prone to drought is changing.

Any careful reading of the 2013 IPCC report and other recent scientific literature about on the subject reveals that droughts have been worsening in some regions in recent decades while lessening in other regions, and that the IPCC's "low confidence" about a global trend relates mainly to the question of total area prone to drought and a lack of sufficient measurements to settle it. Here is the key passage from the Technical Summary from IPCC WGI's 2013 report (http://www.climatechange2013.org/images/report/WG1AR5_TS_FINAL.pdf, p 112):

Compelling arguments both for and against significant increases in the land area affected by drought and/or dryness since the mid-20th century have resulted in a low confidence assessment of observed and attributable large-scale trends. This is due primarily to a lack and quality of direct observations, dependencies of inferred trends on the index choice, geographical inconsistencies in the trends and difficulties in distinguishing decadal scale variability from long term trends.

The table that accompanies the above passage from the IPCC's report—captioned "Extreme weather and climate events: global-scale assessment of recent observed changes, human contribution to the changes, and projected further changes for the early (2016-2035) and late (2081-2100) 21st century"—has the following entries for "Increases in intensity and/or duration of drought": under changes observed since 1950, "low confidence on a global scale, likely changes in some regions" [emphasis added]; and under projected changes for the late 21st century, "likely (medium confidence) on a regional to global scale".

Dr. Pielke's citation of a 2012 paper from Nature by Sheffield *et al.*, entitled "Little change in global drought over the past 60 years", is likewise misleading. That paper's abstract begins as follows:

Drought is expected to increase in frequency and severity in the future as a result of climate change, mainly as a consequence of decreases in regional precipitation but also because of increasing evaporation driven by global warming¹⁻³. Previous assessments of historic changes in drought over the late twentieth and early twenty-first centuries indicate that this may already be happening globally. In particular, calculations of the Palmer Drought Severity Index (PDSI) show a decrease in moisture globally since the 1970s with a commensurate increase in the area of drought that is attributed, in part, to global warming^{4,5}.

The paper goes on to argue that the PDSI, which has been relied upon for drought characterization since the 1960s, is too simple a measure and may (the authors' word) have led to over-estimation of global drought trends in previous climate-change assessments—including the IPCC's previous (2007) assessment, which found that "More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics."

The authors argue for use of a more complex index of drought, which, however, requires more data and more sophisticated models to apply. Their application of it with the available data shows a smaller global drought trend than calculated using the usual PDSI, but they conclude that better data are needed. The conclusion of the Sheffield *et al.* paper has proven controversial, with some critics pointing to the inadequacy of existing observations to support the more complex index and others arguing that a more rigorous application of the new approach leads to results similar to those previously obtained using the PDSI.

A measure of the differences of view on the topic is available in a paper entitled "Increasing drought under global warming in observations and models", published in Nature Climate Change at about the same time as Sheffield *et al.* by a leading drought expert at the National Center for Climate Research, Dr. Aiguo Dai. Dr. Dai's abstract begins and ends as follows:

Historical records of precipitation, streamflow, and drought indices all show increased aridity since 1950 over many land areas^{1,2}. Analyses of model-simulated soil moisture^{3,4}, drought indices^{1,3,6}, and precipitation minus evaporation⁷ suggest increased risk of drought in the twenty-first century. ... I conclude that the observed global aridity changes up to 2010 are consistent with model predictions, which suggest severe and widespread droughts in the next 30-90 years over many land areas resulting from either decreased precipitation and/or increased evaporation.

The disagreement between the Sheffield *et al.* and Dai camps appears to have been responsible for the IPCC's downgrading to "low confidence", in its 2013 report, the assessment of an upward trend in global drought in its 2007 Fourth Assessment and its 2012 Special Report on Extreme Events (<http://www.ipcc-wg2.gov/SREX/>).

Interestingly, a number of senior parties to the debate—including Drs. Sheffield and Dai—have recently collaborated on a co-authored paper, published in the January 2014 issue of Nature Climate Change, entitled "Global warming and changes in drought". In this new paper, the authors identify the reasons for their previous disagreements; agree on the need for additional data to better separate natural variability from human-caused trends; and agree on the following closing paragraph (quoted here in full):

Changes in the global water cycle in response to the warming over the twenty-first century will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will probably increase, although there may be regional exceptions. Climate change is adding heat to the climate system and on land much of that heat goes into drying. A natural drought should therefore set in quicker, become more intense, and may last longer. Droughts may be more extensive as a result. Indeed, human-induced warming effects accumulate on land during periods of drought because the 'air conditioning effects' of water are absent. Climate change may not manufacture droughts, but it could exacerbate them and it will probably expand their domain in the subtropical dry zone.

Additional References (with particularly relevant direct quotes in italics)

Christopher R. Schwalm *et al.*, Reduction of carbon uptake during turn of the century drought in western North America, Nature Geoscience, vol. 5, August 2012, pp 551-556.

The severity and incidence of climatic extremes, including drought, have increased as a result of climate warming. ... The turn of the century drought in western North America was the most severe drought over the past 800 years, significantly reducing the modest carbon sink normally present in this region. Projections indicate that drought events of this length and severity will be commonplace through the end of the twenty-first century.

Gregory T. Pederson *et al.*, The unusual nature of recent snowpack declines in the North American Cordillera, Science, vol. 333, 15 July 2011, pp 332-335.

Over the past millennium, late 20th century snowpack reductions are almost unprecedented in magnitude across the northern Rocky Mountains and in their north-south synchrony across the cordillera. Both the snowpack declines and their synchrony result from unparallelled springtime warming that is due to positive reinforcement of the anthropogenic warming by decadal variability. The increasing role of warming on large-scale snowpack variability and trends foreshadows fundamental impacts on streamflow and water supplies across the western United States.

Gregory T. Pederson *et al.*, Regional patterns and proximal causes of the recent snowpack decline in the Rocky Mountains, US, Geophysical Research Letters, vol. 40, 16 May 2013, pp 1811-1816.

The post-1980 synchronous snow decline reduced snow cover at low to middle elevations by ~20% and partly explains earlier and reduced streamflow and both longer and more active fire seasons. Climatologies of Rocky Mountain snowpack are shown to be seasonally and regionally complex, with Pacific decadal variability positively reinforcing the anthropogenic warming trend.

Michael Wehner *et al.*, Projections of future drought in the continental United States and Mexico, Journal of Hydrometeorology, vol. 12, December 2011, pp 1359-1377.

All models, regardless of their ability to simulate the base-period drought statistics, project significant future increases in drought frequency, severity, and extent over the course of the 21st century under the SRES A1B emissions scenario. Using all 19 models, the average state in the last decade of the twenty-first century is projected under the SRES A1B forcing scenario to be conditions currently considered severe drought (PDSI<-3) over much of the continental United States and extreme drought (PDSI<-4) over much of Mexico.

D. R. Cayan *et al.*, Future dryness in the southwest US and the hydrology of the early 21st century drought, Proceedings of the National Academy of Sciences, vol. 107, December 14, 2010, pp 21271-21276.

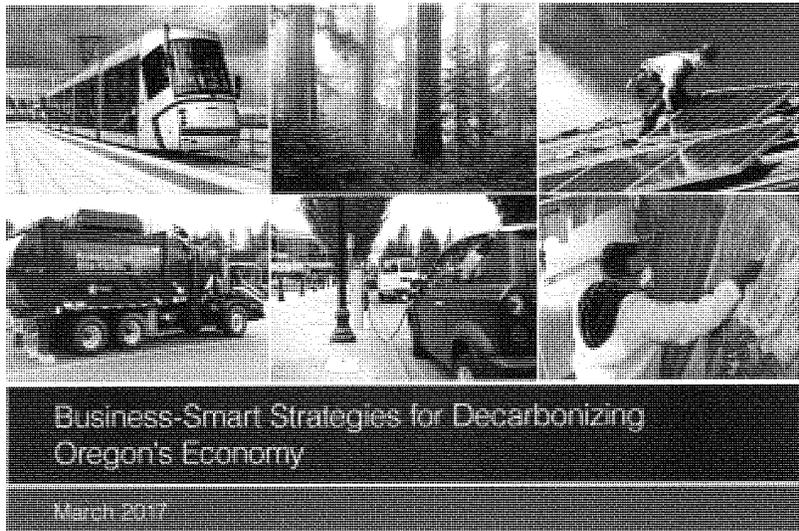
Although the recent drought may have significant contributions from natural variability, it is notable that hydrological changes in the region over the last 50 years cannot be fully explained by natural variability, and instead show the signature of anthropogenic climate change.

E. P. Maurer *et al.*, Detection, attribution, and sensitivity of trends toward earlier streamflow in the Sierra Nevada, Journal of Geophysical Research, vol. 112, 2007, doi:10.1029/2006JD08088.

The warming experienced in recent decades has caused measurable shifts toward earlier streamflow timing in California. Under future warming, further shifts in streamflow timing are projected for the rivers draining the western Sierra Nevada, including the four considered in this study. These shifts and their projected increases through the end of the 21st century will have dramatic impacts on California's managed water system.

H. G. Hidalgo *et al.*, Detection and attribution of streamflow timing changes to climate change in the western United States, Journal of Climate, vol. 22, issue 13, 2009, pp 3838-3855, doi: 10.1175/2009JCLI2740.1.

The advance in streamflow timing in the western United States appears to arise, to some measure, from anthropogenic warming. Thus the observed changes appear to be the early phase of changes expected under climate change. This finding presages grave consequences for the water supply, water management, and ecology of the region. In particular, more winter and spring flooding and drier summers are expected as well as less winter snow (more rain) and earlier snowmelt.



Business-Smart Strategies for Decarbonizing
Oregon's Economy

February 2017

PREFACE

In January 2016, we convened the Oregon Business Leaders' Greenhouse Gas Emissions Reduction Task Force to design a five-year strategy for significantly reducing greenhouse gas emissions while maintaining the viability and competitive health of Oregon businesses. The task force came together with the recognition that (1) climate change presents a significant threat to our livelihoods and well-being; (2) accelerating actions to reduce emissions today is critical; (3) decoupling our economy from carbon will make us more competitive in the future; and (4) the Oregon business community can and should play an important role in determining how to best transition to a lower-carbon economy. The longer we delay, the more climate change adaptation and mitigation will cost. Taking the wrong actions today could also increase costs: increasing energy prices would hurt the pocketbooks of Oregonians and reduce the competitiveness of Oregon businesses in the global marketplace.

As members of the business community, representing a wide range of industries from manufacturing to farming and forestry, our goal was to identify practical solutions that reduce greenhouse gas emissions and contribute to a prosperous future. The task force met from January through December 2016. We were assisted by an expert technical team that provided a series of briefing papers to give task force members a foundation of common understanding regarding Oregon's greenhouse gas emissions profile, policies, programs and possibilities. We covered

a range of topics including residential, commercial and industrial energy use; transportation; and forestry and agriculture, as well as multisector strategies such as carbon pricing, incentive programs and administrative measures.

The following report identifies a set of strategies and measures the task force members think show promise for reducing greenhouse gas emissions while creating jobs, growing the economy and positioning the State to provide leadership and model positive change. Oregon acting alone, no matter how well intentioned, will not have a significant national or global impact on greenhouse gas emissions reduction. But our actions can demonstrate leadership and provide meaningful options for the larger economy.

By recommending these strategies and measures, we hope to put Oregon in a position to help advance viable energy alternatives and benefit from what is likely to be a more than \$1 trillion market to decarbonize the global economy.

We acknowledge that the sum of the strategies presented here will not fully realize the State's greenhouse gas reduction goals, but we do believe they are part of a significant next step in Oregon's history—one we have been honored to participate in.

Sincerely,

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The Nature Conservancy

Merritt Paulson,
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The Nature Conservancy's mission is to conserve the lands and waters on which all life depends by advancing solutions that help nature and people thrive together. The Conservancy provided technical support to the Oregon Business Leaders' Greenhouse Gas Emissions Reduction Task Force to provide a forum for business leaders to identify smart strategies for reducing greenhouse gas emissions and inform our work in Oregon. The Nature Conservancy's Oregon Board of Trustees endorses the task force's work and extends its thanks to task force members for their time and dedication to this important issue.

¹ The recommendations in this Strategic Plan represent the personal views of the task force members and don't necessarily represent the views of the companies they are associated with.

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EXECUTIVE SUMMARY

GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

Global greenhouse gas² (GHG) emissions, as measured in carbon dioxide equivalents or CO₂e, are increasing and, in turn, exponentially increasing atmospheric CO₂e concentrations. Increased GHG concentrations are already resulting in significant climate change impacts.

To avoid the irreversible consequences of climate change, consensus in the scientific community predicts that we need to keep global warming to less than 2° C, and preferably, less than 1.5° C. For this to happen, atmospheric concentrations of CO₂e need to stay below 450 parts per million (ppm) (Intergovernmental Panel on Climate Change [IPCC] 2014). In March 2016, CO₂e concentrations surpassed 400 ppm. Stabilizing concentrations at 450 ppm requires that we significantly reduce emissions as soon as possible while also investing in ecosystem approaches to mitigating GHG emissions.

How quickly we act to reduce and offset GHG emissions will have profound effects on the health and prosperity of businesses and communities in Oregon and around the world. Failing to act now will result in drastically higher climate change adaptation and mitigation costs later.

THE BUSINESS CASE FOR TAKING ACTION NOW

In 2014, the Risky Business Project, co-chaired by Henry Paulson, Michael R. Bloomberg and Tom Steyer, issued a report, *The Economic Risks of Climate Change in the United States* (Risky Business Project 2014). The report highlights the substantial and diverse risks facing the United States economy and assets due to rising sea levels, increased damage from storm surges, more frequent extreme heat events, and other side effects of climate change. The report urges business leaders to “act aggressively to both adapt to the changing climate and mitigate future impacts by reducing carbon emissions.”

In addition to avoiding business costs that would result from increased climate change impacts, early investments in climate change mitigation

and adaptation have the potential to significantly benefit Oregon’s economy in the immediate future. As carbon becomes more constrained and expensive around the world, businesses that pursue innovations to reduce their footprint and produce products that help others reduce their GHG emissions will have a significant market advantage. Similarly, jurisdictions that have a low-carbon, low-cost energy supply and supportive policies for reducing GHG emissions will be well positioned to attract new businesses and to incite business expansion in their communities.

OREGON’S GHG PROFILE

Oregon has made significant headway in decoupling our GDP and GHG emissions. Oregon companies have taken significant actions to redesign their products and production processes to reduce their carbon footprint. Public investments and policies have also played an important role in supporting business efforts to reduce GHG emissions and innovate. The carbon intensity of Oregon’s economy is already one of the lowest in the country. However, the Oregon Global Warming Commission (OGWC) (2017) projects that the State will not meet its 2020 or 2050 legislatively adopted GHG goals without further economy-wide actions to reduce emissions.

STRATEGIES AND MEASURES

The task force heard from experts and discussed a wide range of strategies to reduce GHG emissions in various sectors including residential, commercial and industrial energy use, transportation, and forestry and agriculture, as well as multi-sector strategies such as carbon pricing, incentive programs and administrative measures. We looked for GHG emissions reduction strategies with the potential to create jobs, grow the economy, and position the State to serve as a role model of responsible economic and environmental stewardship.

² Greenhouse gases are atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth’s surface. They include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (NO₂), and fluorinated gases, including hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride.

EXECUTIVE SUMMARY

With these goals in mind, the task force recommends the following set of strategies and measures for reducing GHG emissions in Oregon.

Strategy 1: Address congestion in the Portland metropolitan area to get freight and people moving.

- Direct and fund the Oregon Department of Transportation to work with the City of Portland, TriMet and Metro to design and implement congestion pricing and a complementary transit improvement program for the Portland metropolitan area.
- Strategically invest funds generated as part of the 2017 transportation package in order to:
 - Accelerate the adoption of "intelligent transportation systems" to improve the flow of traffic, reduce delays, and provide travelers with information that improves driving habits and choices.
 - Address key bottlenecks in the Portland metropolitan area, specifically the Abernathy Bridge on I-205, Highway 217 between Denny Road and I-5, and I-5 around the Rose Quarter.

Strategy 2: Accelerate conversion to alternative-fuel vehicles.

- Design alternative-fuel vehicle incentives to achieve maximum GHG benefits, including the electrification of buses and the use of compressed natural gas/renewable natural gas in refuse collection and other medium- and heavy-duty truck fleets.
- Support development and implementation of utility plans and the regulatory treatment of utility costs to stimulate greater investment in alternative-vehicle infrastructure.
- Develop a blueprint for the deployment of renewable natural gas as an important low-carbon resource, especially valuable for the heavy-duty vehicle sector.

Strategy 3: Regain Oregon's leadership in energy efficiency.

- Adopt progressive building codes and design Oregon's energy efficiency incentive programs to buy down the incremental cost of meeting the new codes.
- Develop a new state tax incentive program for building owners who provide energy efficiency retrofits for their renters.

Strategy 4: Invest in the development of a thorough analysis and modeling effort to inform development of any carbon pricing program.

The task force had a robust discussion of carbon pricing. While the task force was open to the possible development of a carbon pricing program designed to be neutral to positive for Oregon's economy and business sectors, task force members had differing views on how to best frame a strategy recommendation. There was strong support for actively endorsing and developing such a program as the best way to make a major impact on carbon emissions. There was equally strong support for the importance of further examination before endorsing a carbon pricing program. All task force members agreed that an effective carbon pricing program would need to be informed by a thorough analysis of the potential impacts to the economy, including impacts to the competitiveness of Oregon business sectors, energy prices and interactions with the existing regulatory framework (e.g. the Renewable Portfolio Standard and Oregon Clean Electricity and Coal Transition Plan). The program must also include effective mitigation measures to protect low-income Oregonians. The task force recommends that the business community participate constructively in any legislative effort to develop a carbon pricing program.

Strategy 5: Maximize Oregon's potential to benefit from agriculture, forestry and ecosystem-based climate mitigation solutions.

- Develop comprehensive land-based carbon accounting for Oregon and policies to expand economically sound use of ecosystem-based carbon mitigation.
- Invest in life cycle assessments and forest carbon analysis to document the carbon implications of woody biomass utilization.
- Extend the Biomass Producer or Collector Tax Credit for a wide range of biomass types, including incentives for woody biomass, municipal food waste and food processing residues to produce biomethane or renewable energy.
- Invest in modernizing irrigation systems where it will reduce energy consumption, increase water conservation, create opportunities for hydropower generation and produce additional environmental benefits.

Strategy 6: Modernize how Oregon invests in GHG emissions.

- Reauthorize the Energy Incentive Program with modifications to maximize private-sector investment. Specific improvements should:
 - Increase incentive levels and provide incentives for a broader array of energy efficiency projects.
 - Allow for funds to be disbursed on a rolling basis until the tax credit allocation is met in its entirety for the biennium.
 - Allow for incentives to be paid out based on performance instead of on an individual measure basis.
 - Allow for incentives to be provided for deep retrofit improvements that currently are required in the energy codes.
 - Better align the conservation incentive program with climate goals (i.e., tie an incentive to meeting an energy efficiency target baseline reduction, rather than to utility avoided cost rates).
- Authorize Oregon's Small-Scale Energy Loan Program to use credit enhancements and other beneficial financial tools to better leverage private sector investment, transforming the program into a fully functioning Green Bank.

Strategy 7: Require the State to develop an effective climate change mitigation and adaptation plan, and adequately fund an implementation strategy to ensure that we meet our GHG emissions reduction goals.

Strategy 8: Advocate for increased federal investments in research and development and continued investment in Oregon Built Environment and Sustainable Technologies to maintain Oregon's leadership in low-carbon technologies.

DESIGNING EFFECTIVE POLICIES

Decarbonizing Oregon's economy and adapting to the unavoidable impacts of climate change will require a strong economy that can support significant public and private investments. Just as climate change is predicted to have detrimental impacts on people and nature, measures to reduce GHG emissions, if not well designed, can also have significant negative impacts on people and nature.

Our approach to climate change adaptation and mitigation matters. Maintaining affordable energy will be critical, not only to protect rate payers—particularly low-income Oregonians—but also to maintain one of Oregon's best economic development tools. The strategies and measures listed above will need analysis and careful design to keep the economy vibrant while we reduce GHG emissions.

This report describes why it is imperative that we act now. It provides an overview of important basic facts about Oregon's economy and GHG emissions. It gives examples of how effectively designed policies can reduce our GHG footprint while strengthening our state's economy. Finally, it presents background and justification for the recommendations described above.

All too often we are faced with the false dichotomy of either protecting our environment or enhancing our economy. It is our hope that the actions described in this report will provide a roadmap for how the business and environmental communities can work together to make significant headway in reducing GHG emissions while strengthening the overall economy.

THE IMPACTS OF CLIMATE CHANGE

Climate change is ranked as the number one threat to both people and nature (Figure 1). The clearest and most economically significant climate change risks include damage to coastal property and infrastructure from rising sea levels and increased storm surges, climate-driven changes in agricultural production and energy demand, and the impact of higher temperatures on labor productivity and public health (Risky Business Project 2014).

Small changes in global temperature result in significant increases in the frequency of extreme weather events (Intergovernmental Panel on Climate Change [IPCC] 2007). Extreme weather events associated with climate change—already detrimentally affecting our transportation, drinking water, wastewater and energy systems—increase maintenance costs, interrupt business activity and put people's safety at risk. From 1995 to 2015, weather-related disasters affected an estimated 4.1 billion people and resulted in \$1.891 trillion in financial losses (U.N. Office for Disaster Risk Reduction and Centre for Research on the Epidemiology of Disasters 2015).

The frequency and size of uncharacteristically severe fires, a different kind of extreme event, are also increasing. Climate change's side effects—increased annual average temperatures, decreased summer precipitation, decreased snowpack and earlier snowmelt—all contribute to longer fire seasons (Westerling et al. 2006; Littell et al. 2009; Vose, Peterson and Patel-Waynard 2012; Kilos, Link and Abatzoglou 2014). The global mean fire-weather season expanded by more than 16 percent from 1979 to 2013, and the area affected by long fire-weather seasons doubled (Jolly et al. 2016). Uncharacteristically severe wildfires impact ecosystems, increase air pollution, interrupt business activity and put communities in harm's way. They have also had increasing impacts on the federal budget. In 2015, firefighting cost taxpayers more than \$2 billion, up from \$240 million in 1985, consuming more than 50 percent of the Forest Service's budget (National Interagency Fire Center 2016).

Increasing temperatures and drought are impacting crop production in some regions. Studies predict a 12 percent decline in corn yields by 2035 (Hawkins et al. 2012) and a 30 percent decline in wheat and soybean

harvests by 2050 (Challinor et al. 2014) as the world warms. In 2012, the hottest year on record, the United States had the worst corn yields in 20 years (Carrington 2013).

In the ocean, increasing temperatures and acidification are resulting in more dead zones and harmful algal blooms impacting fisheries. Climate-driven warming reduces vertical mixing of ocean water that brings nutrients up and delivers oxygen to down to deeper waters. Ocean acidification increases the energetic cost of calcification, impacting coral reefs and oyster beds, and reduces some marine organisms' ability to absorb oxygen (Fabry et al. 2008). Ocean acidification, along with the reduction of nutrients at the surface and oxygen at depth, hinders ocean productivity and the economic benefits it provides (Behrenfeld et al. 2006).

Climate change is already responsible for several known species extinctions (Urban 2015). Staudinger et al. (2012) reported these conclusions:

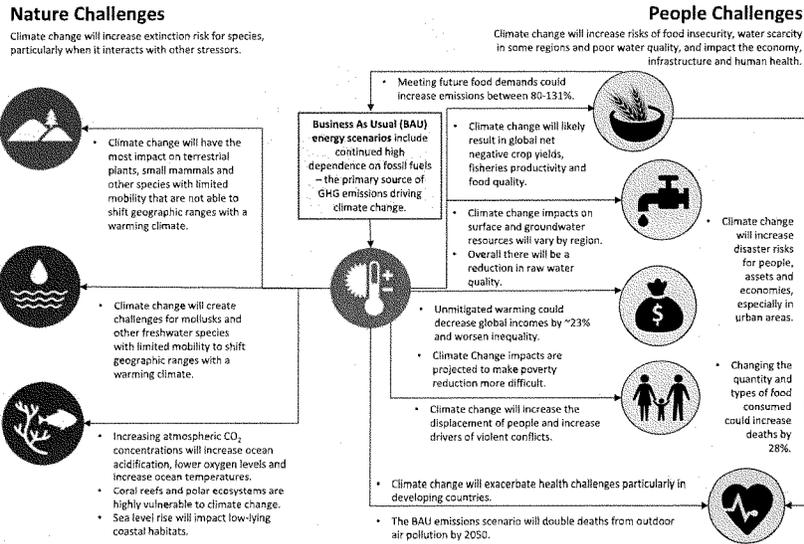
- Evidence that climate change is having impacts on biodiversity is "unequivocal" and expected to increase.
- Terrestrial species are moving upward in elevation at rates two to three times faster than earlier estimates, marine species' ranges are shifting at rates that exceed those reported for terrestrial species.
- Scientists have documented population declines that can be directly attributed to climate change.
- Species at the greatest risk of extinction are those that are ecological specialists and those that live at high altitudes and latitudes.

If the earth warms by 2°C, more than five percent of global species are predicted to become extinct. On the current emissions trajectory, the risk increases substantially with the predicted extinction of one in six species (Urban 2015).

Dalton et al. (2017) provide the following overview of expected climate changes in Oregon if we stay on our current GHG emissions trajectory:

- Oregon's climate is expected to warm on average 3 to 7°F by the 2050s and 5 to 11°F by the 2080s.

Figure 1: Overview of Climate Change Impacts on Nature and People



Sources: IPCC 2014; Burke, Hsiang, and Miguel 2015; Searchinger et al. 2013; Springmann et al. 2016; Tilman and Clark 2014

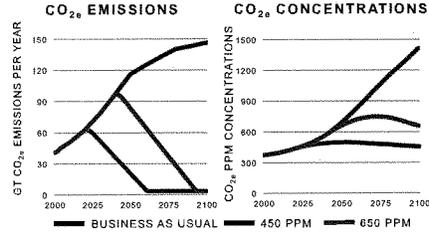
IMPACTS OF CLIMATE CHANGE

- Extreme heat events are expected to increase in frequency, duration and intensity due to warming temperatures.
 - Oregon's already dry summers are projected to become drier while winter, spring and fall are projected to become wetter.
 - The median summer drought extent is projected to triple during the 21st century.
 - By 2050, the snowpack will be reduced by more than 50 percent from what it was in the last century.
 - At Newport, Oregon, for example, sea level is projected to rise between 12 to 47 inches by the end of the 21st century.
 - Impacts from greater ocean acidity, less dissolved oxygen and warmer ocean temperatures are already occurring, including impacts to oyster hatchery operations.
 - Wildfire frequency and scale in all forest types will increase.
- While these changes are sobering, predictions are that the Pacific Northwest will be less impacted by climate change than other parts of the country and the world. More significant climate change impacts elsewhere are predicted to increase migration to the Pacific Northwest, putting increased demands on our land and water resources and infrastructure, and compounding the impacts of climate change.

To avoid the irreversible consequences of climate change, consensus in the scientific community is that we need to keep global warming to less than 2° C, and preferably less than 1.5° C. For this to happen, atmospheric concentrations of CO₂e need to stay below 450 parts per million (ppm) (IPCC 2014). Stabilizing concentrations at 450 ppm requires that we significantly reduce emissions as soon as possible (Figure 2). In March 2016, CO₂e concentrations surpassed 400 ppm.

Decarbonizing our economy alone will not be enough to stabilize the climate. Investments in ecosystem approaches to reducing and mitigating GHG emissions will also be critical. How quickly we act to reduce and offset GHG emissions will have profound effects on the health and prosperity of businesses and communities in Oregon and around the world.

Figure 2: Change in CO₂e Concentrations Resulting from Three Different CO₂e Emissions Scenarios



Source: *Energy Innovation*; graph data come from *Climate Interactives C-Roads Model*

OREGON'S GREENHOUSE GAS EMISSIONS AND THE ECONOMY

Greenhouse gas emissions vary considerably across states—whether measured on an absolute or on a per capita basis (U.S. Energy Information Administration 2015). Oregon currently ranks 38th in the nation in both total energy consumption per capita and total carbon dioxide emissions. A number of factors affect a state's GHG intensity, including the available fuel mix used to generate electricity, population density and climate, as well as state policies and investments. In terms of these factors, Oregon is generally advantaged. The state is situated in a relatively temperate corner of the continent, has access to hydroelectric power, and has long promoted policies to curb urban expansion and encourage public transportation.

The make-up of the economy also affects a state's GHG intensity. States with higher shares of manufacturing often have higher energy use and higher GHG emissions. Manufacturing represents nearly 30 percent of Oregon's GDP, second only to Indiana (Scott 2015). Manufacturing is critically important to many urban and rural communities in Oregon, with jobs that pay 30 percent more relative to the average worker's wage (Oregon Office of Economic Analysis 2015).

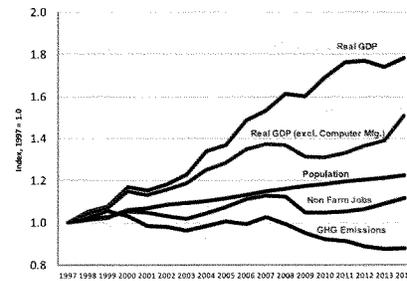
Historically, GHG emissions in Oregon were strongly influenced by economic conditions. The stronger our economy, the more GHG emissions we produced. However, since 1999, GDP and GHG emissions have been largely "decoupled." From 1997 to 2014, Oregon's real GDP increased by almost 80 percent while total GHG emissions declined by approximately 12 percent (Figure 3).

Taken together, at any one point in time, fuel mix and a temperate climate make Oregon a relatively low-emissions state. Over time, innovation and improved energy efficiency are reshaping the relationship between the value of goods and services that Oregonians produce and the resulting level of GHG emissions.

CONTRIBUTIONS FROM OREGON BUSINESSES

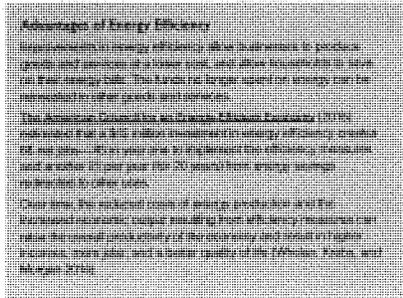
Businesses in Oregon have taken a leadership role in helping to achieve this decoupling. Oregon semiconductor manufacturers are a good example of business achievements through innovation. They have exponentially

Figure 3: Indexed Measures of Economic Activity and GHG Emissions, 1997-2014



Sources: Oregon GDP data: U.S. Bureau of Economic Analysis, 2016; Oregon Nonfarm Jobs and Population: Federal Reserve Bank of St. Louis, Federal Reserve Economic Data (FRED), 2016; Oregon Greenhouse Gas Emissions, 1990-2014, Oregon Department of Environmental Quality, accessed October 2016

increased the power and economic value of semiconductor chips while reducing energy inputs. Intel, for example, has reduced their global GHG emissions by nearly 60 percent since 2000. They purchased approximately 18.9 billion kilowatt hours (kWh) of green power globally from 2008 through



2015, which has had a GHG emissions impact equivalent to taking 2.7 million cars off the road for one year. Through collaboration with their logistics suppliers, they have reduced their transportation-related GHG emissions 32 percent since 2011. Intel is committed to further reducing direct GHG emissions globally by 10 percent on a per unit basis by 2020 (from 2010 levels).

Many other businesses have also stepped up in significant ways to reduce GHG emissions. Since 2002, Oregon's energy efficiency programs in investor-owned utilities have generated \$3.9 billion in economic activity, including \$1.2 billion in wages and \$223 million in small-business income, and created 3,200 full-time jobs. They have saved ratepayers \$1.9 billion on their utility bills and reduced carbon dioxide emissions by 14.6 million tons, the equivalent of removing more than 2.5 million cars from the roads in a single year (Energy Trust of Oregon 2014). Similarly, the Bonneville Power Administration and Oregon's public utilities have made significant investments in promoting energy efficiency.

The Port of Portland joined a coalition of aviation leaders, including Boeing, Alaska Airlines, and their sister Ports in Seattle and Spokane, to pursue

a shared vision to increase the use of fuels produced from biomass. They have addressed the first challenge: proving that jet fuel developed from biomass can be used interchangeably with conventional fuel with no impact on performance. The next challenge is to develop regional feedstocks for biofuels (including oilseeds, forest residue, solid waste and algae) at the necessary scale for aviation fuel. According to the Port, one step in accomplishing this goal is to develop price signals, through policies such as the Clean Fuel Standard, to bolster development of biofuels.

The Oregon trucking industry has made significant strides in improving fuel economy and continues to seek innovative ways to increase vehicle efficiency. Many Oregon businesses have converted, or have started to convert, their fleets to alternative-fuel vehicles. In addition, many businesses have installed workplace charging stations for their employees, creating a rippling GHG reduction effect. Employees are six times more likely to own an electric vehicle if their workplace provides charging stations (Drive Oregon 2015).

According to The Energy Trust of Oregon (2015), "Oregon's dairies, wastewater treatment plants, municipal solid waste collectors and food processors collectively produce enough organic material to generate about 100 megawatts (MW) of biogas capacity annually—enough electricity to power all the homes in the City of Salem for a year." As of 2014, these entities had invested in the infrastructure needed to generate 20 MW of renewable energy.

Many of these innovations produce multiple benefits for Oregonians. Investments in biodigesters, for example, reduce greenhouse gas emissions; reduce food and other organic wastes that would otherwise end up in landfills; improve local air and water quality; recover nutrients; produce a local source of fertilizer for farms; and create jobs—all while generating new revenue streams and cost savings for our farmers, small businesses and water treatment facilities.

While most, if not all, businesses continue to invest in reducing their energy consumption and GHG emissions, it is important to remember that some goods and services are energy intensive by nature. For these businesses, especially those that are highly traded, changes in state policies can have a major impact on their global competitiveness. Many energy-intensive, highly traded businesses—specifically, Intel, Precision Castparts, Greenbrier, Vigor Industrial and Daimler Trucks—are in Oregon's computer,

electronics, metals and transportation manufacturing sectors. The long-term stability and viability of our manufacturing sector is an important economic consideration for Oregon.

In addition, when thinking about GHG emissions and our economy, it is important to remember that Oregon is big and geographically diverse. Long distances separate individuals in rural Oregon from necessary goods and services, and even longer distances separate rural towns and urban centers. Thus, measures to reduce GHG emissions need to recognize and avoid disproportionate impacts on rural economies.

CONTRIBUTIONS FROM LOCAL, STATE AND FEDERAL POLICIES AND PROGRAMS

Local, state and federal policies and programs have played an important role in supporting business efforts to decarbonize the economy.

In 2007, in Oregon Revised Statute 468A.205, the Oregon State Legislature codified the following non-binding GHG emissions goals:

- Begin to reduce greenhouse gas emissions by 2010.
- Reduce greenhouse gas levels to 10 percent below 1990 levels by 2020.
- Reduce greenhouse gas levels to 75 percent below 1990 levels by 2050.

Additionally, the Legislature directed the Oregon Department of Environmental Quality (ODEQ) to begin tracking emissions from transportation, energy generation, residential use, waste processing and disposal, and agricultural and industrial operations. And in 2015, Governor Brown signed the *Subnational Global Climate Leadership Memorandum of Understanding* (better known as the "Under 2 MOU").

The **OGWC** reports to the Legislature each biennium on the state's progress in reducing GHG emissions and works to analyze options for further reductions. For these purposes, the State tracks both in-boundary emissions and consumption-based emissions (OGWC 2015).

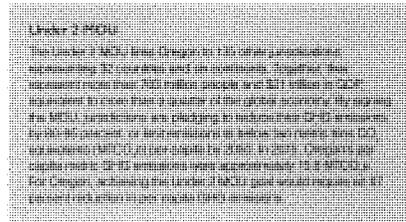
Along with setting emissions reduction goals, Oregon has already enacted a wide range of policies to help reduce greenhouse gas emissions. Here are some examples.

Energy Efficiency

Sector-specific incentive and rebate programs have helped to maximize energy efficiency and conservation. Oregon has adopted on-bill financing for energy efficiency, passed energy efficiency codes and standards for appliances and buildings, required low-income weatherization programs, and enabled energy savings performance contracting.

Energy Generation

In 2007, the State Legislature passed a bipartisan bill to authorize the state's Renewable Portfolio Standard (RPS). The RPS requires all electric utilities in Oregon to invest in a percentage of renewable resources but leaves each utility to decide how, when and where to invest. In 2016, with the passage of Senate Bill 1547, the Oregon Clean Electricity and Coal Transition Plan, the Legislature increased the RPS for Portland General Electric and PacifiCorp, the two largest investor-owned utilities in Oregon. The legislation requires these utilities to generate 50 percent of their total energy resource mix from renewable energy sources by 2040. In addition, the bill requires electric investor-owned utilities to completely divest from coal generation. In combination with Oregon's large supply of hydroelectric power, this bill should result in at least 60 percent of Oregonians' power being generated by renewable resources after 2040.



In addition to the RPS, the State has a number of complementary policies and programs to increase investments in clean energy generation, including distributed generation, net metering and tax incentives.

Transportation

Oregon has dramatically increased efficiencies in transportation and reduced fuel consumption and emissions over the last four decades. Investments in transit and bike infrastructure over the past 20 years in Portland have resulted in significantly fewer average annual driving miles per person. The Continuous Lower Energy, Emissions and Noise (CLEEN) program, within the Federal Aviation Administration's NextGen program, is improving the efficiency of commercial and freight aircraft and reducing travel delays.

Other state policies and programs that have reduced Oregon's transportation GHG footprint include:

- Investments in compact, multimodal and mixed-use communities.
- Accelerated fleet transition to alternative-fuel vehicles.
- Implementation of intelligent transportation systems.
- Incentives for alternative-fuel vehicles and lower-carbon fuels.
- Innovative financing programs.

Research and Development

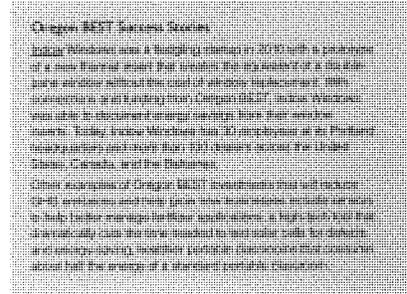
Research and development serves the vital function of ensuring that progress in clean energy technologies is ongoing and that we have ever greater opportunities to reduce GHG emissions. Strong research and development also can serve as an important economic development tool. Most clean technology research and development is conducted through the U.S. Department of Energy's national laboratories.

The Oregon Innovation Council created the Built Environment and Sustainable Technologies (BEST) program to help transfer technologies from Oregon University System schools to businesses, and to provide mentorship programs and lab space to people working on developing clean energy technologies. In their first six years, they helped over 220 faculty members leverage more than 10 dollars of revenue for every state dollar invested in clean technology research or startups and helped dozens

of companies develop, test and deploy new products. BEST has invested in a number of projects that will contribute to GHG emission reductions.

Finally, Oregon has been working for a number of years to closely align its emissions reduction policies with those of other West Coast jurisdictions, including British Columbia, Washington State and California. Working from a memorandum of understanding signed by the jurisdictions' leaders in 2013 and updated in 2016, the states and province are able to leverage each other's programs to lower the cost of reducing greenhouse gas emissions through economies of scale.

As a result, based on the in-boundary analysis Oregon's total GHG emissions declined by approximately 10 percent, or 7.3 MMT CO₂e, between 2000 and 2015. As part of that reduction, statewide per capita GHG emissions have dropped by 24 percent (ODEQ 2016).



WHERE DO WE GO FROM HERE? STRATEGIES FOR SUCCESS

While Oregon has made important gains in reducing our GHG emissions, more can, and must, be done to continue decarbonizing our economy. On our current path, the state's forecast indicates that we will exceed Oregon's 2020 GHG emissions reduction goal by 22 percent, just under 11 MMTCO₂e, and far exceed the 2050 goal (Figure 4).

Developing effective measures for reducing GHG emissions requires an understanding of complex interacting factors, including the changing composition of Oregon's economy, ongoing innovations in energy use, Oregon's existing regulatory framework and emissions reduction policies in neighboring jurisdictions. The task force reviewed Oregon's greenhouse gas emissions profile and evaluated policies and programs that could be adopted to further reduce our GHG emissions. The topics we covered included residential, commercial and industrial energy use;

transportation; forestry and agriculture; as well as multisector strategies such as carbon pricing, financing mechanisms and administrative measures.

Our goal as business leaders is to promote practical solutions that reduce greenhouse gas emissions while creating a prosperous clean energy future. We looked for strategies and measures that would support the following objectives:

- Make a meaningful difference in Oregon's GHG footprint.
- Have potential for creating jobs and providing benefits to Oregon businesses.
- Avoid or mitigate disproportionate impacts to low-income Oregonians and to rural economies.
- Build on Oregon's strengths.
- Meet multiple state goals.

We believe that the following eight broad strategies and associated measures outlined below are critical elements of a blueprint for a lower-carbon economy. These strategies and measures will help protect us from future risks and competitively position the State to provide technological solutions, not just in Oregon but as Oregon, to help advance the larger solution.

Strategy 1: Address congestion in the Portland metropolitan area to get freight and people moving.

Strategy 2: Accelerate conversion to alternative-fuel vehicles.

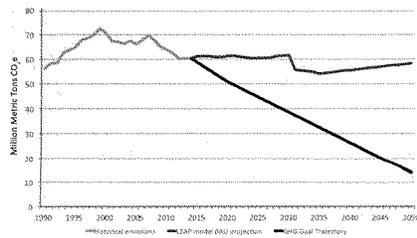
Strategy 3: Regain Oregon's leadership in energy efficiency.

Strategy 4: Invest in the development of a thorough analysis and modeling effort to inform development of any carbon pricing program.

Strategy 5: Maximize Oregon's potential to benefit from agriculture, forestry and ecosystem-based climate mitigation solutions.

Strategy 6: Modernize how Oregon invests in GHG emissions.

Figure 4: Oregon's Historical Greenhouse Gas Emissions, and the Current "Business as Usual" Forecast Compared to the 2020/2050 Goal Trajectory



Source: OGWC 2017

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Strategy 7. Require the State to develop an effective climate change mitigation and adaptation plan and adequately fund an implementation strategy to ensure that we meet our GHG emissions reduction goals.

Strategy 8. Advocate for increased federal investments in research and development and continued investment in Oregon Built Environment and Sustainable Technologies (BEST) to maintain Oregon's leadership in low-carbon technologies.

The suggested strategies fall into seven categories:

- Transportation
- Energy efficiency
- Carbon pricing
- Agriculture, forestry and ecosystems
- Public investment programs
- Agency structure and authorities
- Research and development

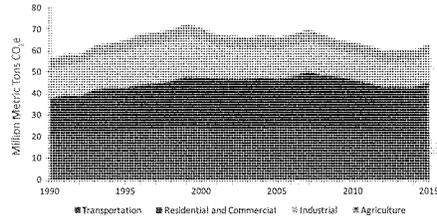
Additional information on why each of these strategies and their associated measures are being recommended is described below.

TRANSPORTATION

Sound transportation policy and investments are essential for meeting Oregon's GHG emissions reduction goals and critical to Oregon's economic future. At 23.2 million metric tons of carbon dioxide equivalents (MMTCO₂e), the transportation sector makes up 37 percent of Oregon's GHG emissions (ODEQ 2016) (Figure 5).

Businesses move products to market, employees travel to and from work, and customers use roadways to buy goods and services. In 2012, more than \$300 billion in goods moved on all of Oregon's modes of transportation (Economic Development Research Group 2014). In that same year, there were more than 193,000 transportation-related jobs in Oregon and another 153,900 transportation-dependent jobs—nearly 20 percent of all jobs in Oregon. Oregon's traded-sector industries (computer equipment, electronics, wood products, agriculture, food/beverage manufacturing and metal manufacturing) are especially reliant on efficiency across all modes of transportation in the West Coast network.

Figure 5: Oregon's Greenhouse Gas Emissions (in MMTCO₂e) by Sector



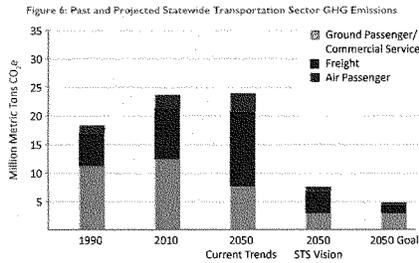
Source: ODEQ 2016

Governor Brown and the Legislature have both prioritized passing a transportation package in 2017, creating an important opportunity to advance transportation measures for reducing GHG emissions. The task force identified two key strategies in this sector.

Strategy 1: Address congestion in the Portland metropolitan area to get freight and people moving.

Freight vehicle miles traveled and the associated GHG emissions have been growing faster than any other transportation segment and are projected to increase under business as usual projections to 2050. (Figure 6.) Much of the increase in freight emissions is due to the growing congestion in Portland, an issue of statewide concern to Oregon business leaders (Transportation Vision Panel 2016). In 2014 alone, Portland area drivers consumed 39 million excess gallons of fuel as a result of congestion (Schrunk, 2015). The total cost of congestion in 2014, which included wasted time and fuel, was \$1.8 billion. As a result, the task force recommends that the Legislature:

Direct and fund the Oregon Department of Transportation to work with the City of Portland, TriMet and Metro to design and implement congestion pricing and a complementary transit improvement program for the Portland metropolitan area. (Measure 1.)



Adapted from the Oregon Department of Transportation's 2013 Statewide Transportation Strategy (STS)

Given the growing scope of the congestion problem and its impacts on businesses across the state, we believe it is critical for businesses to show strong support for accelerated action to implement a congestion pricing program. Reducing congestion in the Portland metropolitan area would reduce costs to businesses and speed delivery of goods to market, while improving air quality and reducing air quality related health costs. At least 14 states, including California, Florida and Texas have implemented forms of congestion pricing.

Three types of congestion pricing should be considered:

- Dynamic highway tolling (charging higher tolls to travel on highways during high-use times and lower or zero tolls during off-peak hours).
- Cordon pricing (implementing a congestion charge for entering the downtown "cordon").
- Peak-hour parking fees (placing a surcharge on entering/exiting parking garages at peak hours).

The latter two approaches would be effective tools for reducing congestion in the downtown area. However, they would be ineffective at changing incentives for drivers who do not originate or terminate a trip in downtown Portland. Drivers on Hwy 217 and I-205, and those on I-5 who bypass the city center, would be unaffected by these policies. All three types of congestion pricing may be beneficial as part of a comprehensive program for the Portland metropolitan area. Dynamic highway tolling would do the most for freight movement.

Dynamically priced highways have several benefits. First, they incentivize drivers with less need to travel at peak times to alter their time, route or mode of travel. Less congestion means less wasted time for drivers, less fuel consumption and greenhouse gas emissions, and easier mobility for freight traffic. Second, collection of tolls provides revenues for highway improvements that can address pinch points and further ease congestion. Third, the tolls can be mapped to tell transportation officials the location of high-demand facilities. As a member of the federal Value Pricing Pilot Program, Oregon is eligible to implement tolling on existing interstate highways if the tolling scheme is done to manage congestion.

Two primary issues need to be addressed to implement a fair and effective congestion pricing program. First, congestion pricing has disproportionate impacts on low-income motorists who often have less flexibility about when they work and where they live. Any congestion pricing program needs to address this concern. The Oregon Department of Transportation should work with stakeholders—particularly those representing low-income Oregonians—to fully understand the costs, benefits and community-wide implications of congestion pricing in order to design a fair and equitable program. Second, for congestion pricing to work, complementary improvements must be made in public transit to provide alternative options for drivers. For example, when London introduced their congestion pricing scheme, they deployed an extra 300 buses with new and expanded routes. They documented a 14 percent increase in bus ridership as a result of the congestion pricing scheme.

Moving people by train, bus or trolley, to and from their homes and where they work or shop, significantly reduces congestion and GHG emissions. The Transportation Vision Panel's (2016) report to Governor Brown recommends making public transit options easier to use in order to increase ridership. Specifically, they recommend reducing gaps in transit

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service, maximizing transit funds (particularly the potential for leveraging federal matching funds) and increasing the flexibility of K-12 student transportation services.

Finally, while transportation experts warn that it is impossible to build your way out of congestion problems, the task force also recommends strategically investing funds generated as part of the 2017 transportation package in order to:

Address key bottlenecks in the Portland metropolitan area: the Abernathy Bridge on I-205, Highway 217 between Denny Road and I-5, and I-5 around the Rose Quarter. (Measure 1.2)

Accelerate adoption of “intelligent transportation systems” to improve the flow of traffic, reduce delays, and provide travelers with information that improves driving habits and choices. (Measure 1.3)

Strategy 2: Accelerate conversion to alternative-fuel vehicles.

Today, there are an estimated 10,000 electric and 80,000 hybrid vehicles in Oregon. The OGWG *Roadmap to 2020* (OGWG 2010) projects that the state would need to convert 10 percent of the fleet to electric by 2020 to meet the state’s goals (about 300,000 cars). Oregon and California have regulations requiring automakers to increase electric vehicle car sales to 15 percent by 2025 (about 130,000 cars). The Oregon Sustainable Transportation Strategy (ODOT 2013) estimates that 53 percent of vehicles in Oregon, or about 90 percent of all new vehicles sold, will need to be electric or hybrid-electric vehicles by 2050 to reach the state’s GHG emissions reduction goals.

Converting personal, public and commercial vehicles from gasoline and diesel to alternative fuels (including natural gas, renewable natural gas or biomethane, electricity, hydrogen fuel cells and biofuels) would not only significantly and immediately reduce GHG emissions, it would save consumers and businesses money. The task force recommends that the Legislature advance the following measure:

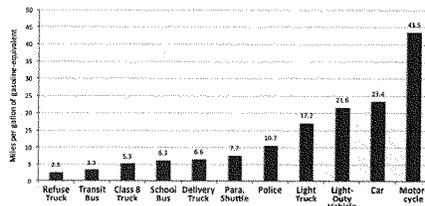
Design alternative-fuel vehicle incentives to achieve maximum GHG benefits, including electrification of buses and the use of compressed natural gas/RNG in refuse and other medium- and heavy-duty truck fleets. (Measure 2.1)

Conventional transit buses and refuse trucks have the lowest average fuel economy and higher operations and maintenance costs as compared to those fueled by electricity (Figure 7). In addition, the 2012 *Federal Transportation Act*, MAP-21, includes incentives for the acquisition of alternative-fuel buses. Both TriMet and the Lane Transit Districts received grants to purchase electric buses and are in the process of doing so.

Making alternative-fuel vehicles more practical to own and operate requires investment in residential, workplace and public charging stations (to ensure that users can fuel up when and where they need to) and public investments and incentives to accelerate the adoption of alternative-fuel vehicles.

Oregon currently ranks ninth in public and private alternative-fuel fueling stations—23 biodiesel (B20 and above), 15 compressed natural gas, 10 E85-ethanol flex fuel, 529/1,217 electric-electric vehicle stations and outlets, zero hydrogen, two liquefied natural gas, and 58 liquefied petroleum gas—with a total of 1,325 stations (U.S. Department of Energy 2016). California ranks first with 13,655 stations. Expanding natural gas fueling infrastructure is especially important to provide an alternative fuel for long-haul trucks.

Figure 7: Average Fuel Economy of Major Vehicle Categories



Source: U.S. Department of Energy, *Alternative Fuels Data Center 2015*

It will be difficult to establish the necessary public charging and refueling infrastructure without the engagement of Oregon's utilities. As a result, the task force recommends the Legislature and/or the Public Utility Commission advance the following two measures to expand refueling infrastructure:

Approve the development and implementation of utility plans and the regulatory treatment of utility costs as a way to accelerate investment in alternative-fuel infrastructure. (Measure 2.2)

Develop and approve a blueprint for the deployment of renewable natural gas (RNG) as an important low-carbon resource, especially valuable for the heavy-duty vehicle sector. (Measure 2.3)

The recent Oregon Clean Electricity and Coal Transition Plan enables Portland General Electric and PacifiCorp to plan for expanding the adoption of electric vehicles. These plans might include such options as a quick-charge network, a time-of-use pilot, dealer/customer education and a low-income pilot. We also support passage of legislation to enable natural gas utilities to develop similar plans for expanding the adoption of natural gas vehicles. The Oregon Department of Transportation has designated key alternative-vehicle corridors and has nominated these for future development. State policies and utility plans should be proposed that are consistent with and supportive of this coordinated corridor development.

Unlike the plans for renewable electricity, the policy and regulatory framework for integrating renewable natural gas into our transportation systems, homes and businesses has not been fully developed. A roadmap is needed to guide the policy, incentives and regulatory structures required to make these opportunities commercially viable. Legislation would be needed to implement certain portions of the roadmap and establish capital investment incentives—either on capital investment such as tax credits or through production incentives like the Renewable Fuel Standard—to help build the asset base needed for RNG to support GHG reduction goals. As an example, California's renewable fuel policies have resulted in half of all natural gas vehicles operating on RNG rather than on conventional natural gas.

In addition, Oregon currently has a great opportunity to target the \$68 million Volkswagen settlement to reduce diesel emissions.

ENERGY EFFICIENCY

Strategy 3: Regain Oregon's leadership in energy efficiency.

The task force recommends that the State focus on the built environment, which is Oregon's second largest contributor to GHG emissions.

Energy efficiency, conservation and demand management are universally recognized as the most cost-effective ways to meet increasing energy needs and reduce GHG emissions. In addition, energy efficiency investments make a positive contribution to a region's economic growth potential (Whelan, Krebs, and Morgan 2014). As described earlier, improvements in energy efficiency allow businesses to produce goods and services at a lower cost, and allow households to save on their energy bills. The funds no longer spent on energy can be reinvested in other goods and services. Over time, the reduced costs of energy production and the increased economic output from efficiency measures can raise the overall productivity of the economy resulting in higher incomes, more jobs and a better quality of life.

Despite the success of Oregon's existing energy efficiency programs, there is still significant work to be done to reduce emissions in this sector. The OGWC (2015) projected that investments in energy efficiency and conservation measures could result in a reduction of 6.6 MMT of carbon dioxide equivalent, or 30 percent of the total reduction from all sectors (not including a carbon tax).

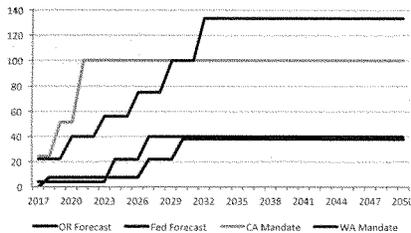
The Northwest Power and Conservation Council's *Seventh Power Plan* (2016) projects that 100 percent of the region's predicted 36 percent increase in energy demand can be met through energy efficiency and conservation. The council's modeling found that energy efficiency consistently proved to be the least expensive and economically risky means of meeting future demand growth. They recommend aggressive action for the next six years to achieve this energy efficiency goal.

While Oregon has been a national leader in deploying energy efficiency, our residential and commercial energy codes have fallen behind those of other states (Figure 8). Therefore, the task force recommends two important measures to regain Oregon's leadership in energy efficiency:

Adopt progressive building codes and design Oregon's energy efficiency incentive programs to buy down the incremental cost of meeting the new codes. (Measure 3.1)

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Figure 8. Forecasted Oregon and Federal Residential Energy Codes Relative to Oregon's 2014 Energy Code and Compared to Washington (Legislative) and California (Administrative) Mandates*



Source: Earth Advantage 2017

* The area under each mandate or projection represents the relative energy savings from different residential energy codes.

The task force considered two options: U.S. Department of Energy's 2015 Model Code or the Architecture 2030 Code. Both options have been adopted by other jurisdictions and provide implementation case studies.

In 2015, the U.S. Department of Energy developed a new model code for residential and commercial buildings. That code has been adopted by Idaho, Montana, Alabama and Utah to name a few.

Other jurisdictions are working to adopt the Architecture 2030 code, a code ensuring that all new buildings, developments and major renovations will be carbon neutral by 2030. Steps toward adopting the 2030 goal have been taken in a number of states. For example, Minnesota, Illinois and Ohio have laws that require buildings receiving state funding to meet the goal. New Mexico has an executive order requiring the same for state-funded buildings. Massachusetts has a grant program to help building owners achieve the goal. States have been creative in developing implementation strategies that work well for their own jurisdictions and economies. The

2030 codes have been endorsed by the National Governors Association, the United States Conference of Mayors and the National Association of Counties. Oregon's voluntary Reach Code is modeled on the Architecture 2030 Code. Building code updates can be implemented through a regulatory process administered by the Building Codes Division of Oregon's Department of Consumer and Business Services or by legislative action or executive order.

The Pacific Northwest National Laboratory (2014) conducted an analysis of nationwide adoption of the 2015 Model Code. Their analysis, looking at a period from 2013 to 2040, predicts that the cumulative energy cost savings of adopting the new code would equal approximately \$330 billion (in 2012 dollars). Annual CO₂ savings potential would reach 461 MMT at the end of 2040; the cumulative potential carbon savings by 2040 are estimated at more than 6.2 billion metric tons of CO₂. The laboratory (2013) also conducted a study of the cost effectiveness of implementing the model code. That study found all of the model code measures to be cost effective.

According to the U.S. Department of Energy's calculations, the economic impact of adopting the model code for commercial buildings in Oregon would save commercial building owners \$0.097/square foot annually, save \$0.253/square foot in construction costs and save \$1.5/square foot over the life cycle of the asset.

California recently adopted ambitious performance-based building codes. The state set an aspirational goal that all new residential buildings need to be zero net energy by 2020, and all commercial buildings must follow suit by 2030. The code also applies to retrofit projects that pass certain thresholds. The California Energy Commission (CEC) anticipates that their recently adopted residential energy code will cut energy use in homes by 28 percent and save consumers \$31 a month. In addition, CEC found that the standard will cut energy use by about 281 gigawatt hours of electricity and 16 million therms of natural gas per year, reducing carbon dioxide emissions by about 160,000 metric tons per year. The 30-year cumulative savings add up to the equivalent energy use of 12 large power plants.

In the finance section below, we propose that the Oregon Legislature reauthorize the Energy Incentive Program and modify the program to maximize private-sector investment to help drive down emissions in the built environment.

Finally, there is no population in greater need of the benefits of energy efficiency than low-income Oregonians. While there are programs to help prevent their utilities from being shut off, there are insufficient resources to ensure energy efficiency retrofits for renters. In addition, building occupants are often served by separate meters and therefore pay their own utility bills. Incentives may be provided to building owners to retrofit their buildings but, since they are not paying the utility bills, there is no economic incentive for them to retrofit. Renters are left having to pay for the utilities but with no way to reduce their bills. Therefore, the task force also recommends that the State:

Develop a new tax incentive program to encourage building owners to provide energy efficiency retrofits for their renters. (Measure 3.2)

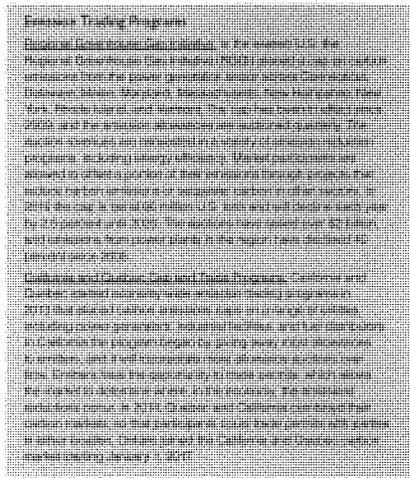
The program should provide a meaningful financial incentive, such as a property tax abatement, for landlords serving a low-income population to conduct energy efficiency retrofits. It could be administered by Oregon Housing and Community Services or another relevant agency, with technical energy oversight, measurement, and verification provided by Oregon Department of Energy. The energy savings would benefit low-income tenants.

CARBON PRICING

Strategy 4: Invest in the development of a thorough analysis and modeling effort to inform development of any carbon pricing program.

Economists overwhelmingly consider putting a price on carbon a less costly approach to reducing GHG emissions than regulatory measures (University of Chicago Booth School of Business 2011). There are two overarching economic arguments for pricing carbon. One, it corrects an underlying market failure by including the external costs of GHG emissions and their contribution to climate change. And two, it reduces GHG emissions at a lower cost than source- and sector-based mandates for technologies or processes (COES 2013).

There are two major mechanisms for pricing carbon, carbon taxing and emissions trading. The latter is often referred to as a “cap-and-trade” or “cap-and-invest” program. Both options lead to lower emissions without dictating exactly where and how the reductions occur. Likewise, both also generate revenues. Individual pricing programs vary in how those revenues are distributed or invested. A carbon tax is effective in providing certainty



on the price of carbon, while a cap-and-trade system is better at providing certainty on carbon reductions. To achieve needed emission reductions, a carbon tax needs to be high enough to substantially change behaviors that result in higher GHG emissions. Over time, the tax rate can be adjusted to achieve the emissions levels desired.

A cap-and-trade program involves setting a cap on the amount of carbon dioxide emissions that can be produced in a given jurisdiction over a given compliance period. Cap-and-trade programs provide emitters with

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flexibility in how they comply. Permits (or "allowances") to emit carbon up to that overall cap are distributed (sold, auctioned or given away for free) to emitters. Entities that emit over their allowance are required to either reduce their emissions or purchase credits to come into compliance with their allowance through a carbon marketplace. Entities that emit less than their allowance can sell a portion of their allowance or "credits." Cap-and-trade programs identify an array of other activities that can be used to "generate credits," such as forestry and agricultural measures that capture and store carbon. As more credits flood the market, the value decreases, lowering the cost of compliance. Cap-and-trade programs include provisions for adjusting the cap downward over time, which leads to the creation of a stable and predictable long-term market. A cap-and-trade program would address one of the key challenges we currently face in meeting Oregon's GHG emission goals by turning Oregon's non-binding goals into mandatory goals.

Ideally, a global or national pricing system would be adopted to level the playing field for businesses in different jurisdictions. However, implementation of global or national system seems unlikely in the near term. Just as there are potential impacts from adopting a carbon pricing program, there are risks to waiting. In addition to avoided business costs from increased climate impacts, over the long term, early investments in climate change mitigation and adaptation has the potential to significantly benefit our economy. As carbon around the world becomes more constrained and expensive, jurisdictions that have a full suite of supportive policies for reducing GHG emissions will be well-positioned to attract new businesses and incite business expansion in their communities.

The state commissioned a marginal abatement cost curve study to evaluate the cost effectiveness of measures that could be taken in various sectors: transportation; energy generation; residential, commercial and industrial energy efficiency; agriculture and materials; and waste (Oregon Department of Energy 2012). The OGWC used the cost curve study to evaluate whether implementing a combination of cost-effective sector-focused measures would meet the state's 2035 GHG target. In their analysis, using sector measures alone, the state's GHG emissions would exceed the 2035 goal by 30 percent—when factoring in carbon pricing in addition to sector measures, the state's GHG emissions would meet the 2035 goal.

The task force had a robust discussion of carbon pricing. While the task force was open to the possible development of a carbon pricing program designed to be neutral to positive for Oregon's economy and business sectors, task force members had differing views on how to best frame a strategy recommendation. There was strong support for actively endorsing and developing such a program as the best way to make a major impact on carbon emissions. There was equally strong support for the importance of further examination before endorsing a carbon pricing program. All task force members agreed that an effective carbon pricing program would need to be informed by a thorough analysis of the potential impacts to the economy, including impacts to the competitiveness of Oregon businesses, energy prices and interactions with the existing regulatory framework (e.g. the Renewable Portfolio Standard and Oregon Clean Electricity and Coal Transition Plan). It would also need to include effective mitigation measures to protect low-income Oregonians.

In March 2016, the Legislature requested that the ODEQ conduct a study (completed in February 2017) on how a market-based approach to reducing greenhouse gas emissions could work in Oregon, specifically a cap-and-trade program. Their results indicate that a cap-and-trade program can produce emission reductions at a lower cost and can more effectively mitigate impacts to businesses than a carbon tax.

A number of critical questions must be addressed as Oregon considers next steps in developing a carbon pricing program. One of the most important questions to answer is, "How can we design a program that does not result in Oregon businesses shifting production or relocating to states or countries with a lower price on carbon?" This is referred to as "leakage." The potential for leakage can be especially significant for emissions-intensive and trade-exposed business sectors. Oregon will need to identify and evaluate the risks of leakage to different business sectors and identify the policies that would work best to avoid leakage.

A variety of policies could be considered for mitigating potential impacts to Oregon businesses:

- Proceeds from a carbon pricing program could be used to help companies reduce their emissions.
- A portion of allowances can be distributed free of charge to emissions-intensive, trade-exposed sectors.

- Market design features can be included to provide compliance flexibility.
- The use of offset credits can be allowed as a compliance instrument.
- Border carbon adjustments could be used to level the playing field for traded goods (e.g., electricity imports) and reduce leakage.

In addition, the State will need to address additional design considerations that could have positive and negative impacts on Oregon business sectors:

- Would carbon pricing be introduced as a revenue generating or revenue neutral program?
 - If revenue generation is a goal, what would the revenue fund and how would that spending affect environmental outcomes?
 - If revenue neutrality is a goal, which existing taxes and fees would be reduced and what would be the economic effects of the resulting package? And, as carbon reduction goals are met, how would the tax system be adjusted to remain neutral instead of reducing overall revenues for public services?
- How should the implementation of carbon pricing affect the levels of other existing energy taxes?
- How should the State mitigate impacts to low-income households that spend a disproportionate share of their incomes on energy?
- How should the State address disproportionate regional impacts—especially on rural populations?
- How should a local pricing system address non-CO₂ agriculture and forest-related emissions?
- If a price on carbon is introduced, should the State adjust other regulations (e.g. Renewable Portfolio Standard and Oregon Clean Electricity and Coal Transition Plan) designed to reduce GHG emissions or tailor the pricing mechanism to recognize the GHG emission reductions achieved by the existing regulations?
- How should the State administer a tradable-permits market and/or monitor emissions?

The task force recommends that business leaders invest in the development of additional economic modeling to test the assumptions and conclusions in ODEQ's report and constructively engage and inform any legislative efforts to develop a carbon pricing program for Oregon.

AGRICULTURE, FORESTRY, AND ECOSYSTEMS

Strategy 5: Maximize Oregon's potential to benefit from agriculture, forestry and ecosystem-based climate mitigation solutions.

Agriculture and forestry are an important part of Oregon's heritage. They provide products and raw materials for our manufacturing sector and are a large contributor to our rural economies. These sectors are unique in that they both produce GHG emissions but also can provide GHG emissions mitigation through actions that increase sequestration. The potential to reduce GHG emissions from these sectors appears to be much smaller than from the energy generation, energy efficiency and transportation sectors. However, due to their importance in Oregon, the task force believes it is important to advance measures to reduce GHG emissions that would benefit these sectors. The right investments in the way we manage our farm and forest lands would not only help to continue the positive economic benefits these land uses provide, but also set the stage for continued innovation that would provide GHG benefits and help achieve other state goals, such as increased efficiency in water use and reduction of wildfire risk.

The 2015 Paris Climate Agreement encourages the use of land- or ecosystem-based measures to reduce emissions and sequester carbon. A recent global analysis estimates that these natural pathways involving conservation, restoration and changes in land management could provide up to 37 percent of the global GHG emissions reduction needed by 2030 (Griscom et al. *in review*).

Calculating greenhouse gas emissions related to agriculture, forestry and ecosystem is complex. Scientists disagree on how to best calculate the carbon emissions implications associated with land management actions and the use of biomass as a substitute for other fuels. The State's current GHG emissions tracking protocols don't fully account for emissions or for the sequestration potential in Oregon's farms, forests and ecosystem-based carbon pools. Without a more comprehensive assessment, it is hard to create an ecosystem market that maximizes contributions from these sectors. The task force recommends advancing four measures to reduce emissions and increase opportunities for sequestration in this sector:

Develop comprehensive land-based carbon accounting for Oregon and policies to expand economically sound use of ecosystem-based carbon mitigation. (Measure 5.1)

Improved land-based carbon accounting would offer new opportunities for landowners to finance sustainable land management activities and help to mitigate climate change. The OGWC is currently collaborating with Oregon's Departments of Forestry, Energy and Environmental Quality to discuss issues related to the natural carbon flux associated with different forest types and different management scenarios. We recommend that these discussions be expanded and that the State develop a comprehensive carbon accounting methodology for all lands.

Invest in life cycle assessments and forest carbon analysis to document the carbon implications of woody biomass utilization. (Measure 5.2)

If sourced appropriately, woody and agricultural biomass can be a lower-carbon source for energy production than traditional baseload fossil fuels. In order to realize these benefits, policy development and planning and implementation of biomass projects need to be fully informed by science.

Oregon is in a strong position to add expertise in forest carbon accounting to these debates. In addition, Oregon has active programs to accelerate forest restoration and state policies that promote the use of sustainable biomass for energy production. Once the State has addressed the outstanding questions about the role biomass can play in meeting Oregon's GHG targets and federal compliance requirements, additional policies could be implemented to support scientifically sound use of woody biomass to replace fossil fuels.

Extend the Biomass Producer or Collector Tax Credit for a wide range of biomass types, including incentives for woody biomass, municipal food waste and food processing residues to produce biomethane or renewable energy. (Measure 5.3)

As described earlier, anaerobic digesters allow for the production of biomethane that can produce renewable electricity or gas that can be conditioned into pipeline-quality renewable natural gas to be used to fuel vehicles or to serve natural gas customers. Anaerobic digesters may be located at waste water treatment plants, farms, food processing facilities, and food waste handling facilities. Food waste has been recognized as a significant contributor to methane emissions, and the ODEQ has reported that only two percent of food waste is currently recovered. There is significant room to improve the management of these organic waste streams to provide beneficial and GHG-reducing uses.

Oregon currently provides an incentive for anaerobic digesters through the Biomass Producer or Collector Tax Credit. Under this program, biomass that is delivered to an anaerobic digester facility and used to produce energy is eligible for a volumetric incentive, depending on the type of biomass that is used. The current program provides an incentive for animal manure, agricultural biomass, used oil, and woody biomass. In 2015, the Oregon Legislature extended the tax credit for animal manure through 2021 at a reduced rate. Incentives for the other forms of biomass will end in 2017, when the broader program is set to expire.

Invest in modernizing irrigation systems where it will reduce energy consumption, increase water conservation, create opportunities for hydropower generation and produce additional environmental benefits. (Measure 5.4)

Oregon State University reports that the agricultural industry in Oregon accounts for more than \$49 billion, or 15 percent, of the state's economic activity (Oregon Business Plan 2016). Associated jobs number more than 260,742 or 12 percent of the state's employment. Irrigation systems in Oregon move 85 percent of the state's water; many irrigation systems were built decades ago without the benefit of modern technology. Modernizing irrigation systems can provide multiple agricultural and environmental benefits. Where modernization can reduce waste, such water can be put back into streams to benefit fish and wildlife and/or be made available to more junior water users. Where new systems decrease the amount of energy needed to pump water and provide an opportunity for in-conduit hydropower installations, this can also reduce GHG emissions.

Oregon currently has utility-funded agricultural energy efficiency programs, such as those administered by the Bonneville Power Administration and the Energy Trust of Oregon, as well as policies and programs that encourage the installation of hydropower generation facilities. Business leaders should support a continuation of these incentive programs.

PUBLIC INVESTMENT PROGRAMS

Strategy 6: Modernize how Oregon invests in GHG emissions.

Transitioning to a low-carbon economy will require "unprecedented amounts of dependable, accessible, and fully-scaled capital-financing ... with varying risk tolerances" (Berlin et al. 2012). While regulations provide a pathway to reducing GHGs in Oregon's economy, public

investment programs can help to reduce the cost of compliance, scale new technologies, accelerate market transformation, and spur private sector innovation and investment.

Federal investments in clean energy projects through direct lending, tax expenditures and loan guarantees have declined significantly since 2009 (Jenkins et al. 2012). Oregon's primary clean technology investment programs—the *Energy Incentive Program*, the *Renewable Energy Development Grant Program*, and the *Transportation Tax Credit Program*—are scheduled to expire at the end of 2018. The Legislature would need to reauthorize them in the 2017 session. This would provide an opportunity to make changes to the energy conservation incentive program. Also, these programs could be better designed to maximize private sector innovation and investment, leveraging the state's dollars to achieve a greater level of total investment and GHG reduction. To work best, state investments and incentive programs should be assessed and updated as new technologies are developed and market conditions change. In addition, they should be designed to leverage federal, rate-payer or private funding programs, and to maximize the total investment. Well-designed public financing programs can create jobs, increase state revenue and leverage private sector investment that otherwise would not happen. The task force recommends two measures for modernizing Oregon's investments in GHG reduction:

Reauthorize the Energy Incentive Program (EIP), with modifications, to maximize private sector investment. (Measure 6.1)

Specific improvements should include the following objectives:

- Increase incentive levels and provide incentives for a broader array of energy efficiency projects.
- Allow for funds to be disbursed on a rolling basis until the tax credit allocation is met in its entirety for the biennium.
- Allow for incentives to be paid out based on performance instead of on an individual measure basis.
- Allow for incentives to be provided for deep retrofit improvements that currently are required in the energy codes.
- Better align the conservation incentive program with climate goals (i.e., tie incentives to meeting targeted energy efficiency baseline reduction, rather than to utility avoided-cost rates).

Authorize Oregon's Small-Scale Energy Loan Program to use credit enhancements and other beneficial financial tools to better leverage private sector investment, transforming it into a fully functioning Green Bank. (Measure 6.2)

"Green Banks" bridge existing gaps between borrowers who wish to install smaller renewable energy and energy efficiency projects and existing sources of private capital. The differentiating principle of a Green Bank is that it can leverage public funds by deploying them to facilitate private financing, rather than directly granting or gifting funds. Green Banks are designed to be self-sustaining; public funds are recovered and reused. Green Banks help leverage an initial seed investment from the state. Connecticut's and New York's Green Banks have successfully done so through offering credit enhancement to the private sector.

Green Banks can help with market transformation. By intervening in the market and facilitating the private financing of renewable energy projects, Green Banks can lower overall costs by growing the market for renewable energy and efficiency projects, and achieving economies of scale in installation and manufacturing. A Green Bank would accomplish this goal by acting as a direct lender to small renewable energy and energy efficiency projects, and by providing credit enhancements to private lenders.

Oregon's Small-Scale Energy Loan Program (SELP) has the same overarching goal as other Green Banks in that it is used to fund clean technology. However, the SELP is currently only able to do direct lending; it does not have the authority to use all of the financial instruments available to more sophisticated Green Banks. The Legislature would need to authorize the use of credit enhancements for the agency administering the program. In addition, the task force supports Governor Brown's recommendations to move financial oversight of SELP to Business Oregon to create a way for Oregon Department of Energy to provide technical oversight, measurement, and verification for renewable energy and energy efficiency grants, loans and loan guarantees; and to fully recapitalize the program.

AGENCY STRUCTURE AND AUTHORITIES

Strategy 7: Require the State to develop an effective climate change mitigation and adaptation plan and adequately fund an implementation strategy to ensure that we meet our GHG emissions reduction goals.

Agency structure, authorities, and funding also limit Oregon's ability to meet our GHG emissions reduction goals. The programs for reducing GHG emissions in Oregon are spread across numerous state agencies. Currently, the OGWC, staffed by personnel (less than one full-time equivalent) housed in the Oregon Department of Energy, is responsible for reporting the State's progress toward climate goals and developing policy recommendations. The commission receives little to no state financial support. The Oregon Legislature's Joint Interim Committee on Department of Energy Oversight (2016) identified climate policy as needing more attention and better coordination at the state level. Without an effectively resourced and functioning focal point for climate policy, it will be extremely difficult, if not unlikely, for Oregon to meet our GHG emissions reduction goals. The task force supports action to develop an effective climate change mitigation and adaptation plan and adequately fund an implementation strategy.

With the proper staffing and funding, the OGWC could leverage its existing expertise to help the State make faster progress in reducing GHG emissions. Increasing OGWC's staff and analytic capacity would create an entity that can comprehensively address long-term and incremental planning for meeting the state's GHG reduction goals. Moreover, these changes will help ensure the State places meeting its GHG reduction goals alongside other priorities.

Increasing staff and analytic capacity for the OGWC would provide the State and stakeholders with better data regarding potential pathways to meeting GHG reduction goals and their economic impacts. Over time, the state would benefit from more strategic oversight, planning, and implementation of policies and programs. This new capacity and function for OGWC would also increase transparency and improve input into policy proposals.

While it is not appropriate for OGWC to have regulatory oversight over the broad array of state agencies that need to engage in GHG emissions reduction, the OGWC does need to be able to access existing data from these agencies to inform policy development moving forward. The

Joint Interim Committee on Department of Energy Oversight (2016) recommended that each agency with a role in reducing GHG emissions be given statutory direction on their roles and expected contributions to meeting the state's climate goals.

RESEARCH AND DEVELOPMENT

Strategy 8: Advocate for increased federal investments in research and development and continued state investment in Oregon BEST to maintain Oregon's leadership in low-carbon technologies.

Last, as described earlier, research can play a critical role in accelerating new technologies and building Oregon businesses. As noted above, most clean technology research and development is conducted through the U.S. Department of Energy's national laboratories. However, the Oregon BEST program has helped to build Oregon businesses by transferring technologies from Oregon University System schools, and providing mentorship programs and lab space to people working on clean energy technologies. The task force recommends that business leaders support continued investments in Oregon BEST.

DESIGNING EFFECTIVE POLICIES

We are confident that the strategies and measures identified above are important for further reducing GHG emissions in Oregon. However, it also matters how these measures are ultimately designed. Just as climate change is predicted to impact people and nature, measures to reduce GHG emissions can also impact people and nature if they are not designed well. We will not succeed in meeting our climate mitigation and adaptation goals if measures to reduce our GHG footprint drive businesses out of Oregon.

Energy Innovation (2015) cautions that there are many more examples of ineffective GHG emissions reduction policies than there are of good ones. For example, aggressive policy mandates with no consumer protection mechanisms can spike the cost of energy, whether electricity or transportation fuels. Today, Oregon ranks 43rd in the nation in total energy expenditures per capita. We have some of the most competitive energy prices in the country (U.S. Energy Information Administration 2015). Maintaining affordable energy is not only important to protecting rate payers, particularly low-income individuals, as described earlier, affordable energy is an economic development tool the State can use to recruit large industrial and manufacturing facilities and other businesses to Oregon.

In addition to reducing greenhouse gas emissions, Energy Innovation suggests that the best policies should save money, boost the economy, and preserve the environment. They identify a number of design principles that are important to achieving all of these desired outcomes.

Performance Standards

- Design standards to provide businesses with long-term certainty and a fair planning horizon.
- Build in continuous improvement.
- Set the desired outcomes and allow businesses to find the best way to achieve them.

Economic Signals

- Create a long-term goal and provide business certainty

- When the cost of negative externalities for a technology is known, set taxes or subsidies at that price and let the market achieve the outcome.
- When the desired performance outcome is known, use price-finding mechanisms to achieve the outcome.
- Streamline processes to accelerate adoption of clean energy technologies.
- Reward production, not investment, for clean energy technologies.
- Capture 100 percent of the market and go upstream when possible.
- Ensure that economic incentives are liquid and minimize unnecessary transaction costs.

Support for Research and Development

- Create long-term commitments to research.
- Use peer review to help set research priorities.
- Set milestones to identify underperforming projects early and redirect funding.
- Concentrate research and development by type or subject to build critical mass, reduce coordination challenges, facilitate knowledge sharing, and avoid duplication of work.
- Make high-quality public sector facilities and expertise available to private firms.
- Protect intellectual property without stymying innovation.
- Ensure that companies have access to high-level science, technology, engineering, and math talent.

These principles—along with the importance of the manufacturing sector in Oregon's economy, the disproportionate impact GHG emissions reduction measures can have on low-income Oregonians, and the added burden remote, rural communities face due to longer travel distances—should all be taken into account in deciding how the strategies and measures we recommend are designed and implemented.

CONCLUSIONS

The Risky Business Project (2014) identified the substantial and diverse economic risks climate change poses to businesses and communities. Our task force took these risks seriously.

As we reflect on our task force discussions, three key take-aways stand out:

- It is possible to grow the value of the goods and services we produce while reducing GHG emissions. Oregon's GDP and GHG emissions have been largely "decoupled." Over the past two decades, Oregon businesses have proven this by growing the value of the goods and services they produce by almost 80 percent while helping to reduce total GHG emissions by approximately 12 percent.
- Well-designed public policies and investments have an important role to play in supporting business efforts to reduce GHG emissions and innovate; they can also provide economic benefits. We learned of many examples of the positive effects GHG emissions reduction measures can have on the economy.
- Oregon needs to strengthen its approach to addressing emissions and climate adaptation. Oregon will not meet our GHG emissions reduction goals without additional sector-specific and economy-wide actions. On our current path, the state's forecast indicates that we will exceed Oregon's 2020 GHG emissions reduction goal by nearly 11 MMTCO₂e or 22 percent, and far exceed the state's 2050 goal. Climate policy needs more attention and better coordination at the state level. All relevant agencies need statutory direction on their roles and expected contributions to meeting the state's climate goals.

The strategies and measures we selected will significantly reduce GHG emissions in Oregon. If done well, they will also improve the resilience of our economy, create jobs, and protect and enhance our natural environment. The business community can, and should, play a vital role in the design and implementation of the strategies and measures we identified to ensure that we achieve all of these goals critical to Oregon's future.

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THE WALL STREET JOURNAL.

The Myth of the Climate Change '97%'

What is the origin of the false belief—constantly repeated—that almost all scientists agree about global warming?

By

Joseph Bast And Roy Spencer

May 26, 2014 7:13 p.m. ET

Last week Secretary of State John Kerry warned graduating students at Boston College of the "crippling consequences" of climate change. "Ninety-seven percent of the world's scientists," he added, "tell us this is urgent."

Where did Mr. Kerry get the 97% figure? Perhaps from his boss, President Obama, who tweeted on May 16 that "Ninety-seven percent of scientists agree: #climate change is real, man-made and dangerous." Or maybe from NASA, which posted (in more measured language) on its [website](#), "Ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities."

Yet the assertion that 97% of scientists believe that climate change is a man-made, urgent problem is a fiction. The so-called consensus comes from a handful of surveys and abstract-counting exercises that have been contradicted by more reliable research.

One frequently cited source for the consensus is a 2004 opinion [essay](#) published in *Science* magazine by Naomi Oreskes, a science historian now at Harvard. She claimed to have examined abstracts of 928 articles published in scientific journals between 1993 and 2003, and found that 75% supported the view that human activities are responsible for most of the observed warming over the previous 50 years while none directly dissented.

Ms. Oreskes's definition of consensus covered "man-made" but left out "dangerous"—and scores of articles by prominent scientists such as Richard Lindzen, John Christy, Sherwood Idso and Patrick Michaels, who question the consensus, were excluded. The methodology is also flawed.

A study published earlier this year in Nature noted that abstracts of academic papers often contain claims that aren't substantiated in the papers.

Another widely cited source for the consensus view is a 2009 article in "Eos, Transactions American Geophysical Union" by Maggie Kendall Zimmerman, a student at the University of Illinois, and her master's thesis adviser Peter Doran. It reported the results of a two-question online survey of selected scientists. Mr. Doran and Ms. Zimmerman claimed "97 percent of climate scientists agree" that global temperatures have risen and that humans are a significant contributing factor.

The survey's questions don't reveal much of interest. Most scientists who are skeptical of catastrophic global warming nevertheless would answer "yes" to both questions. The survey was silent on whether the human impact is large enough to constitute a problem. Nor did it include solar scientists, space scientists, cosmologists, physicists, meteorologists or astronomers, who are the scientists most likely to be aware of natural causes of climate change.

The "97 percent" figure in the Zimmerman/Doran survey represents the views of only 79 respondents who listed climate science as an area of expertise and said they published more than half of their recent peer-reviewed papers on climate change. Seventy-nine scientists—of the 3,146 who responded to the survey—does not a consensus make.

In 2010, William R. Love Anderegg, then a student at Stanford University, used Google Scholar to identify the views of the most prolific writers on climate change. His findings were published in Proceedings of the National Academies of Sciences. Mr. Love Anderegg found that 97% to 98% of the 200 most prolific writers on climate change believe "anthropogenic greenhouse gases have been responsible for 'most' of the 'unequivocal' warming." There was no mention of how dangerous this climate change might be; and, of course, 200 researchers out of the thousands who have contributed to the climate science debate is not evidence of consensus.

In 2013, John Cook, an Australia-based blogger, and some of his friends reviewed abstracts of peer-reviewed papers published from 1991 to 2011. Mr. Cook reported that 97% of those who stated a position explicitly or implicitly suggest that human activity is responsible for some warming. His findings were published in Environmental Research Letters.

Mr. Cook's work was quickly debunked. In Science and Education in August 2013, for example, David R. Legates (a professor of geography at the University of Delaware and former director of its Center for Climatic Research) and three coauthors reviewed the same papers as did Mr. Cook and found "only 41 papers—0.3 percent of all 11,944 abstracts or 1.0 percent of the 4,014 expressing an opinion, and not 97.1 percent—had been found to endorse" the claim that human activity is causing most of the current warming. Elsewhere, climate scientists including Craig Idso, Nicola Scafetta, Nir J. Shaviv and Nils- Axel Morner, whose research questions the alleged consensus, protested that Mr. Cook ignored or misrepresented their work.

Rigorous international surveys conducted by German scientists Dennis Bray and Hans von Storch—most recently published in Environmental Science & Policy in 2010—have found that most climate scientists disagree with the consensus on key issues such as the reliability of climate data and computer models. They do not believe that climate processes such as cloud formation and precipitation are sufficiently understood to predict future climate change.

Surveys of meteorologists repeatedly find a majority oppose the alleged consensus. Only 39.5% of 1,854 American Meteorological Society members who responded to a survey in 2012 said man-made global warming is dangerous.

Finally, the U.N.'s Intergovernmental Panel on Climate Change—which claims to speak for more than 2,500 scientists—is probably the most frequently cited source for the consensus. Its latest report claims that "human interference with the climate system is occurring, and climate change poses risks for human and natural systems." Yet relatively few have either written on or reviewed research having to do with the key question: How much of the temperature increase and other climate changes observed in the 20th century was caused by man-made greenhouse-gas emissions? The IPCC lists only 41 authors and editors of the relevant chapter of the Fifth Assessment Report addressing "anthropogenic and natural radiative forcing."

Of the various petitions on global warming circulated for signatures by scientists, the one by the Petition Project, a group of physicists and physical chemists based in La Jolla, Calif., has by far the most signatures—more than 31,000 (more than 9,000 with a Ph.D.). It was most recently published in 2009, and most signers were added or reaffirmed since 2007. The petition states that "there is no convincing scientific evidence that human release of . . . carbon dioxide, methane, or

other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate."

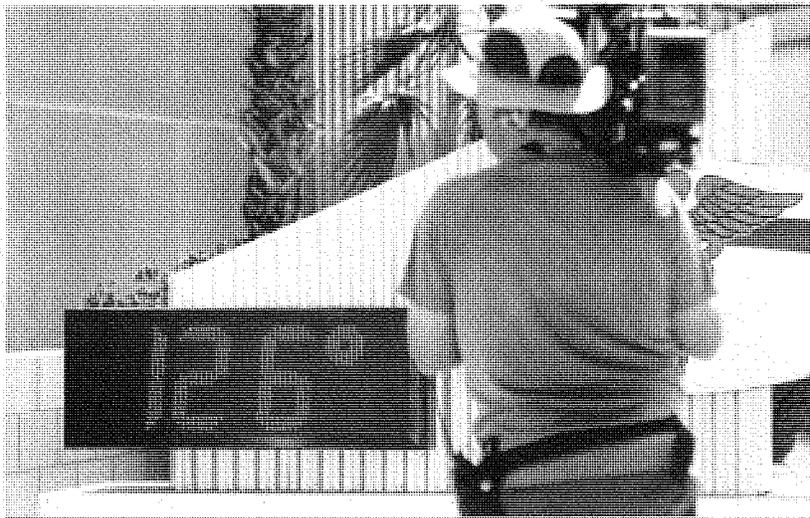
We could go on, but the larger point is plain. There is no basis for the claim that 97% of scientists believe that man-made climate change is a dangerous problem.

Mr. Bast is president of the Heartland Institute. Dr. Spencer is a principal research scientist for the University of Alabama in Huntsville and the U.S. Science Team Leader for the Advanced Microwave Scanning Radiometer on NASA's Aqua satellite.

THE WALL STREET JOURNAL

Keeping Cool About Hot Temperatures

Last year was warmer by 0.04 Celsius, but it was also an El Niño year.



Updated Jan. 19, 2017 8:21 p.m. ET

414 COMMENTS

By now you've seen the headline: 2016 was the hottest year on record. The news has been paired with predictions of civilization's imminent demise. But a closer look at the evidence reveals that the political heat is overwrought—and there's still no reason to re-engineer the global economy to mitigate small climate fluctuations.

The National Oceanic and Atmospheric Administration (NOAA) announced this week that last year was the warmest in the agency's 137-year series, and that 2016 broke the previous record

for the third consecutive year. This sounds alarming, until you read that 2016 edged out 2015 by a mere 0.04 degrees Celsius. That's a fraction of the margin of error. Atmospheric data from satellites detected similarly small warming over previous years. In other words, no one really knows if last year was a record.

Here's what we do know: 2015 and 2016 were major years for El Niño, a Pacific trade winds phenomenon known to produce temperature spikes. The Cato Institute's Patrick Michaels has detailed in [these pages](#) how in 1998, another big El Niño year, average surface temperatures increased about a quarter-degree Fahrenheit and then dropped in the following years. That is similar to the increase in 2015—and by the end of 2016 temperatures were falling back toward 2014 levels. Even NOAA admits El Niño's role.

The underreported news here is that the warming is not nearly as great as the climate-change computer models have predicted. As climatologist Judith Curry testified to Congress in 2014, U.N. Intergovernmental Panel on Climate Change simulations forecast surface temperatures to increase on average 0.2 degrees Celsius per decade in the early 21st century. The warming over the first 15 years was closer to 0.05 degrees Celsius. The models also can't explain why more than 40% of the temperature increase since 1900 happened between 1910 and 1945, which accounts for only 10% of the increase in carbon emissions.

These nuances are important because phrases such as "hottest year ever" are waved around as a pretext for political action that usually involves giving more control over the economy to governments. This is inevitably sold as urgently required to save the planet.

But even these regulations, taxes and subsidies would do little to reverse global temperature trends, though they could reduce the economic growth and wealth creation needed to cope with the consequences of higher temperatures. That is true of all President Obama's ministrations—from the Clean Power Plan to the Paris climate accord to subsidies for Al Gore's green-energy portfolio.

The most inconvenient truth during the Obama years has been that the biggest cause of lower U.S. CO₂ emissions has been the energy shift to natural gas from coal. Yet the climate-change lobby opposes fracking.

The Earth's surface has warmed over the last century by close to a degree Celsius, and the trend bears watching. But the additional questions to consider are about future magnitudes and impact, and what if any policies would make a difference without doing serious economic harm. The best insurance against the risks of climate change is economic growth and innovation—more efficient batteries, for example.

But adding to human knowledge on climate requires a thorough airing and debate over the evidence. That won't happen as long as alarmists continue to try to shut down debate by spinning doomsday tales about sizzling temperatures.

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March 30, 2017

The Honorable Lamar Smith
Chairman
Committee on Science, Space & Techonology
U.S. House of Representatives
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Smith:

I was advised that yesterday Congressman Beyer (D-VA) submitted to the record of a hearing on climate science two letters purporting to state that I did not have the permission of the U.S. Environmental Protection Agency to act as an attorney in the matter of ATI v. Rector and Visitors of the University of Virginia, a case seeking copies of emails from a former professor at that university.

In fact, I did have such permission, and I wish to correct and amplify the record of your hearing in that regard. As such, I ask that you submit to the record this letter and the attached affidavit that makes clear why the letters submitted to the record by Congressman Beyer are misleading.

Sincerely,

cc: Congressman Don Beyer

VIRGINIA:

IN THE CIRCUIT COURT OF PRINCE WILLIAM COUNTY

**THE AMERICAN TRADITION
INSTITUTE, and
THE HONORABLE DELEGATE
ROBERT MARSHALL**

Petitioners,

v.

**RECTOR AND VISITORS OF THE
UNIVERSITY OF VIRGINIA,**

Respondent.

Civil Docket No. CL 11-3236

Affidavit of David W. Schnare

AFFIDAVIT OF DAVID W. SCHNARE

On this day, David W. Schnare personally appeared before me, a certified Notary Public in and for the Commonwealth of Virginia, and after first being duly sworn to tell the truth, testified as follows:

1. My name is David W. Schnare. I am licensed to practice law in the Commonwealth of Virginia (VA Bar. No. 44522) and am subject to the Virginia Rules of Professional Conduct established by the Supreme Court of the Commonwealth of Virginia. I am also a member of the U.S. Courts of Appeal for the Second and Fourth Circuits and the Supreme Court of the United States.

2. I am the Director of the Environmental Law Center at American Tradition Institute (ATI), Director of the Center for Environmental Stewardship at the Thomas Jefferson Institute for Public Policy and Director of the nascent George Mason Environmental Law Clinic. I am an appointee to the Chesapeake Bay Exceptions Review Commission of Fairfax County, the

largest urban county in the nation, and Chairman of the Environmental and Land Use Committee of the Occoquan Watershed Coalition, an organization of 143 homeowners associations in western Fairfax County, Virginia.

3. ATI has no in-house counsel and uses Hackstaff Law Group of Denver, Colorado, when it needs corporate legal advice.

4. In the recent past, I have been CEO of Schnare and Associates, Inc., a professional corporation providing legal representation, legal and policy analysis.

5. I retired from 37 years of federal service to this nation on September 30, 2011. I gave 33 years of service within the U.S. Environmental Protection Agency (EPA).

6. My professional affiliations are public knowledge and have been available on the internet for many years. *See, e.g.,*

http://epw.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=23a539ea-802a-23ad-45fd-606dcd273a3a&Witness_ID=10fdc301-084b-4845-af15-c0cfd2b4493, first published Sept. 2007, *see*

http://web.archive.org/web/20070926230854/http://epw.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=23a539ea-802a-23ad-45fd-606dcd273a3a&Witness_ID=10fdc301-084b-4845-af15-c0cfd2b4493;

<http://www.epa.gov/compliance/resources/cases/civil/caa/aleric.html>, published Aug. 2009.

<http://www.owccoalition.org/owcbios.htm>, first published Mar. 2001, *see*,
<http://web.archive.org/web/20010303030914/http://www.owccoalition.org/owcbios.htm>;

http://www.thomasjeffersoninst.org/staff_scholars.php, first published Nov. 2010) *see*,
http://web.archive.org/web/20101108001119/http://www.thomasjeffersoninst.org/staff_scholars.php (November 2010);

<http://thehardlook.typepad.com/about.html>, first published July 2008, *see*,
<http://web.archive.org/web/20080724005251/http://thehardlook.typepad.com/about.html>;

7. Throughout my federal career, I have actively contributed *pro bono* services to non-federal organizations (*see* Exhibit 3), routinely specifying an activity is not associated with EPA, as required under federal and EPA ethics regulations. *See, e.g.,* Exhibit 2, note 1, which states:

Dr. Schnare is the Institute's Senior Fellow for Energy and the Environment. His position with the Institute is pro bono. He has been employed by the U.S. Environmental Protection Agency for 30 years and currently serves as a Senior Counsel in the Office of Civil Enforcement prosecuting violations of the nation's Clean Air Act. This testimony reflects the views of the author and does not necessarily reflect the position of the U.S. EPA or the Thomas Jefferson Institute.

And see, the standard bio I provide conveners for speeches:

David W. Schnare, Esq. Ph.D. Dr. Schnare is a senior attorney with the U.S. Environmental Protection Agency's Office of Enforcement and Compliance Assurance and President of Schnare & Associates, an administrative and environmental law appellate practice. He has served on the staff of the Senate Appropriates Committee and as the nation's Senior Regulatory Economist with the U.S. Office of Advocacy for Small Business. He holds the position of Director of the Center for Environmental Stewardship at the Thomas Jefferson Institute. HIS REMARKS TODAY ARE HIS OWN AND DO NOT REPRESENT ANY ORGANIZATION WITH WHOM HE IS OTHERWISE AFFILIATED.

8. On May 24, 2011, outside a courtroom in Prince William County Circuit Court, during casual introductory conversation between me and Richard Kast, counsel representing the University of Virginia (UVA), Mr. Kast inquired as to my professional background. To the best of my memory I stated, "I have worked for the U.S. EPA for many years and I'm here today doing *pro bono* public interest law." This was accurate and not misleading. This statement follows a long-standing practice of federal employees to minimize their federal responsibilities when acting outside a federal capacity. We do this to ensure there is no confusion as to whom we represent. This was a very brief, informal inter-personal conversation and did not take the form of any formal exchange as to potential conflicts of interest or other formalist representation. At no time did I state or imply that I was "formerly" with EPA. Mr. Kast did not indicate he took this to mean I had departed EPA, such as by asking me when I left the Agency, if I left the Agency, or other follow-up. Had Mr. Kast asked whether or when I separated from EPA, I would have informed him of my employment status at EPA and my authority to engage in outside activity

under the ethics rules, something I have done countless times during my 33 years with EPA. Further, this is the first allegation in 33 years that my standard reply has been characterized as misleading.

9. In my interaction with Mr. Kast, I closely followed the federal rules with regard to stating my representations, to wit:

5 C.F.R. 2635.807(b) Reference to official position. An employee who is engaged in teaching, speaking or writing as outside employment or as an outside activity shall not use or permit the use of his official title or position to identify him in connection with his teaching, speaking or writing activity or to promote any book, seminar, course, program or similar undertaking

10. My *pro bono* litigation activities began in 2000 and have continued ever since. The first such representation is documented at *Jessup v. American Kennel Club, Inc.*, 210 F.3d 111 (2d Cir. N.Y. 2000).

11. To pursue *pro bono* and other outside activities, I have routinely filed outside employment notices as required under federal and EPA ethics rules. *See, e.g.*, Exhibit 9, a 2008 filing to present a paper, and Exhibit 10, the 2010 filing to act as *pro bono* Director of the ATI Environmental Law Center.

12. The November 16, 2010, ethics filing was made contemporaneous with the transition of the Western Traditions Institute into the American Tradition Institute and was made the day following my statement of intent to the ATI Board to serve as the Director of the ATI Environmental Law Center, subject to filing of the ethics memoranda. Exhibit 5 is the metadata associated with that memorandum, showing the memo was created and last edited on November 16, 2010, the same day it was signed and hand-carried to the initial addressee, Greg Fried. This memorandum was not “purportedly” prepared on November 16th, the clear evidence shows it was in fact prepared on that date.

13. Recently, on November 18, 2011, I spoke with Phil Brooks, Director of EPA's Air Enforcement Division and Mr. Fried's immediate supervisor regarding his investigation on the handling of the memorandum. Mr. Brooks informed me that his investigation revealed that Mr. Fried had received the memorandum on the date it had been prepared, but failed to forward it to Mr. Kushner, the Deputy Ethics Officer.¹ Until Mr. Brooks contacted me as part of his investigative, I was not aware Mr. Fried had failed to carry out his duties in this regard. I was aware, however, that Mr. Fried had the memorandum as it was hand-delivered to him on the day it was created and we spent about half an hour discussing the nature of the outside activity. Neither at that time nor at any time thereafter did Mr. Fried voice concern to me about the contents of the memorandum

14. While Mr. Kushner, the Deputy Ethics Officer may not have received a copy of the memorandum, he had constructive knowledge of its existence and clear knowledge of the outside activity as it was listed on the 2011 OMP Form 450, and Ms. Jeanne Duross, who manages ethics matters for Mr. Kushner, discussed the filing with me in August or September 2011. See, Exhibit 4, documenting Ms. Duross' February 7, 2011 receipt of the form and the clear notice of my outside activities with ATL.

15. In his affidavit, Richard Kast misrepresented EPA's October 6, 2011, FOIA response to Peter Fontaine regarding documents associated with my outside employment. Mr. Fontaine, like me, is a former EPA enforcement attorney.² He is also a personal friend of Ms.

¹ Mr. Brooks related to me that when asked about why he had not forwarded the memorandum, Mr. Fried replied, "I fucked up." EPA's FOIA response to Mr. Fontaine now makes every effort to shield Mr. Fried from public criticism for his failure. I have long known Mr. Fried. He is a relatively inexperienced supervisor, but is intelligent, resourceful and highly motivated. He works long hours to do a job that is, by any measure, overwhelming to a new supervisor. I believe Mr. Fried simply did not understand the significance of the memorandum, had never received one before, and has learned a hard lesson that I personally hope does not limit his advancement at EPA.

² Mr. Fontaine and I share more than history as enforcement attorneys working in the Air Enforcement Division. Both Mr. Fontaine and I received the EPA's Award for Excellence, an award given annually to one lawyer in the

Justina Fugh, Senior Counsel for Ethics, the EPA official who signed the response letter. In the letter (Kast Aff. Exhibit 26), Ms. Fugh states that my responsibility as follows:

“In order to engage in outside activity that involves the practice of a profession or that deals in significant part with any ongoing Agency program, policy or operation, Mr. Schnare was required to seek prior approval from his Deputy Ethics Official. 5 C.P.R. § 2634.801 and 5 C.P.R. §640 1.1 03.

Ms. Fugh then indicates they have no record of Mr. Kushner receiving or approving the request. The letter is notably silent on the fact that I did what Ms. Fugh indicated I was required to do. It is also silent on Mr. Fried’s failure to forward my memorandum to Mr. Kushner or the fact that Mr. Kushner had constructive notice of the memorandum and actual notice of the activity.

16. On November 18, 2011, I contacted Ms. Fugh to inquire as to my duties as a former EPA employee to correct the FOIA response in order to deal with the omissions and her intimation that the letter was no more than “purportedly prepared”. At a point when she was aware that the metadata for the letter, all still in the custody of EPA, as well as the investigation by Mr. Brooks and the statements by Mr. Fried as to his failures, indicate her adverb was inaccurate, she offered the following response to my query as to my ethical duties to correct the letter. She said, “You have none, and neither do I.” She then abruptly ended the telephone call. I note that, in my experience and as reported by others, this abruptness is normal behavior for Ms. Fugh, and thus dismiss it. However, I also note for the record her admission during the telephone call of Agency management error, defensiveness over this inaccuracy and unwillingness to acknowledge an ethical duty to go on the record as to having not fully and honestly represented to her friend Mr. Fontaine the full facts of the matter.

120-lawyer Office of Enforcement and Compliance Assurance, he in 1994 and me in 1996. I do not know if he was ever given the Agency’s highest award (Gold Medal). I have been awarded five EPA Gold Medals and another five Bronze Medals.

17. Ms. Jeanne Duross indicated to me on September 29, 2011, that Mr. Fontaine and Ms. Fugh had discussed this matter prior to his submission of his FOIA request. During that meeting, Ms. Duross also stated that my approvals for my law firm activities (Schnare and Associates) and approvals for the Thomas Jefferson Institute for Public Policy were sufficient to cover any activities in the instant matter.

18. The EPA Fugh letter also fails to indicate that no federal employee is barred from representing himself at law, even against the agency for which they work. *See*, 5 C.F.R. § 3801.106(b)(i). "Outside Employment." In light of this rule, the approval for outside employment to represent myself in the instant matter cannot be denied, mooted whether it was ever approved.

19. I am a Petitioner in this matter and represent my own interests, interests identical to those of the other petitioners, and thus have no conflict of interest and have a legal right to an approval of my application for outside employment which would have been granted for the instant case had the memorandum been forwarded to Mr. Kushner.

20. I should also note that this case is not the only one being prosecuted by ATI. ATI is in federal district court in Colorado on a constitutional issue and in the District of Columbia district court on a matter involving a federal FOIA. Because I am not a plaintiff in either matter, I am not entered in either case, a practice exactly as stated in the outside employment memorandum.

21. I note that it is not possible for me to have a conflict of interest in this case as nothing now before this Court in the above titled matter has any relationship to any issue or matter before the U.S. EPA, much less any particular matter on which I worked while an EPA

attorney. This is even more particularly true in light of my recusal from working on the climate-related endangerment finding at EPA, a recusal made before creation of ATI. *See*, Exhibit 6.

22. I reiterate my statement in my outside employment memo that I have performed my duties outside of normal duty hours. Thus, they were either performed prior to commencement of my work day, after the work day, during lunch or break periods or while on leave. Every email sent to by me to Mr. Kast was sent through a non-governmental email system allowed by EPA to be used by its employees and not sent through the EPA email system.

23. I have made no misleading statement to Richard Kast about my employment status with EPA and made no false statements, demonstrable or otherwise, about conflicts of interest with EPA while being employed by EPA.

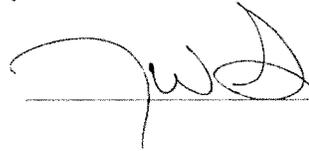
24. ATI is not a competitor of the University of Virginia (UVA), Pennsylvania State University (PSU) or any of their faculty associated with global warming and climate change. ATI does not offer products or services in competition with UVA or PSU. ATI is not a competitor for research grants, professional publications, scientific research or any other normal element of a UVA or PSU faculty member or the universities at large. ATI does not make company decisions that affect contracts, marketing, employment, pricing, product design, or any decisions that reflect similar or corresponding activities by UVA or PSU.

25. I do not participate in ATI decision-making with regard to contracts, marketing, employment, pricing, product design, or research grant proposals of the kind similar to those decisions made by UVA or PSU. Nor do I participate in ATI decision-making with regard to contracts, marketing, employment, pricing, or product design. My function with each organization involves legal and policy analysis, case selection and litigation.

26. I have agreed to comply with the Protective Order issued by the Court in this matter, have signed an agreement to that effect and have previously reiterated my commitment to honor this duty, both in line with the Court's Order and under the Virginia Rules of Professional Conduct. I reiterate this commitment again today in this sworn affidavit.


David W. Schnare

Seen to and subscribed before me on this 24th day of October, 2011.



My commission expires: 1/31/2013

Lindsey William Smith
Notary Public
Commonwealth of Virginia
Registration #7300833
My Comm. Exp. 1-31-2013

DOCUMENT SUBMITTED BY REPRESENTATIVE PAUL TONKO

Joe Walker

To: Global Climate Science Team
Cc: Michelle Ross; Susan Moya
Subject: Draft Global Climate Science Communications Plan

As promised, attached is the draft Global Climate Science Communications Plan that we developed during our workshop last Friday. Thanks especially to those of you who participated in the workshop, and in particular to John Adams for his very helpful thoughts following up our meeting, and Alan Caudill for turning around the notes from our workshop so quickly.

Please review the plan and get back to me with your comments as soon as possible.

As those of you who were at the workshop know, we have scheduled a follow-up team meeting to review the plan in person on Friday, April 17, from 1 to 3 p.m. at the API headquarters. After that, we hope to have a "plan champion" help us move it forward to potential funding sources, perhaps starting with the global climate "Coordinating Council." That will be an item for discussion on April 17.

Again, thanks for your hard work on this project. Please e-mail, call or fax me with your comments. Thanks.

Regards,
Joe Walker

April 3, 1998

Global Climate Science Communications

Action Plan

Situation Analysis

In December 1997, the Clinton Administration agreed in Kyoto, Japan, to a treaty to reduce greenhouse gas emissions to prevent what it purports to be changes in the global climate caused by the continuing release of such emissions. The so-called greenhouse gases have many sources. For example, water vapor is a greenhouse gas. But the Clinton Administration's action, if eventually approved by the U.S. Senate, will mainly affect emissions from fossil fuel (gasoline, coal, natural gas, etc.) combustion.

As the climate change debate has evolved, those who oppose action have argued mainly that signing such a treaty will place the U.S. at a competitive disadvantage with most other nations, and will be extremely expensive to implement. Much of the cost will be borne by American consumers who will pay higher prices for most energy and transportation.

The climate change theory being advanced by the treaty supporters is based primarily on forecasting models with a very high degree of uncertainty. In fact, it not known for sure whether (a) climate change actually is occurring, or (b) if it is, whether humans really have any influence on it.

Despite these weaknesses in scientific understanding, those who oppose the treaty have done little to build a case against precipitous action on climate change based on the scientific uncertainty. As a result, the Clinton Administration and environmental groups essentially have had the field to themselves. They have conducted an effective public relations program to convince the American public that the climate is changing, we humans are at fault, and we must do something about it before calamity strikes.

The environmental groups know they have been successful. Commenting after the Kyoto negotiations about recent media coverage of climate change, Tom Wathen, executive vice president of the National Environmental Trust, wrote:

"...As important as the extent of the coverage was the tone and tenor of it. In a change from just six months ago, most media stories no longer presented global warming as just a theory over which reasonable scientists could differ. Most stories described predictions of global warming as the position of the overwhelming number of mainstream scientists. That the environmental community had, to a great extent, settled the scientific issue with the U.S. media is the other great success that began perhaps several months earlier but became apparent during Kyoto."

Because the science underpinning the global climate change theory has not been challenged effectively in the media or through other vehicles reaching the American public, there is widespread ignorance, which works in favor of the Kyoto treaty and against the best interests of the United States. Indeed, the public has been highly receptive to the Clinton Administration's plans. There has been little, if any, public resistance or pressure applied to Congress to reject the treaty, except by those "inside the Beltway" with vested interests.

Moreover, from the political viewpoint, it is difficult for the United States to oppose the treaty solely on economic grounds, valid as the economic issues are. It makes it too easy for others to portray the United States as putting preservation of its own lifestyle above the greater concerns of mankind. This argument, in turn, forces our negotiators to make concessions that have not been well thought through, and in the end may do far more harm than good. This is the process that unfolded at Kyoto, and is very likely to be repeated in Buenos Aires in November 1998.

The advocates of global warming have been successful on the basis of skillfully misrepresenting the science and the extent of agreement on the science, while industry and its partners ceded the science and fought on the economic issues. Yet if we can show that science does not support the Kyoto treaty — which most true climate scientists believe to be the case — this puts the United States in a stronger moral position and frees its negotiators from the need to make concessions as a defense against perceived selfish economic concerns.

Upon this tableau, the Global Climate Science Communications Team (GCSCCT) developed an action plan to inform the American public that science does not support the precipitous actions Kyoto would dictate, thereby providing a climate for the right policy decisions to be made. The team considered results from a new public opinion survey in developing the plan.

Charlton Research's survey of 1,100 "informed Americans" suggests that while Americans currently perceive climate change to be a great threat, public opinion is open to change on climate science. When informed that "some scientists believe there is not enough evidence to suggest that [what is called global climate change] is a long-term change due to human behavior and activities," 58 percent of those surveyed said they were more likely to oppose the Kyoto treaty. Moreover, half the respondents harbored doubts about climate science.

GCSCCT members who contributed to the development of the plan are A. John Adams, John Adams Associates; Candace Crandall, Science and Environmental Policy Project; David Rothbard, Committee For A Constructive Tomorrow; Jeffrey Salmon, The Marshall Institute; Lee Garrigan, Environmental Issues Council; Lynn Bouchey and Myron Ebell, Frontiers of Freedom; Peter Cleary, Americans for Tax Reform; Randy Randol, Exxon Corp.; Robert Gehri, The Southern Company; Sharon Kneiss, Chevron Corp; Steve Milloy, The Advancement of Sound Science Coalition; and Joseph Walker, American Petroleum Institute.

The action plan is detailed on the following pages.

Global Climate Science Communications

Action Plan

Project Goal

A majority of the American public including industry leadership, recognizes that significant uncertainties exist in climate science, and therefore raises questions among those (e.g. Congress) who chart the future U.S. course on global climate change.

Progress will be measured toward the goal. A measurement of the public's perspective on climate science will be taken before the plan is launched, and the same measurement will be taken at one or more as-yet-to-be-determined intervals as the plan is implemented.

Victory Will Be Achieved When

- Average citizens "understand" (recognize) uncertainties in climate science; recognition of uncertainties becomes part of the "conventional wisdom"
- Media "understands" (recognizes) uncertainties in climate science.
- Media coverage reflects balance on climate science and recognition of the validity of viewpoints that challenge the current "conventional wisdom"
- Industry senior leadership understands uncertainties in climate science, making them stronger ambassadors to those who shape climate policy
- Those promoting the Kyoto treaty on the basis of extant science appear to be out of touch with reality.

Current Reality

Unless "climate change" becomes a non-issue, meaning that the Kyoto proposal is defeated and there are no further initiatives to thwart the threat of climate change, there may be no moment when we can declare victory for our efforts. It will be necessary to establish measurements for the science effort to track progress toward achieving the goal and strategic success.

Strategies and Tactics

- I. **National Media Relations Program:** Develop and implement a national media relations program to inform the media about uncertainties in climate science; to generate national, regional and local media coverage on the scientific uncertainties, and thereby educate and inform the public, stimulating them to raise questions with policy makers.

Tactics: These tactics will be undertaken between now and the next climate meeting in Buenos Aires, Argentina, in November 1998, and will be continued thereafter, as appropriate. Activities will be launched as soon as the plan is approved, funding obtained, and the necessary resources (e.g., public relations counsel) arranged and deployed. In all cases, tactical implementation will be fully integrated with other elements of this action plan, most especially Strategy II (National Climate Science Data Center).

- Identify, recruit and train a team of five independent scientists to participate in media outreach. These will be individuals who do not have a long history of visibility and/or participation in the climate change debate. Rather, this team will consist of new faces who will add their voices to those recognized scientists who already are vocal.
- Develop a global climate science information kit for media including peer-reviewed papers that undercut the "conventional wisdom" on climate science. This kit also will include understandable communications, including simple fact sheets that present scientific uncertainties in language that the media and public can understand.
- Conduct briefings by media-trained scientists for science writers in the top 20 media markets, using the information kits. Distribute the information kits to daily newspapers nationwide with offer of scientists to brief reporters at each paper. Develop, disseminate radio news releases featuring scientists nationwide, and offer scientists to appear on radio talk shows across the country.
- Produce, distribute a steady stream of climate science information via facsimile and e-mail to science writers around the country.
- Produce, distribute via syndicate and directly to newspapers nationwide a steady stream of op-ed columns and letters to the editor authored by scientists.
- Convince one of the major news national TV journalists (e.g., John Stossel) to produce a report examining the scientific underpinnings of the Kyoto treaty.
- Organize, promote and conduct through grassroots organizations a series of campus/community workshops/debates on climate science in 10 most important states during the period mid-August through October, 1998.

- Consider advertising the scientific uncertainties in select markets to support national, regional and local (e.g., workshops/debates), as appropriate.

National Media Program Budget — \$600,000 plus paid advertising

- II. **Global Climate Science Information Source:** Develop and implement a program to inject credible science and scientific accountability into the global climate debate, thereby raising questions about and undercutting the "prevailing scientific wisdom." The strategy will have the added benefit of providing a platform for credible, constructive criticism of the opposition's position on the science.

Tactics: As with the National Media Relations Program, these activities will be undertaken between now and the next climate meeting in Buenos Aires, Argentina, in November 1998, and will continue thereafter. Initiatives will be launched as soon as the plan is approved, funding obtained, and the necessary resources arranged and deployed.

- Establish a Global Climate Science Data Center. The GCSDC will be established in Washington as a non-profit educational foundation with an advisory board of respected climate scientists. It will be staffed initially with professionals on loan from various companies and associations with a major interest in the climate issue. These executives will bring with them knowledge and experience in the following areas:
 - Overall history of climate research and the IPCC process;
 - Congressional relations and knowledge of where individual Senators stand on the climate issue;
 - Knowledge of key climate scientists and where they stand;
 - Ability to identify and recruit as many as 20 respected climate scientists to serve on the science advisory board;
 - Knowledge and expertise in media relations and with established relationships with science and energy writers, columnists and editorial writers;
 - Expertise in grassroots organization; and
 - Campaign organization and administration.

The GCSDC will be led by a dynamic senior executive with a major personal commitment to the goals of the campaign and easy access to business leaders at the CEO level. The Center will be run on a day-to-day basis by an executive director with responsibility for ensuring targets are met. The Center will be funded at a level that will permit it to succeed, including funding for research contracts that may be deemed appropriate to fill gaps in climate science (e.g., a complete scientific critique of the IPCC research and its conclusions).

- The GCSDC will become a one-stop resource on climate science for members of Congress, the media, industry and all others concerned. It will be in constant contact with the best climate scientists and ensure that their findings and views receive appropriate attention. It will provide them with the logistical and moral support they have been lacking. In short, it will be a sound scientific alternative to the IPCC. Its functions will include:
 - Providing as an easily accessible database (including a website) of all mainstream climate science information.
 - Identifying and establishing cooperative relationships with all major scientists whose research in this field supports our position.
 - Establishing cooperative relationships with other mainstream scientific organizations (e.g., meteorologists, geophysicists) to bring their perspectives to bear on the debate, as appropriate.
 - Developing opportunities to maximize the impact of scientific views consistent with ours with Congress, the media and other key audiences.
 - Monitoring and serving as an early warning system for scientific developments with the potential to impact on the climate science debate, pro and con.
 - Responding to claims from the scientific alarmists and media.
 - Providing grants for advocacy on climate science, as deemed appropriate.

Global Climate Science Data Center Budget - \$5,000,000 (spread over two years minimum)

- III. **National Direct Outreach and Education:** Develop and implement a direct outreach program to inform and educate members of Congress, state officials, industry leadership, and school teachers/students about uncertainties in climate science. This strategy will enable Congress, state officials and industry leaders will be able to raise such serious questions about the Kyoto treaty's scientific underpinnings that American policy-makers not only will refuse to endorse it, they will seek to prevent progress toward implementation at the Buenos Aires meeting in November or through other ways. Informing teachers/students about uncertainties in climate science will begin to erect a barrier against further efforts to impose Kyoto-like measures in the future.

Tactics: Informing and educating members of Congress, state officials and industry leaders will be undertaken as soon as the plan is approved, funding is obtained, and the necessary resources are arrayed and will continue through Buenos Aires and for the foreseeable future. The teachers/students outreach program will be developed and launched in early 1999. In all cases, tactical implementation will be fully integrated with other elements of this action plan.

- Develop and conduct through the Global Climate Science Data Center science briefings for Congress, governors, state legislators, and industry leaders by August 1998.
- Develop information kits on climate science targeted specifically at the needs of government officials and industry leaders, to be used in conjunction with and separately from the in-person briefings to further disseminate information on climate science uncertainties and thereby arm these influentials to raise serious questions on the science issue.

- Organize under the GCSDC a "Science Education Task Group" that will serve as the point of outreach to the National Science Teachers Association (NSTA) and other influential science education organizations. Work with NSTA to develop school materials that present a credible, balanced picture of climate science for use in classrooms nationwide.
- Distribute educational materials directly to schools and through grassroots organizations of climate science partners (companies, organizations that participate in this effort).

National Direct Outreach Program Budget — \$300,000

- IV. Funding/Fund Allocation: Develop and implement program to obtain funding, and to allocate funds to ensure that the program it is carried out effectively.

Tactics: This strategy will be implemented as soon as we have the go-ahead to proceed.

- Potential funding sources were identified as American Petroleum Institute (API) and its members; Business Round Table (BRT) and its members, Edison Electric Institute (EEI) and its members; Independent Petroleum Association of America (IPAA) and its members; and the National Mining Association (NMA) and its members.
- Potential fund allocators were identified as the American Legislative Exchange Council (ALEC), Committee For A Constructive Tomorrow (CFACT), Competitive Enterprise Institute, Frontiers of Freedom and The Marshall Institute.

Total Funds Required to Implement Program through November 1998 — \$2,000,000 (A significant portion of funding for the GCSDC will be deferred until 1999 and beyond)

Measurements

Various metrics will be used to track progress. These measurements will have to be determined in fleshing out the action plan and may include:

- Baseline public/government official opinion surveys and periodic follow-up surveys on the percentage of Americans and government officials who recognize significant uncertainties in climate science.
- Tracking the percent of media articles that raise questions about climate science.
- Number of Members of Congress exposed to our materials on climate science.
- Number of communications on climate science received by Members of Congress from their constituents.
- Number of radio talk show appearances by scientists questioning the "prevailing

- Number of school teachers/students reached with our information on climate science.
- Number of science writers briefed and who report upon climate science uncertainties.
- Total audience exposed to newspaper, radio, television coverage of science uncertainties.

DOCUMENT SUBMITTED BY REPRESENTATIVE DANA ROHRABACHER

Copy of document submitted by Rep. Rohrabacher was not tendered.

DOCUMENT SUBMITTED BY REPRESENTATIVE CLAY HIGGINS

Left Exposed

Michael E. Mann



Michael E. Mann is an atmospheric science professor at Penn State University, a climate catastrophe advocate, and a militant campaigner against scientists who disagree with him. He is most famous as the creator of the discredited and controversial "hockey stick graph," which has been discredited by statisticians for distorting past climate history and offering outlandish predictions of future carbon-dioxide-induced global warming.

Mann is the author of the books *Dire predictions: understanding global warming* (2008) and *The Hockey Stick and the Climate Wars: Dispatches from the Front Lines* (2012), which have been described as self-aggrandizing scare tomes. He is a member of the Council of Advisers of the Climate Accountability Institute, which held the Planning Workshop that guided the state attorneys general "AGs United for Clean Power" to prosecute climate skeptics.

Mann is also a direct collaborator with the RICO20 professors, who along with U.S. Sen. Sheldon Whitehouse (D-Rt), have called for prosecution of all climate skeptics. Mann's arrogant, intolerant and vengeful attitudes — as reflected in his writings and even his Twitter feed — have caused even colleagues to be wary of him, and spurred the targets of his attacks to redouble their efforts. In a June 2016 speech, Mann tried to convince the Democratic Party Platform drafting committee that Democrats must act urgently to enforce his alarmist agenda before the "right wing denial machine" distorts his message.

Background & History

Mann was born in 1965 and brought up in Amherst, Massachusetts, where his father was a professor of mathematics at the University of Massachusetts. At school he showed early interest in math, science, and computing. When he reached college age, Mann selected the University of California, Berkeley, where he took a double major, graduating with honors in 1989 with an A.B. in applied mathematics and physics. Mann then attended Yale University, intending to obtain a PhD in physics, and received both an MS and an MPhil in physics in 1991.

While still finishing his PhD research, Mann met University of Massachusetts climate science professor Raymond S. Bradley and began research in collaboration with him and seismologist Jeffrey Park, which was to lead him to the Hockey Stick and public notice. Mann was granted his PhD in geology and geophysics from Yale in 1998.

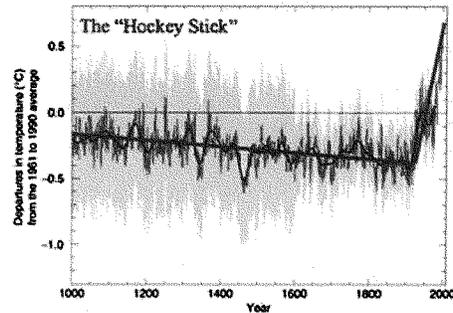
Mann is a Distinguished Professor of Atmospheric Science at Pennsylvania State University. As a professor at Penn State, Mann is known for encouraging his students to be policy advocates with an agenda, or as he puts it, to “see public participation as part of their roles as scientists.”

Mann’s many research grants, publications, invited lectures, and other experiences are completely listed in his *curriculum vitae*. Mann’s highly detailed 79 page Curriculum Vitae is posted here.

Mann’s Penn State salary and benefits are over \$200,000 annually with his income fattened by speeches he gives for up to \$10,000 according to reports, but he has not attracted a benefactor to support an Endowed Chair, unlike peers such as former Environmental Defense Fund climate scientist Michael Oppenheimer, who holds a multi-million-dollar endowed professorship at Princeton University.

Controversies

The Hockey Stick



Michael Mann’s discredited hockey stick graph

Mann’s career began as a minor new PhD co-investigator in the National Science Foundation research that produced 1999’s highly controversial “Hockey Stick graph” (Mann is ubiquitously and erroneously identified as the lead investigator, who was actually Robert Bradley of the University of Massachusetts.)

The NSF research grant was specifically biased to only seek evidence for man-made climate change — rather than investigate whether or how much mankind had caused climate change. The one-sided research purported to find a historical record beginning with low atmospheric temperatures in 1000 AD, and ending with a sudden increase in recent times to allegedly “unprecedented” levels. The blame went to human greenhouse gas emissions, reinforcing the already roiling dispute about man-made global warming.

By 2001 Mann had cemented his alarmist reputation as lead author of the chapter on Observed Climate Variability and Change in the Third Scientific Assessment Report of the United Nations’ Intergovernmental Panel on Climate Change (IPCC). The IPCC Report used his “hockey stick graph” as its logo and it became a symbol of the emerging controversy between climate change skeptics and believers.

Mann's Hockey Stick research was questioned by statistical analyst Steve McIntyre and environmental economist Ross McKittrick for minimizing or removing the Medieval Warm Period and the Little Ice Age from the historical record, among other peculiar data treatments. The challenge prompted wide publicity and a US congressional inquiry and report debunking Mann's findings.

In defense, Mann and several alarmist colleagues created their own vanity website, Real Climate, to attack their critics. This scientific confrontation brought Mann more government grants to find human causes for climate change, placing him in the spotlight of the developing debate on Anthropogenic Global Warming (AGW). His growing prominence gained him colleagues in the United Kingdom's Climate Research Unit (CRU) at the University of East Anglia, and elevated him into something of a celebrity with a notoriously short temper with intolerance for differing opinions.

Thin-skinned Autocrat

Mann's career has been characterized as one of abrasive relationships with colleagues as well as challengers. Marc Morano, creator of the Climate Depot website and the documentary film *Climate Hustle*, has researched and reported on Michael Mann for years. Morano said:

Mann is the embodiment of everything that is wrong with climate science today. He is a hardcore political activist, very thin skinned, does not take criticism well at all, and he surrounds himself within his own little world of supportive warmist activists. Even the scientists in Mann's "own little world" resented his knee-jerk reactions to criticism from other scientists, as made clear in this Climategate email from a colleague who sent it anonymously to a list of trusted scientists:

two people have a forthcoming 'Energy & Environment' paper that's being unveiled tomoro (monday) that -- in the words of one Cato / Marshall/ CEI type -- "will claim that Mann arbitrarily ignored paleo data within his own record and substituted other data for missing values that dramatically affected his results.

When his exact analysis is rerun with all the data and with no data substitutions, two very large warming spikes will appear that are greater than the 20th century.

Personally, I'd offer that this was known by most people who understand Mann's methodology: it can be quite sensitive to the input data in the early centuries. Anyway, there's going to be a lot of noise on this one, and knowing Mann's very thin skin I am afraid he will react strongly, unless he has learned (as I hope he has) from the past...."

Mann's demands that everyone obey his wishes received a blunt reply from British colleague Phil Jones of the Climate Research Unit (CRU) at the University of East Anglia:

From: Phil Jones <p.jones@uea.ac.uk>
 To: mann@snow.geo.umass.edu
 Subject: Straight to the Point
 Date: Thu, 06 May 1999 17:37:34 +0100
 Cc: k.briffa@uea.ac.uk,t.osborn@uea.ac.uk,mhughes@ltrr.arizona.edu, rb:

Mike,

Just back from two weeks away and from discussions with Keith and Tim and some emails you seem quite pissed off with us all in CRU. I am somewhat at a loss to understand why. It is clear from the emails that this relates to the emphasis placed on a few words/phrases in Keith/Tim's Science piece. These may not be fully resolved but the piece comes out tomorrow. I don't want to open more wounds but I might by the end of the email.

Critiques of Mann's work began to appear in peer reviewed journals, which prompted him to lead all-out attacks against not only the critical scientists, but also the journals, their peer panels and their editors to silence disagreement and eradicate disagreement with his preferred public policy.

Tactics included gaining control of science journals and libel lawsuits against scientific critics. Mann and colleagues from the IPCC science team became the featured players in the 2009 "ClimateGate" scandal over leaked emails that revealed their cunning tactics to destroy the careers and publications of perceived opponents.

Mann's Hockey Stick research was investigated by Penn State University, for which Mann was a valuable cash cow in federal grants, and by the National Science Foundation, which could count on Mann for politically correct research results. He was found to have done no technical wrong, beyond using sloppy word choices. These investigators turned a blind eye to his role in collaborating to damage or destroy skeptic publications and scientists, but the British government investigators found faults they deemed serious, including information that may have been deleted to avoid disclosure.

Affiliation with Climate Accountability Institute

As of July 2014, Mann appears as a member of the Board of Advisors of the Climate Accountability Institute (CAI) on the organization's website. His affiliation connects him directly with the organized efforts to prosecute climate skeptics via RICO statutes, which got its start with Naomi Oreskes, co-founder of CAI.

RICO, the Racketeering Influenced and Corrupt Organization, is a law designed to battle organized crime, but was later used in civil cases, particularly against tobacco companies that were subject to billion-dollar lawsuits to compensate for the health problems of their customers. Oreskes conflated tobacco with fossil fuels, seeking to enforce penalties sufficient to destroy the fossil fuel industry through prosecution of both producers and advocates, particularly climate skeptics.

Mann's affiliation with this effort indicates his dedication to prosecute "deniers." (The environmental left has chosen this term specifically to equate those skeptical of catastrophic man-caused global warming to Holocaust deniers. Mann refuses to use the term "skeptic.") Mann's allegiance to prosecution for skeptics is symbolized by his advisory status with the CAI, and his close ties to its allied group, the Union of Concerned Scientists.

Collusion with the RICO20

The RICO20 refers to 20 scientists — including professors from nine universities and scientists from two institutes — who signed a letter known as the RICO 20 letter, sent to the U.S. Attorney General and the President of the United States on September 1, 2015. It called for a federal criminal investigation into possible “racketeering” and collaboration among entities questioning the science backing the hypotheses of human-caused, catastrophic climate change.

The leader of the effort, George Mason University professor Jagadish Shukla, also operated a now-defunct and controversial nonprofit climate group, the Institute of Global Environment and Society, which was almost totally funded by millions in federal grants. Shukla said he got the idea to make a splash in academia by gathering many professors who would support Sen. Sheldon Whitehouse’s public call for prosecution of climate skeptics using RICO in an op-ed in the March 29, 2015 *Washington Post* titled “The Fossil-fuel Industry’s Campaign to Mislead the American People.”

Shukla’s recruitment of academics stalled when a result some feared — angry backlash from skeptics and the media — quickly appeared. Shukla and the scientists were reassured by Sen. Whitehouse, as discovered in emails of the conspiracy obtained by FOIA lawsuits. The scientists sought help in dealing with the blowback, and Michael Mann provided it. He introduced Shukla to two veteran activists — one from the Union of Concerned Scientists (UCS), and the other from ClimateNexus — requesting their help and guidance for the RICO20. Mann’s affiliation with the Climate Accountability Institute (CAI) linked him with UCS, which had helped form CAI and co-hosted the attack workshop in LaJolla, California in 2012. His cordial introduction of Shukla to his UCS friend is revealing:

From: Michael Mann <mmann01@comcast.net>
Date: Tuesday, September 29, 2015 11:48 AM
To: Aaron Huertas <ahuertas@ucsusa.org>, Philip Newell <pnewell@climatenexus.org>
Cc: Shukla <shukla@iges.org>
Subject: J Shukla

Hi Aaron, Phil,

Let me introduce, via this email, (Jagadish) Shukla, one of our most respected climate scientists (more info on Shukla here: <http://www.iges.org/people/shukla.html>).

As you may know, Shukla was recently involved in the effort to call fossil fuel interests accountable for their decades-long campaign of denial and disinformation via RICO.

As a result of this, Shukla is all-too predictable being attacked by the usual suspects (see threat below), and he could use some professional help.

I’m hoping one or both of you might have some suggestions and/or resources that you can bring to bear here,
 mike

Climategate Scandal

The Climategate scandal erupted on November 19, 2009, when a collection of email messages, data files and data processing programs were leaked from the Climatic Research Unit (CRU) at the University of East Anglia in the United Kingdom. The emails revealed scientific fraud and data manipulation by scientists bent on maintaining belief in the hypothesis of catastrophic man-caused global warming despite data revealing its flaws.

A person who calls himself "Mr. FOIA" is recognized as the insider who leaked the emails. On three occasions — in 2009, 2011, and 2013 — "Mr. FOIA" copied thousands of emails and computer files to various internet locations. Mann was the key U.S. player in the Climategate scandal, according to John Costella, who edited and annotated a 2010 report titled "The Climategate Emails." Costella wrote:

Mike Mann leapt from relative obscurity to international fame with his "hockey stick", a graph of global temperatures from 1000 AD to the present, which was the showpiece at the launching of the 2001 IPCC Third Assessment Report in Shanghai in January 2001. The hockey stick became a corporate logo for the IPCC, but because it rubbed out the Mediaeval Warm Period and the Little Ice Age from the historical record, it was subjected to a US congressional inquiry. Eventually it was shown that random data fed into the algorithms used by Mann to produce his hockey stick from bristle cone pine tree ring data, also yielded hockey stick results.

Costella also wrote: "The Climategate emails show us how a small cabal of climate scientists, based at the University of East Anglia and at Penn State University, were able to control the temperature record fed into the critical Intergovernmental Panel on Climate Change (IPCC) reports and which comprised the foundation on which the whole global warming structure was based." Costella concluded "that this was a real conspiracy is beyond argument. The word 'conspiracy' is used by the players themselves. In any conspiracy there is a tight inner core and then successive rings of collaborators, who accept the leadership of the central core."

Mann defends himself by saying Penn State looked into the e-mails and decided that he had not suppressed data at any time. However, an inquiry conducted by the British parliament came to a different conclusion. "The leaked e-mails appear to show a culture of non-disclosure at CRU and instances where information may have been deleted to avoid disclosure," the House of Commons' Science and Technology Committee announced in its findings.

The following individuals comprise the key players in the Climategate scandal, according to Costella:

- Michael Mann: lead player in the United States.
- Phil Jones: lead player in the United Kingdom.
- Keith Briffa: older player whose blunders lead the others to all but abandon him.
- Tom Wigley: older player who becomes increasingly worried about the unfolding scandal.
- Ben Santer: dangerously arrogant and naive young player in the United States.

'Hide the Decline' & Other Climategate Email Revelations

The emails reveal scientists producing the desired result by any means necessary. [NOTE: Links go to a publicly available archive of the unedited 2009 Climategate emails.]

- The notorious "hide the decline" email which generations of schoolchildren to come will study as the 33 words which summarize one of the most serious scientific frauds in the history of Western science. "Phil Jones to Ray Bradley, Mike Mann, Malcolm Hughes, Keith Briffa, and Tim Osborn, regarding a diagram for a World Meteorological Organization Statement: I've just completed Mike's *Nature* trick of adding in the real temperatures to each series for the last 20 years (i.e. from 1981 onwards) and from 1961 for Keith's to hide the decline."
- In this next very long email, nearly halfway through several messages and replies, Keith Briffa raises one of the issues that is central to the infamous "hide the decline" email. "Keith Briffa responding to Mike Mann, Phil Jones, Tom Karl, and Chris Folland: I know there is pressure to present a nice tidy story as regards 'apparent unprecedented warming in a thousand years or more in the temperature proxy data' but in reality the situation is not quite so simple. We don't have a lot of temperature proxies that come right up to today and those that do (at least a significant number of tree proxies) have some unexpected changes in response that do not match the recent warming. I do not think it wise that this issue be ignored in the chapter. I believe that the recent warmth was probably matched about 1000 years ago." The issue is so complex that those interested in a more thorough account of all the methods used to "hide the decline" should refer to Steve McIntyre's extensive discussion.
- Dodging Freedom of Information demands for emails. Ben Santer: "There is a real danger that such FOIA requests could (and are already) being used as a tool for harassing scientists rather than for valid scientific discovery. Mr. McIntyre's FOIA requests to the DOE and the NOAA are but the latest in a series of such requests. In the past, Mr. McIntyre has targeted scientists at Penn State University, the United Kingdom's Climatic Research Unit, and the National Climatic Data Center in Asheville. Now he is focusing his attention on me. The common denominator is that Mr. McIntyre's attention is directed towards studies claiming to show evidence of large-scale surface warming, and/or a prominent human "fingerprint" in that warming. These serial FOIA requests interfere with our ability to do our job."
- Deleting embarrassing secret emails. Phil Jones: "Subject: Climatic Change needs your advice—YOUR EYES ONLY !!!!!Mike, This is for YOUR EYES ONLY. Delete after reading—please! I'm trying to redress the balance. One reply from Christian Pfister said you should make all available!! Pot calling the kettle black—Christian doesn't make his methods available. ... I told Steve separately, and told him to get more advice from a few others, as well as Kluwer (publishers), and the legal department.PLEASE DELETE—just for you, not even for Ray Bradley and Malcolm Hughes."
- Six UK agencies commissioned a handbook of sophisticated public behavior change tactics for public relations tone-deaf scientists. Its title: "The Rules of the Game: Evidence base for the Climate Change Communications Strategy." It is horrifying Orwell-like non-fiction backed by Big Money from The Carbon Trust. It has to be read to be believed. It is posted here.
- Acknowledgement among scientists of the uncertainty of their research methods and results. Paleoclimatologist Tommy Wils (2013 email number CG1682) giving advice to his colleagues on how to respond to Steve McIntyre and ClimateAudit: "*What if climate change appears to be just mainly a multi-decadal natural fluctuation? They'll kill us probably...*"

- Unethical efforts to discredit and expel colleagues with contrary views or findings. "Phil Jones: The other paper by McKittrick and Michaels is just garbage—as you knew. De Freitas is the Editor again. Pielke is also losing all credibility as well by replying to the mad Finn as well—frequently, as I see it. I can't see either of these papers being in the next IPCC Report. Kevin and I will keep them out somehow—even if we have to redefine what the 'peer-review literature' is!"
- Plotting to destroy peer reviewed journals that publish skeptic papers. "Michael Mann: With respect to Peiser's guest editing of *Energy and Environment* and your review, following up on Kevin's suggestions, we think there are two key points. First, if there are factual errors (other than the fraud allegation) it is very important that you point them out now. If not, Keenan could later allege that he made the claims in good faith, as he provided you an opportunity to respond and you did not. Secondly, we think you need to also focus on the legal implications. In particular, you should mention that the publisher of a libel is also liable for damages—that might make Sonja Boehmer-Christiansen be a little wary. Of course, if it does get published, maybe the resulting settlement would shut down *Energy and Environment* and Benny and Sonja all together! We can only hope, anyway. So maybe in an odd way it's actually win-win for us, not them. Lets see how this plays out..."
- Discrediting and sabotaging peer reviewed journals for publishing skeptic papers. "Michael Mann: The Soon and Baliunas paper couldn't have cleared a "legitimate" peer review process anywhere. That leaves only one possibility—that the peer-review process at *Climate Research* has been hijacked by a few skeptics on the editorial board. And it isn't just De Freitas; unfortunately, I think this group also includes a member of my own department... The skeptics appear to have staged a "coup" at *Climate Research* (it was a mediocre journal to begin with, but now it's a mediocre journal with a definite "purpose")."
- Expecting peer reviewed science journal editors to allow their team to block skeptic papers. Costallo: Phil Jones is upset that Julia Uppenbrink, the Editor at *Science*, did not send a piece to them to review, which would have allowed them to block it: "Phil Jones: Obviously this isn't great as none of us got to review it. Odd that she didn't send it to one of us here as she knew we were writing the article she asked us to!" [It is noteworthy that these scientists have assumed that every single article published in *Science* relating to climate science in any way, would automatically be sent to them for approval.]

Mark Steyn v. Michael Mann

In 2012, Mann sued *National Review*, columnist Mark Steyn, Rand Simberg and the Competitive Enterprise Institute for defamation because they wrote critically about his famous hockey stick graph. The suit centered on two separate blog posts by Mann and Simberg that compared what they considered a whitewash investigation by Penn State of Mann's involvement in the Climategate scandal to the way the university ignored decades of serial child molestation by former football coach Jerry Sandusky. Steyn wrote, in part:

If an institution is prepared to cover up systemic statutory rape of minors, what won't it cover up? Whether or not he's "the Jerry Sandusky of climate change", he remains the Michael Mann of climate change, in part because his "investigation" by a deeply corrupt administration was a joke.

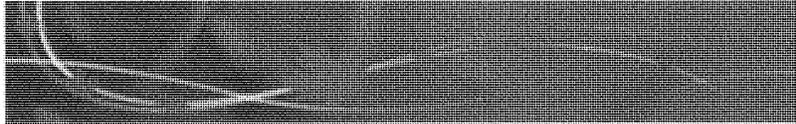
As the case continued to drag on, Steyn separated himself from his fellow defendants — who were attempting to get the case struck down on anti-SLAPP grounds — and countersued Mann for the purposes of getting him on the stand to defend the science he employed to create the hockey stick graph. Steyn contends Mann and the Circuit Court for the District of Columbia are dragging their feet on the case, even noting in June 2016 that one of his potential key witnesses died while waiting the nearly two years for the case to move forward. From the *Daily Caller*:

"Steyn's expert witnesses are older than Mann's; time affects them more," Steyn's lawyers wrote in their filing. "Many of Steyn's expert witnesses are emeritus professors and comparatively advanced in years, being of an age and eminence that enables them to stand against the bullying and intimidation that prevails in climate science. Indeed, one of Steyn's proposed witnesses has, in fact, died while this interlocutory appeal has been with the appellate court."

While he has waited, Steyn wrote a book titled *A Disgrace to the Profession*, which is largely comprised of quotes from scientists around the world who have criticized Mann's hockey stick graph and the effect of alarmism on the field of climate science.

Steyn and his attorneys consider this an important First Amendment case, protecting the right of citizens to criticize climate alarmists and their scientific claims — especially if they work at public institutions.

DOCUMENT SUBMITTED BY REPRESENTATIVE MARK TAKANO

Environment and
Climate Change CanadaEnvironnement et
Changement climatique Canada

Dr. Ben Santer
Lawrence Livermore National Laboratory

27 March 2017

Dear Dr. Santer,

As co-authors of the Fyfe *et al.* Commentary published in 2016 in *Nature Climate Change* we thank you for your letter clarifying what our Commentary actually says and does not say. We are in full agreement with your scientific characterization of our Commentary and how it pertains to the Karl *et al.* paper published in 2015 in *Science Magazine*.

As you correctly point out our Commentary reiterates that the rate of global surface temperature increase in the early-2000s was slower than during the latter part of the twentieth century. Our Commentary does not say that the recent correction to observations of surface temperature has led to disagreement over whether the human influence on climate change is real or ongoing. Nor does it say that that human-caused global warming has stopped, paused, or even slowed.

It is well understood that human influence has been the dominant cause of observed warming since the mid-20th century, and that future increases in greenhouse gases will lead to further warming. Nothing in our Commentary contradicts this understanding.

Sincerely,

For Drs. John C. Fyfe, Gregory M. Flato, Nathan P. Gillett and Neil C. Swart.
The Canadian Centre for Climate Modelling and Analysis, Environment and
Climate Change Canada

Canada



Lawrence Livermore National Laboratory

Dr. Benjamin D. Santer
 PCMDI, Lawrence Livermore National Laboratory
 P.O. Box 808, Mail Stop L-103
 Livermore, CA 94550
 Tel: (925) 423-3364; Email: santer1@llnl.gov

The Honorable Lamar Smith
 Chairman
 Committee on Science, Space, and Technology
 U.S. House of Representatives
 Washington, D.C. 20515

Cc: Honorable Eddie Bernice Johnson
 Ranking Member
 Committee on Science, Space, and Technology

March 28, 2017

Dear Mr. Smith,

We are coauthors of the Fyfe *et al.* paper published in 2016 in *Nature Climate Change*.¹ You recently referenced this paper at a Subcommittee hearing on March 16, 2016.² We are writing to clarify what the Fyfe *et al.* paper actually finds and claims. We also want to ensure that the conclusions of the Fyfe *et al.* paper are not misconstrued as a criticism of Thomas Karl, of the Karl *et al.* paper published in *Science* in 2015,³ or of the valuable research that Dr. Karl and his team have performed over many years.

Thomas Karl is a first-rate climate scientist. He served NOAA with distinction for decades. Dr. Karl and his colleagues at the National Center for Environmental Information (NCEI) developed rigorous scientific methods for estimating global changes in land and ocean surface temperatures. This is a critically important area of climate science.

NCEI made its surface temperature data sets freely available to the climate science community. This helped scientists around the world to conduct research on the size, rate, and causes of long-term temperature change, and helped to improve our knowledge of natural climate variability. NCEI temperature data are also key yardsticks for evaluating the performance of computer models of the climate system.

Science is dynamic, not static. All surface temperature data sets have evolved over time, as scientists found better ways of accounting for the effects of changes in measurement systems, measuring practices, and the geographical coverage of observations. Similar improvements have occurred in measurements of the heat content of the world's oceans, and in satellite estimates^{4,5,6} of temperature change in Earth's atmosphere. The evolution of observed temperature data sets is a normal, on-going scientific process. It is not evidence of questionable behavior.

In their 2015 *Science* paper, Karl *et al.* identified changes in three different aspects of surface temperature measurement systems. These observing system changes must be addressed in order to reliably estimate the true, climate-related temperature signals in the data. After accounting for



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the evolution of the measuring system, Karl *et al.* concluded that the rate of surface warming in the first 15 years of the 21st century was “at least as great as (in) the last half of the 20th century”.

Fyfe *et al.* acknowledged the “high scientific value” of the work performed by Dr. Thomas Karl and his colleagues. We stand by our statement. It is of great benefit to understand how observational temperature data are affected by changing measurement systems. Karl *et al.* deserve credit for focusing attention on this issue, and for inspiring important research on the further improvement of surface temperature datasets.⁷

While Karl *et al.* focused on developing a better understanding of temperature observations, Fyfe *et al.* summarized and synthesized scientific understanding of decadal changes in warming arising from natural variability of the climate system. The emphasis in the Fyfe *et al.* paper was on studying internal variability (caused by phenomena like El Niños, La Niñas,⁸ and the Interdecadal Pacific Oscillation^{9,10,11,12}) and on assessing the effects of natural external changes in volcanic aerosols¹³ and the Sun’s energy output.¹⁴

Fyfe *et al.* found that the rate of temperature increase in the early 21st century was slower than during the latter part of the 20th century. Reduced warming was apparent in both surface observations and in satellite measurements of the temperature of Earth’s lower atmosphere (the troposphere).

The bottom line is that Karl *et al.* and Fyfe *et al.* reached different conclusions regarding the warming rate in the early 21st century. This was largely due to different justifiable choices the two sets of authors made about the timescales and periods of interest. The Karl *et al.* finding – that the recent rate of surface warming is larger than in previous data sets – is supported by an independent study of surface temperature measurements.⁷ Other sources of information support the Fyfe *et al.* finding of a reduced rate of surface warming in the early 21st century. These sources include independent satellite estimates of tropospheric temperature change, physical understanding of the waxing and waning of different “modes” of internal variability, and measurements of the changes over time in volcanic aerosols and the Sun.

All of the factors studied by Karl *et al.* and Fyfe *et al.* (changing observing systems, internal variability, and natural variations in the Sun and volcanoes) affect temperature records, and affect our interpretation of the size and significance of decade-to-decade changes in warming rate. The scientific challenge is to reliably quantify the contribution of each factor to short-term changes in warming rate.¹⁵

Finally, we would like to emphasize that Karl *et al.* and Fyfe *et al.* agree on the most important scientific points. We agree that human influence on climate is real, is large, and is ongoing. We agree that this influence is primarily due to fossil fuel burning, and to the resulting human-caused changes in atmospheric levels of heat-trapping greenhouse gases.¹⁶ We agree that human-caused changes in greenhouse gases should lead – and do lead – to global-scale warming of Earth’s atmosphere, oceans, and land surface.¹⁷ We agree that we have identified large global warming signals in the observed surface temperature changes from the late 19th century to the present,¹⁸ in the satellite atmospheric temperature data that have featured prominently in recent Congressional hearings,^{19,20} and in ocean heat content measurements.²¹

And we agree with Karl *et al.* that on top of the underlying global-scale warming trend over the past 150 years, we should see – and do see – natural, decade-to-decade ups and downs caused by internal variability, volcanic activity, and changes in the Sun’s energy output. These decade-to-decade fluctuations in warming are not a scientific surprise. They have been discussed at length in every national and international assessment of climate science. Sometimes the “ups” act in the same direction as human influences, leading to accelerated warming. Sometimes the “downs” lead to a short-term decrease in warming. Our disagreement with Karl *et al.* about the size of the most recent short-term fluctuation does not call into question the reality of long-term human-caused warming.

Sincerely,



Dr. Benjamin D. Santer
Lawrence Livermore National Laboratory



Dr. Matthew H. England
ARC Centre of Excellence for Climate System Science
University of New South Wales, Australia



Dr. Ed Hawkins
National Centre for Atmospheric Science
Dept. of Meteorology, University of Reading, UK



Prof. Michael E. Mann
Dept. of Meteorology and Earth and Environmental
Systems Institute, Pennsylvania State University



Dr. Gerald A. Meehl
National Center for Atmospheric Research



Dr. Yu Kosaka
Research Center for Advanced Science and Technology,
University of Tokyo, Japan



Dr. Shang-Ping Xie
Scripps Institution of Oceanography
University of California at San Diego

P.S.: We are also submitting a letter from our colleagues at the Canadian Centre for Climate Modelling and Analysis: Dr. John Fyfe, Dr. Greg Flato, Dr. Nathan Gillett, and Dr. Neil Swart. Dr. Fyfe was the lead author of the 2016 Fyfe *et al.* *Nature Climate Change* paper, and Drs. Flato, Gillett, and Swart are co-authors of the Fyfe *et al.* paper. All four of our colleagues affirm their scientific support for the statements we have made in our letter.

- ¹Fyfe, J.C., G.A. Meehl, M.H. England, M.E. Mann, B.D. Santer, G.M. Flato, E. Hawkins, N.P. Gillett, S.-P. Xie, Y. Kosaka, and N.C. Swart, 2016: Making sense of the early 2000s global warming slowdown. *Nature Climate Change*, **6**, 224-228.
- ²<https://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-114-SY18-WState-500583-20160316.pdf>
- ³Karl, T.R., A. Arguez, B. Huang, J.H. Lawrimore, J.R. McMahon, M.J. Menne, T.C. Peterson, R.S. Vose, and H.-M. Zhang, 2015: Possible artifacts of data biases in the recent global surface warming hiatus. *Science*, **348**, 1469-1472.
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- ⁵Wentz, F.J., and M. Schabel, 1998: Effects of orbital decay on satellite-derived lower tropospheric temperature trends. *Nature*, **394**, 661-664.
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DOCUMENTS SUBMITTED BY REPRESENTATIVE DONALD S. BEYER, JR.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 20 2016

OFFICE OF
CONGRESSIONAL AND
INTERGOVERNMENTAL
RELATIONS

The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

RECEIVED

APR 20 2016

COMMITTEE ON SCIENCE
& TECHNOLOGY

Dear Congresswoman Johnson:

Thank you for your letter of July 21, 2015, regarding Dr. David Schnare's testimony before the Committee on Science, Space and Technology and his employment at the U.S. Environmental Protection Agency.

The first enclosure to this letter, prepared by EPA's Office of Enforcement and Compliance Assurance, provides information you requested about Dr. Schnare's employment at the EPA.

Also enclosed are documents responsive to your request, the vast majority of which were provided pursuant to a Freedom of Information Act request several years ago. Please note that portions of your request examine internal deliberations of an Executive Branch agency, the EPA, and, as such, raise a confidentiality interest. In order to identify specific documents in which the EPA has a confidentiality interest, we have added a watermark to these documents that reads "Internal Deliberative Document of the U.S. Environmental Protection Agency; Disclosure Authorized Only to Congress for Oversight Purposes." Through this accommodation, the EPA does not waive any confidentiality interests in these documents or similar documents in other circumstances. The EPA respectfully requests that the Committee and staff protect the documents and the information contained in them from further dissemination. Should the Committee determine that its legislative mandate requires further distribution of this confidential information outside the Committee, we request that such need first be discussed with the agency to help ensure the Executive Branch's confidentiality interests are protected to the fullest extent possible.

You will also notice that some of the documents contain redactions of non-responsive or non-substantive material, such as personal privacy information. We redacted this information in a

manner that does not obscure the identity of any individuals involved in the relevant communications.

Please feel free to contact me if you have any questions, or your staff may contact Tom Dickerson in my office at dickerson.tom@epa.gov or (202) 564-3638.

Sincerely,

A handwritten signature in black ink that reads "Nichole Distefano". The signature is written in a cursive, flowing style.

Nichole Distefano
Associate Administrator

Enclosures 

cc: The Honorable Lamar Smith
Chairman

ENCLOSURE TO THE EPA'S RESPONSE

You have asked whether Dr. Schnare received prior written approval from the EPA to engage in outside activity as the Director of the American Traditions Institute (ATI) while he was employed by EPA. This letter confirms that EPA did not grant prior written approval of that activity.

Dr. Schnare was a career EPA employee for more than thirty years. He served as a GS-15 non-supervisory attorney-advisor in the Air Enforcement Division of EPA's Office of Civil Enforcement (OCE) until his retirement on September 30, 2011. As an employee, Dr. Schnare was subject to the Standards of Ethical Conduct for Employees of the Executive Branch, 5 C.F.R. Part 2635, and EPA's supplemental regulations, 5 C.F.R. part 6401. He was required to file an annual confidential financial disclosure report and to take annual ethics training. In order to engage in outside activity that involves the practice of a profession or that deals in significant part with any ongoing Agency program, policy, or operation, Dr. Schnare was required to seek prior approval from his Deputy Ethics Official (DEO). *See* 5 C.F.R. § 2635.801 and 5 C.F.R. § 6401.103. The Standards of Ethical Conduct place the burden on the federal employee to obtain prior written approval of outside activity before engaging in such activity. *See* 5 C.F.R. 6401.103(a).

Dr. Schnare contends that on November 16, 2010, he submitted a paper request to his first line supervisor for approval to serve as the Director of ATI in his outside capacity. The DEO has no record of receiving any such paper request, and, to the best of our knowledge, one was never submitted. Accordingly, no prior written approval of Dr. Schnare's outside activity was given to Dr. Schnare, who nevertheless proceeded to engage in that activity.

Your letter suggests that there is evidence that Dr. Schnare used EPA resources to perform work on behalf of ATI during his official EPA duty hours. Your concern appears to be justified by the enclosed documents, which support an inference that Dr. Schnare was conducting ATI business on his EPA-issued computer during the work day.

Finally, you raised a concern that Dr. Schnare's outside activity as the Director of the ATI constituted a "conflict of interest" with his official EPA duties. Please note that the ethical rules and regulations affecting executive branch employees do permit employees to engage in outside activities, provided they receive prior approval if necessary. To the extent that their outside activities conflict with their assigned duties, they must recuse appropriately. Only if the outside activity so completely conflicts with the central core of their duties should it be denied. *See* 5 C.F.R. § 2635.802(b).

Dr. Schnare's official EPA duties involved specific party matters in which the United States sought to enforce applicable requirements of the Clean Air Act against named parties. His duties did not involve policy-making related to climate change under the Clean Air Act nor any other

federal environmental statute implemented or enforced by EPA. As it happens, though, Dr. Schnare chose to recuse himself voluntarily from any official duties involving climate change.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 20 2016

OFFICE OF
CONGRESSIONAL AND
INTERGOVERNMENTAL
RELATIONS

The Honorable Donna F. Edwards
Ranking Member
Subcommittee on Space
Committee on Science, Space & Technology
U.S. House of Representatives
Washington, DC 20515

RECEIVED

APR 20 2016
COMMITTEE ON SCIENCE
& TECHNOLOGY

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The first enclosure to this letter, prepared by EPA's Office of Enforcement and Compliance Assurance, provides information you requested about Dr. Schnare's employment at the EPA.

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Sincerely,

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Nichole Distefano
Associate Administrator

Enclosures

ENCLOSURE TO THE EPA'S RESPONSE

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federal environmental statute implemented or enforced by EPA. As it happens, though, Dr. Schnare chose to recuse himself voluntarily from any official duties involving climate change.

DONALD S. BEYER, JR.
8TH DISTRICT, VIRGINIA

VICE RANKING MEMBER
COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY

COMMITTEE ON NATURAL RESOURCES

JOINT ECONOMIC COMMITTEE

Congress of the United States
House of Representatives
Washington, DC 20515-4608

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DISTRICT OFFICE
5295 SHILOH ROAD
SUITE 250
ALEXANDRIA, VA 22312

4/10/2017

Dear Chairman Smith and Ranking Member Johnson:

At the March 27, 2017, hearing on climate science, I submitted for the record a letter from the EPA in response to questions from Ranking Member Johnson regarding Dr. David Schnare's involvement in Freedom of Information Act requests on behalf of the American Tradition Institute (ATI) while he was a full-time EPA employee. The letter confirms that:

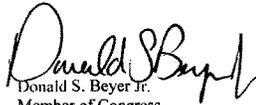
- EPA did not grant prior written approval for David Schnare to engage in those activities, but he nevertheless proceeded to engage in that activity anyway; and
- According to the EPA, Schnare conducted at least some of this work for ATI going after Dr. Mann's e-mails on his EPA-issued computer during EPA work hours.

I am supplementing this letter with the attached affidavit and supporting documents from May 23, 2011, from Richard C. Kast, who at the time was Associate General Counsel at the University of Virginia. Mr. Kast's statement asserts that Dr. Schnare misled University of Virginia officials about the status of his employment with the EPA, and that Dr. Schnare claims to have never used EPA facilities for private work, which EPA says is not accurate.

It should be of great concern to this Committee that Dr. Schnare engaged in outside work activity that involved an ongoing EPA program or policy without first obtaining written approval from the EPA, which is required under law. It should also be of great concern that Dr. Schnare used tax-payer funded resources to perform such work and during official EPA duty hours.

Frankly, the inconsistencies of Dr. Schnare's accounts call into questions his ability to offer useful testimony in front of this Committee.

Sincerely,


Donald S. Beyer Jr.
Member of Congress

VIRGINIA:

IN THE CIRCUIT COURT OF PRINCE WILLIAM COUNTY

THE AMERICAN TRADITION)
INSTITUTE, and HON. DELEGATE)
ROBERT MARSHALL,)
Petitioners,)

v.)

THE RECTOR AND VISITORS OF)
THE UNIVERSITY OF VIRGINIA,)
Respondent.)

CITY OF CHARLOTTESVILLE)

COMMONWEALTH OF VIRGINIA)

FILED

2011 OCT 18 AM 11:37

CIRCUIT COURT CLERK'S OFFICE
PRINCE WILLIAM COUNTY, VA

BY _____ DEPUTY

Civil Action No. CL-11-3236

AFFIDAVIT OF RICHARD C. KAST

On this day, Richard C. Kast personally appeared before me, a certified Notary Public in and for the Commonwealth of Virginia, and after first being duly sworn to tell the truth, testified as follows:

1. My name is Richard C. Kast. As I have previously represented to this Court in an affidavit filed in this matter on May 23, 2011, I have been licensed to practice law in the Commonwealth of Virginia since 1973. I have practiced in the field of higher education since 1985. I have been Associate General Counsel at the University of Virginia ("University") since January 1996.

2. Following the entry by this Court of the protective order on May 24, 2011, I became concerned that press releases and media coverage were misrepresenting the effect of that order in disturbing ways and that these distortions and inaccuracies might indicate that David Schnare and Christopher Horner did not understand their responsibilities pursuant to the order.

3. Immediately following the entry of the protective order, Petitioner Horner himself, in conjunction with Paul Chesser, issued a press release on behalf of The American Tradition Institute ("ATI") stating that "the University was hauled into court" and required to produce the documents sought by ATI "so that ATI can make them available to all who wish to review" them. The press release further stated that "ATI has won the right to look at all of the documents beginning no later than September 21, including those the University refuses to make public." (Exhibit 1.) These representations were obviously antithetical to the spirit, intent, and literal requirements of the protective order and raised concerns in my mind that Mr. Horner did not understand or did not plan to abide by the terms of that order.

4. On May 25, 2011, *The Washington Times* quoted Delegate Robert Marshall, one of the Petitioners in this lawsuit, as follows: "I want to look at what they've given us and examine what they've withheld and see why it's been withheld." This statement concerned me because Delegate Marshall has no access to the exempt documents pursuant to the protective order. (Exhibit 2.)

5. On May 26, 2011, Petitioners Schnare, Horner and Marshall co-wrote an op-ed piece for *The Washington Examiner* entitled: "Yes, Virginia, you do have to produce those 'Global Warming' documents." Petitioners wrote that "[t]he university must also allow attorneys David Schnare and Chris Horner to view any [documents] it believes are exempt from release under FOIA," and noted that although "Schnare and Horner had to promise that they would not disclose the contents of any documents withheld until the court rules on whether UVA's FOIA exemptions are valid, . . . they do get to see all of them. That's a major breakthrough." (Exhibit 3.) Again, these statements were irresponsible and inconsistent with a genuine intent of Petitioners Schnare and Horner to abide by the terms of the protective order.

6. On May 26, 2011, an article appeared in *Commentary* entitled “Climate Scientist Ordered to Release Thousands of Documents.” That article quoted Petitioner Horner and stated that the University “must allow . . . David Schnare and Chris Horner to view any [documents] it believes are exempt from release under FOIA—with the burden of proof on UVA.” The article further noted that even if the University were to attempt not to disclose exempt documents, those documents would “still have to be shown to the two attorneys who filed the public information request.” (Exhibit 4.) Clearly, this latter statement inferred that there was some significance *vis a vis* public disclosure of these documents that was wholly inconsistent with the terms of the protective order.

7. Further disturbing and inaccurate reporting appeared in *The Chronicle of Higher Education*, which reported on May 25, 2011, that the University had “agreed to turn over a potentially enormous trove of climate-research e-mails and other documents to a conservative group that filed a demand for them under the state’s Freedom of Information Act,” (Exhibit 5); *The Virginian Pilot*, which reported on May 26, 2011: “Under the terms of a legal agreement, the work papers of a former University of Virginia climate change professor will be provided to an advocacy group that requested them earlier this year under the state open records law,” (Exhibit 6); and *Inside Higher Ed* which reported on May 26, 2011: “A state judge has ordered the University of Virginia to release documents produced by Michael Mann, who formerly taught there, to a conservative foundation requesting them as open records.” (Exhibit 7.)

8. The ATI press release and this reporting reflected a pervasive misunderstanding of this Court’s protective order. It troubled me that David Schnare and Christopher Horner either originated or were quoted in most of this disturbingly inaccurate information. It further troubled me that neither had done anything as far as I could determine to correct the record.

9. Before I could express my concerns to David Schnare, he sent me an e-mail on May 26, 2011, stating: "Please let your colleagues know that the noise that has arisen since Tuesday is just noise. I look forward to discussing with you how we can bring our disparate philosophies together into a sensible approach to disclose that which is proper to disclose, without visiting harm on the academic community." (Exhibit 8.)

10. On May 27, 2011, I responded to Dr. Schnare noting that, while the University was used to the hyperbole and error that had pervaded much of the reporting on ATI's Freedom of Information Act request, some of what he had characterized as "noise" following the hearing in this Court had been "particularly disturbing in its implication that the Protective Order did not exist or was of no moment." I asked for a specific reassurance from him and Mr. Horner that they remained fully aware of "the requirements for confidentiality and nondisclosure imposed by [this] Court." (Exhibit 9.)

11. Dr. Schnare responded to my May 27 e-mail on the same date acknowledging that the "most disturbing reporting suggested that we would use any knowledge we gain to game the system." He further noted: "[P]lease reassure your colleagues that I will countenance no abrogation of our duty to the court and to UVA." (Exhibit 10.) On June 1, 2011, Dr. Schnare further noted: "Both Mr. Horner and I take our responsibilities to the Court very seriously, but understand the sensitivities at issue in this highly public matter. To that end, Mr. Horner will send you an email documenting his full understanding of the responsibility he took on when he signed the attachment to the protective order and his continuing commitment to that." (Exhibit 11.) Also on June 1 Mr. Horner furnished the referenced e-mail noting that if the University's general counsel had any concerns about his adherence to the protective order, he should contact him directly. (Exhibit 12.)

12. On May 31, 2011, Dr. Schnare sent me an e-mail in which he noted: "I am angered and upset at the mostly irrational and surely uncivil discussion going on (especially on influential internet blogs) with regard to the differences between UVA and GMU in handling our recent FOIA requests, and ATI has done little to help in that regard." (Exhibit 13.) While this statement has the right words, the fact is that Mr. Schnare was then and remains a key staff member of ATI, not some innocent bystander. See *Staff & Board of Directors*, AMERICAN TRADITION INSTITUTE, <http://www.atinstitute.org/about/staff-board-of-directors> (last visited Oct. 14, 2011).

13. Not surprisingly, the vast amount of misinformation, distortion, and "irrational and surely uncivil discussion" that followed this Court's entry of the protective order on May 24, 2011, resulted in a vast outpouring of concern from University faculty, faculty and scientists at other institutions, and professional groups such as the AAUP, the ACLU of Virginia, and the Union of Concerned Scientists. (See representative letters collected at Exhibit 14.) In addition, I myself received communications directly expressing concerns about the University's perceived capitulation to ATI and lack of concern for research integrity and academic freedom. (Exhibit 15.) This groundswell of concern fueled by the pervasive misinformation in the media about what the University had actually agreed to was understandably of concern to University President Teresa Sullivan who responded to it. (Exhibit 16.)

14. More disturbing than the concerns fueled by misinformation, however, were the concerns that remained in the minds of those who perfectly well understood the requirements for confidentiality imposed by the protective order, but nonetheless did not believe that Petitioners Schnare and Horner could be trusted to abide by those requirements. These concerns derived not just from the very public zeal of ATI to discredit Michael Mann (see Exhibit 17 where Dr.

Mann's image is used on the ATI website and described as "discredited" and seeking to keep his University records "hidden from the taxpayer"), but also from the fact that, unlike most situations in which attorneys are granted access to confidential information pursuant to a protective order, Dr. Schnare and Mr. Horner were not just counsel for the Petitioners in this case, they *were* two-thirds of Petitioners in this case.

15. On August 31, 2011, to respond to concerns that had been raised about the possibility of someone seeking access to the documents that were to be shared with Dr. Schnare and Mr. Horner pursuant to the protective order through the issuance of a civil investigative demand, subpoena, or other such demand, I wrote to Dr. Schnare seeking his and Mr. Horner's assurances that they agreed that such attempts could not be successful under the terms of the protective order. (Exhibit 18.)

16. On September 2, 2011, Dr. Schnare wrote to me to assure me that he and Mr. Horner understood the protective order as I did: *i.e.*, it would not allow for their release of documents disclosed to them by the University pursuant to its terms to be further disclosed to third parties in response to a civil investigative demand, subpoena, or other demand. (Exhibit 19.)

17. Because of the numerous and recurrent concerns that had been raised about the protective order, as detailed above, my colleague and co-counsel in this matter, Madelyn Wessel, sent a letter dated September 20, 2011 (the letter was actually transmitted electronically on September 21) to Dr. Schnare proposing an alternative mechanism for review and inviting Dr. Schnare's comments. (Exhibit 20.)

18. On September 29, 2011, having heard no response from Dr. Schnare, Ms. Wessel inquired when he might be available to discuss the proposal made in her September 20 letter.

Dr. Schnare responded that he had been in the midst of “a particularly upsetting family crisis” and further stated: “Among other things, tomorrow is my last day as an employee of the U.S. EPA, and I’ve had to close out a large caseload as well as deal with all manner of federal records matters.” (Exhibit 21.)

19. Dr. Schnare’s statement of his continuing employment status with the EPA through September 30, 2011, came as a complete surprise to me because on May 24, 2011, prior to my appearance in this Court that resulted in the entry of the protective order, Dr. Schnare had told me that he had worked for the EPA but now was doing public interest law and handling such matters as the FOIA request currently before this Court.

20. On September 29, 2011, I communicated my surprise and concern about Dr. Schnare’s apparent misrepresentation to him, noting: “I must say that I am surprised and frankly disturbed by your revelation that you are just now leaving the EPA. You told me when we first met before the initial court appearance in Prince William County Circuit Court on May 24th that you had formerly been with the EPA and were then, and had been for a while, a private, public-interest lawyer.” (Exhibit 22.)

21. Dr. Schnare responded: “I have had authority from the agency to do pro bono public interest law for over 5 years now. That is what I represented to you.” He further noted that he never mentioned EPA duties when doing non-EPA work and never used EPA facilities for private work. (Exhibit 23.) At no time on May 24 or at any subsequent time prior to his e-mail of September 29 had Dr. Schnare ever represented to me that he continued to be employed by the EPA or had had authority to do pro bono public interest law work for over 5 years or for any other period of time. Dr. Schnare had repeatedly sought to convince me and my co-counsel that our expressions of concern about potential misuse of the documents to be provided under the

protective order were insulting to someone who had been an EPA lawyer handling highly confidential documents over a long career. Indeed, he made a similar argument to this court, stating at the hearing on September 16, 2011 that: "Now, because of some dispersions cast, we want to make it clear, Your Honor. I have been a federal prosecutor on environmental issues. I have had access to extremely sensitive business information. If I were a corrupt man, I would not be here today on cash games, insider training, and retiring in Bermuda." (Exhibit 24)

22. To attempt to understand the confusion about Dr. Schnare's employment status, and discuss with him Ms. Wessel's proposal in her September 20 letter, Ms. Wessel and I scheduled a telephone call with him on October 3, 2011. Prior to that conversation, Dr. Schnare sent us an e-mail stating that he wanted us to explain "the nature of [our] concern about the fact that [he] was an employee of EPA, operating under an outside employment waiver, prior to October 1, 2011." He further stated that he had "explained" to me that he "had worked for EPA," but "never made a specific statement as to [his] current employment other than as to [his] pro bono representation in the instant case and [his] general responsibilities for ATL, and had every good and ethical reason to say no more." (Exhibit 25.)

23. On October 3, 2011, in his conversation with Ms. Wessel and me, Dr. Schnare insisted that he had made no misrepresentations to me about his employment status with the EPA and had nothing to apologize for. I vehemently disagreed with these statements and so informed Dr. Schnare.

24. Subsequent to my conversation with Dr. Schnare on October 3, further information came to my attention that confirmed that he had been misleading me about his employment status with the EPA. Specifically, in a letter of October 6, 2011, the Senior Counsel for Ethics with the EPA notified Peter Fontaine, who is representing Michael Mann in his motion

to intervene in this case, that Dr. Schnare had never had the required outside approval “to engage in outside activity that involves the practice of a profession or that deals in significant part with any ongoing Agency program, policy or operation.” Moreover, although a “request for approval of the outside activity was purportedly prepared by Mr. Schnare on or about November 16, 2010, . . . neither his Deputy Ethics Official nor his Assistant Deputy Ethics Official has any record of receiving it or approving this request to engage in the outside activity.” (Exhibit 26.)

25. My review of the request for approval “purportedly prepared” by Dr. Schnare revealed that, even had it been received and approved by the appropriate officials at the EPA, it would not have authorized the work he has undertaken for ATI as counsel in this lawsuit because Dr. Schnare clearly and unambiguously represented: “My duties would not include any representation at law of the Institute or its members. Institute and affiliated attorneys will conduct all representation of any matters at law.” (Exhibit 27.)

26. Further, Dr. Schnare’s memorandum states that “All services will be performed entirely outside normal duty hours.” (Exhibit 27.) However, a review of the e-mail communications I have received from Dr. Schnare since I became involved with ATI’s Freedom of Information Act request in mid-February (the request was made January 6, 2011), reveals that I have received 58 messages from Dr. Schnare from February 17 to September 29, 2011. (Exhibit 28.) Most of these e-mails were sent between 8:30 a.m. and 5:00 p.m. and all were sent on week days and on days that were not federal holidays. Moreover, during this same time period, Dr. Schnare has filed voluminous pleadings in this Court during regular business hours. Mr. Schnare also sent emails to my co-counsel Madelyn Wessel and to the University’s Public Affairs Office during regular business hours. (Exhibit 29).

27. The fact that Dr. Schnare has, for whatever reason, felt compelled to make misleading statements to me about his employment status with the EPA, and demonstrably false statements about his having obtained the requisite approvals to represent ATI in this lawsuit while still being employed by the EPA, is extremely troubling and has destroyed Dr. Schnare's credibility in my mind. Under the circumstances, I cannot feel comfortable with the representations he has made to me about his intent fully to abide by the terms of the protective order. The behavior of Mr. Horner documented in this Affidavit also creates the same concerns. Mr. Horner is also not licensed to practice in Virginia and is therefore not subject to ethical duties and standards set by the Virginia Bar.

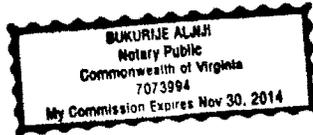
R. C. Kast

Richard C. Kast

Seen to and subscribed before me this 17 day of October, 2011.

Bukurije Aljaj

My commission expires: 11/30/2014



Court Orders University of Virginia to Produce Documents of Dr. Michael Mann

share



FOR IMMEDIATE RELEASE
Wednesday, May 25, 2011

Contacts:

Christopher Horner, chris.horner@atinstitute.org

Paul Chesser, paul.chesser@atinstitute.org

MANASSAS, Va.—On Tuesday, more than four months after the American Tradition Institute's Environmental Law Center requested emails and other files from a specifically identified University of Virginia back-up computer, the University was hauled into court and made to stand and agree to comply with the Commonwealth's Freedom of Information Act (FOIA).

See all court documents, press releases, media coverage of ATI's case against UVA

Under Virginia's FOIA, ATI and co-petitioner Delegate Bob Marshall (R-Manassas) asked UVA to disgorge the emails and files that Virginia's Attorney General also sought under other authority. The emails are specific communications sent and received by Dr. Michael Mann during his tenure at UVA in which he corresponded with, or discussed other, leading voices that represent the climate alarmist perspective. Seminal among them include discussions about his now infamous and discredited 1,000-year temperature reconstruction known as the "hockey stick." There also already appears — from records ATI has received — to be additional information of the kind released in the "Climategate" emails that originated at the Climatic Research Unit at East Anglia University.

Under FOIA the University was required to produce the documents within five days of its receipt of payment for "accessing, duplicating, supplying or searching" for the documents. Alternatively they could have entered into an agreement with ATI on when they would supply the documents, or they could have gone to court to ask for more time. They did none of the above. Instead they promised to provide some of the documents "shortly" on April 6; then specifically on May 6, 2011; and always stated they would get to the others later on. They did none of this either, so ATI went to court to compel production and compliance with the law.

ATI finally received the first approximately 20 percent of the 9,000 pages of documents that UVA says are responsive to ATI's request and that it possesses, only after ATI filed its petition, and two working days before the judicial hearing. Most of what ATI received in this seemingly hurried production, which was more focused on showing volume than content, were ads for Halloween costumes, public news releases from lay

and scientific journals, and a few emails that were printed in computer code so as to be unintelligible in that form. Despite this product of (according to the University) 75 hours of review and more than four months, the University stopped work on producing anything further. Nevertheless some substance made it through UVA's filter, which ATI will discuss after we review the withheld records.

The failure of UVA to honor its own commitments or to follow the law forced ATI to petition the court for relief. ATI filed its petition on May 16th, and the Court heard the matter Tuesday.

It took a petition to force UVA to agree to produce the documents that by statute they should already have produced. The day before the court hearing, UVA finally agreed to a date when they must produce all the documents they believe are not protected from disclosure. The court entered an order that forces UVA to honor that agreement and to produce the documents in easy-to-read electronic form so that ATI can make them available to all who wish to review the work of this highly controversial former Virginia employee. They must produce those documents by August 22nd.

In addition ATI has won the right to look at all the documents beginning no later than September 21, including those the University refuses to make public. The court issued a protective order that allows ATI's attorneys, David Schnare and Christopher Horner, to see them all so that they can challenge any further UVA refusals to supply what the public paid for. The records constitute a history of the "hockey stick" and the activities of Michael Mann, who also during the relevant time served on, e.g., the UN's IPCC, all of which have been the subject of intense scrutiny.

"By the end of this year, ATI and UVA will obtain judicial review of the University's obligation to fulfill the public's right to know how taxpayer-funded employees use the taxpayer's resources," said Mr. Horner, director of litigation at ATI's Environmental Law Center. "The court will determine whether this can be hidden behind the ivy covered walls of our public colleges and universities under a non-existent FOIA exemption of 'academic freedom,' which Virginia's legislature has never recognized."

ATI also put a final issue before the court. Under the Virginia FOIA, UVA is not allowed to impose fees on ATI to recoup the general costs of creating or maintaining records, or of transacting the general business of the University. The University has already admitted that it must obey several laws in fulfillment of its duty to protect some of its records, such as medical files and student information. This is part of the business of the University, just as any governmental body must protect its sensitive records. UVA, however, demanded that ATI pay \$8,500 to offset UVA's costs of doing precisely this regular business, which must be performed when releasing any information, under any authority. ATI argued, and existing case law indicates, this is simply not allowed. The University disagreed, and the court will issue its opinion on that matter on June 15th.

"ATI pursues important public issues," said Dr. Schnare, director of ATI's Environmental Law Center. "This case is about whether the government can put up a pay wall to frustrate the public's right to transparency. If it can, the public can't hold government employees to the high standards of conduct they should meet."

See Prince William County (Va.) Court's Order to Produce Documents in ATI Environmental Law Center's Freedom of Information Act case against the University of Virginia (PDF).

See Prince William County (Va.) Court's Order on Protection of Documents in ATI Environmental Law Center's Freedom of Information Act case against the University of Virginia (PDF).

For an interview with American Tradition Institute senior director of litigation Christopher Horner, email chris.horner@atinstitute.org or call (202)670-2680.

You are currently viewing the printable version of this article, to return to the normal page, please click here.

The Washington Times

Ruling alters climate-papers fight

Judge's order to UVa. to turn over documents welcomed by Cuccinelli

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By Paige Winfield Cunningham

The Washington Times

Wednesday, May 25, 2011

Virginia Attorney General Kenneth T. Cuccinelli II says a judge's order compelling the University of Virginia to turn over thousands of pages of climate-change research will likely alter his own battle for the long-sought documents.

The Republican attorney general and state Delegate Robert G. Marshall have battled the university for more than a year over the release of documents related to the work of former professor Michael Mann. Mr. Mann had been involved in a leaked email exchange with colleagues that climate-change skeptics claimed showed scientific misconduct.

Mr. Marshall, Prince William Republican, requested the documents through the Freedom of Information Act, while Mr. Cuccinelli subpoenaed them. Mr. Cuccinelli said an order issued Tuesday in Prince William County Circuit Court that grants Mr. Marshall's request could affect his own appeal to the state Supreme Court to reverse a previous ruling in favor of the university.

"It certainly can affect what we're doing," Mr. Cuccinelli said. "If they essentially disgorge everything, there's no cause for them to be going to court to try and cover it up."

He said he plans to review the documents and "see how the process unfolds."

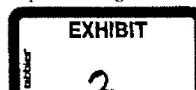
"If, as and when we get copies of the stuff, we'll see what's responsive," he said. "It's kind of hard to tell what isn't produced. You don't see what isn't there."

The university has so far turned over 20 percent of the 9,000 pages of documents it says are responsive to a request from the American Tradition Institute (ATI), a conservative-leaning, environmentally focused group that joined forces with Mr. Marshall in January. ATI filed a petition last week, saying the university had failed to respond to an information request filed early this year.

A judge has given the university until Aug. 22 to supply the rest of the documents. Mr. Marshall said he was pleased with the decision, but is skeptical the university will hand over everything he has requested.

"I want to look at what they've given us and examine what they've withheld and see why it's been withheld," Mr. Marshall told The Washington Times. "The more they stonewall, the more they're making Richard Nixon look like choirboy."

University spokeswoman Carol Wood said the university has been in "frequent and regular contact" with ATI



lawyers, working to clarify their request and work out a "reasonably manageable process" to satisfy the public information law.

Mr. Marshall enlisted ATI's help after a year of pursuing the climate-change documents on his own. After submitting his first information request in December 2009, the university told him it no longer possessed the materials he requested. In response to a second request the following spring, he was told it would cost \$8,500 to prepare the documents.

While state law allows public agencies to charge a reasonable sum to compensate for time and effort in meeting public information requests, Mr. Marshall and ATI said the university was charging an unreasonable sum. The court has yet to determine how much the university may charge to meet the request.

"This case is about whether the government can put up a pay wall to frustrate the public's right to transparency," said David Schnare, director of the ATI Environmental Law Center. "If it can, the public can't hold government employees to the high standards of conduct they should meet."

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Yes, Virginia, you do have to produce those 'Global Warming' documents

By: Christopher C. Horner, David W. Schnare and Robert Marshall | 01/05/11 9:05 PM
Op-Ed Contributors

Today, Virginia taxpayers, a state lawmaker and a public interest law firm are asking the University of Virginia to produce important "global warming" records under that state's Freedom of Information Act. These are records the school no longer denies possessing but nonetheless refuses to release, even to Attorney General Ken Cuccinelli. They address one of the most high-profile claims used to advance massive economic-intervention policies in the name of "global warming."

In response to a previous FOIA request, U.Va. denied these records existed. However, during Cuccinelli's pre-investigation under the Virginia Fraud Against Taxpayers Act ("FATA"), a 2007 law passed unanimously by Virginia's legislature, which clearly covers the work of taxpayer-funded academics, U.Va. stunningly dropped this stance. For this reversal, the taxpayers of Virginia owe Cuccinelli a debt of gratitude.

Still, the school has spent upward of half a million dollars to date fighting Cuccinelli's pursuit, now before the Virginia Supreme Court. However, Virginia's transparency statute FOIA gives the school one week to produce the documents, and offers no exemption for claims U.Va. is using to block Cuccinelli's inquiry.

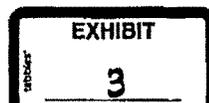
These e-mails and other documents relate to claims made by Michael Mann to obtain, and claim payment under, certain taxpayer-funded grants. Mann worked at the university's department of environmental sciences when he produced what was hailed at the time as the "smoking gun" affirming the theory of catastrophic man-made global warming.

Despite that lofty honorific, persistent controversy led promoters of this notorious "Hockey Stick" graph (principally, the United Nations' Intergovernmental Panel on Climate Change or IPCC) to stop advancing it as serious work.

Leaked "ClimateGate" e-mails discussing these same controversies prompted Cuccinelli's pre-investigation. Sadly, in order to keep the taxpayers' advocate from examining the evidence, U.Va. has offered a series of twists on a novel defense of "academic freedom."

Now we with the American Tradition Institute's environmental law center have requested these documents under FOIA and will presumably put an end to these tactics of denial followed by delay.

Importantly, also under FOIA in late 2009, the pressure group Greenpeace sought, and was promised, e-mails and other materials of Patrick Michaels, who also formerly worked in the same university department.



While the university proceeded to compile the material for Greenpeace, one of us, Virginia Del. Bob Marshall, R-Prince William, thought to ask for records relating to Michaels' former colleague, Mann. Oddly, the university informed Marshall that such records no longer existed because Mann had left the department.

Michaels has stated that the university, in explaining to him these disparate responses, asserted that some people's records are treated differently than others. Mann's were allegedly destroyed; Michaels' were being packaged for delivery to Greenpeace.

One disparity possibly helping to explain the other was that Mann had been an active participant in the IPCC, obtaining many research grants for his work at U.Va. But Michaels had been a very politically incorrect, high-profile "skeptic" of catastrophist claims such as those represented by the IPCC, and particularly Mann's Hockey Stick.

In court in August, U.Va. opted against robustly defending, as a legal argument, its academic-freedom rationale for refusing to produce the records. Yet even this week, it is asking the Virginia Supreme Court to deny Cuccinelli's request for documents possibly showing whether the dense Hockey Stick smoke indeed indicates fire. This does Virginia taxpayers a disservice.

Other records obtained under FOIA reveal that U.Va. has been paying Washington lawyers several thousand dollars per day to deny the requested transparency. As such, in a separate request, we also seek information about this privately underwritten effort to avoid complying with Cuccinelli's inquiry.

The university has previously demanded taxpayers pay thousands of dollars for a FOIA search for Mann's records, on the grounds that it maintains a broadly dispersed record-keeping system. Therefore, we have specifically directed the school to only search the backup server it claimed to the attorney general's office that it finally located as the likely home of the Mann records. As such, demands for huge search fees should not be an obstacle.

We hope for prompt university compliance with FOIA, although we are prepared to fully protect our appellate rights. As Virginia taxpayers, we also hope to see U.Va. rise to its reputation and reflect the highest fidelity toward its statutory and other obligations.

We can then, finally, determine what it is that so many have gone to such great lengths to keep the public from knowing about that for which the public has paid.

Christopher C. Horner is senior director of litigation for the American Tradition Institute's law center and a Virginia resident; David W. Schnare, Ph.D is a Virginia resident and a federal attorney. Del. Bob Marshall is a Virginia Republican delegate representing Prince William County.

<http://washingtonexaminer.com/opinion/op-eds/2011/01/yes-virginia-you-do-have-produce-those-global-warming-documents#ixzz1aZvY17AT>

Commentary

Contentions

Climate Scientist Ordered to Release Thousands of Documents

Alan Goodman/@alanguoodman 05.26.2011 – 1:29 PM

After ClimateGate, when a trove of emails from an East Anglia climate research institute appeared to show scientists conspiring to distort data on global warming, other public climate centers were asked to release similar email exchanges under the Freedom of Information Act. Documents from the University of Virginia were of particular interest, because one of its professors, scientist Michael Mann, was at the center of the ClimateGate controversy.

UVA has refused to release Mann's emails for over a year, but now it looks as if the public might finally get a glimpse at some of these exchanges. The university has been court-ordered to turn over 9,000 of Mann's correspondences within the next 90 days, the *Washington Examiner's* Barabara Hollingsworth reports:

The documents must be released electronically, unlike the printed "hieroglyphics" UVA has released to date. The university must also allow [American Tradition Institute] attorneys David Schnare and Chris Horner to view any it believes are exempt from release under FOIA—with the burden of proof on UVA. "The court will determine whether the public's right to know how taxpayer-funded employees use the taxpayers' resources can be hidden behind the ivy-covered walls of our public colleges and universities under a non-existent FOIA exemption," Horner said in a statement.

UVA may try to hold back some of the most damaging documents by claiming they are exempt from FOIA, but as Hollingsworth points out, these exchanges will still have to be shown to the two attorneys who filed the public information request.

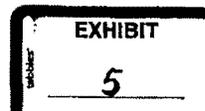
If the documents released by UVA are half as damning as the ones from East Anglia, it will be a serious obstacle for both the scientists who peddle the anthropogenic global warming theory and for lawmakers who favor climate change legislation. A Rasmussen poll from April found that 47% of voters say long-term planetary changes are primarily responsible for climate change, while 36% said that human activity is primarily at fault. This perception will likely grow if more corruption among climate scientists is uncovered, which could be one reason why UVA was so resistant to handing over these documents.



The Chronicle of Higher Education**U. of Virginia Agrees to Release Climate Researcher's E-Mails**

May 25, 2011, 2:28 pm

The University of Virginia has agreed to turn over a potentially enormous trove of climate-research e-mails and other documents to a conservative group that filed a demand for them under the state's Freedom of Information Act. The demand centers on more than a decade's worth of e-mail messages from, to, and about Michael E. Mann, a climate scientist who left the university in 2005 to become director of a research center at Pennsylvania State University. The organization, called the American Tradition Institute, joined with a Republican state legislator to file its request after the university went to court to fight an attempt by Virginia's attorney general, Kenneth T. Cuccinelli II, to use a different law to get the same documents, which he said he needed to investigate possible climate-research fraud. In a court document signed yesterday, the university said it would produce the materials within three months.



Hampton Roads, VA - 10/10/2011

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■ 25 MAY 2011 | 5:17 PM

U.Va. to release climate change papers to interest group

Under the terms of a legal agreement, the work papers of a former University of Virginia climate change professor will be provided to an advocacy group that requested them earlier this year under state open records law.

The agreement was reached Tuesday in Prince William County Circuit Court.

The American Tradition Institute and Del. Bob Marshall, R-Prince William, seek e-mails and other files of noted climate change scientist Michael Mann that are held by the university.

Mann's conclusions have been heralded as proof of climate change by some, and dismissed as faulty science by skeptics.

For more than a year, Attorney General Ken Cuccinelli has been after similar documents from U.Va. as part of an investigation into possible fraud related to taxpayer-funded grants awarded during Mann's tenure.

The institute initially asked for the records in January.

Officials claim U.Va. has been slow in responding to that request, even after the school was paid \$4,000 to cover document reproduction costs.

University officials counter that they negotiated with the institute and have been clear that the process of relieving the documents is time consuming.

The institute recently asked a court to intervene. The agreement between the parties specifies that U.Va. is to turn over all documents within 60 days of the order issued Tuesday.

(About one-fifth of the roughly 9,000 pages of documents sought have been provided to the institute.)

Cuccinelli's pursuit of those records is ongoing in court.

UPDATE: A U.Va. spokeswoman said the judge who heard the matter expects to issue a ruling by June 15.

An unresolved issue before the court is whether state law allows the university to be reimbursed for the cost of reviewing documents before they are released or whether the university must absorb it.

— Julian Walker

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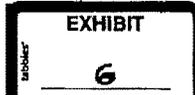
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Quick Takes

May 26, 2011

Michigan Pays \$550,000 to Settle Suit With Former Prof

The University of Michigan has agreed to pay Andrei Borisov, a former non-tenured faculty member in pediatrics, \$550,000, and to remove certain negative statements from his personnel file, to settle his suit against the university. [AnnArbor.com](#) reported. Borisov had resigned in 2008, after being told that his behavior was seen as threatening, following inquiries he had been making into possible plagiarism in reports to federal agencies that made grants to Michigan. The university denied wrongdoing in those cases.

Compromise on Foundation Bill in California

California's public higher education systems have agreed to drop opposition to [a state bill](#) that will require much more disclosure of records about their foundations and auxiliary operations. However, the colleges and universities have been assured of provisions that will preserve in most cases the right of donors to be anonymous. With the agreement, the bill is expected to be enacted.

Judge Orders U.Va. to Release Researcher's Documents

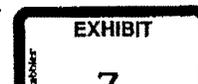
A state judge has ordered the University of Virginia to release documents produced by Michael Mann, who formerly taught there, to a conservative foundation requesting them as open records. [The Washington Examiner](#) reported. Mann is a climate researcher whose work is consistent with the scientific consensus on climate change, but who is doubted by some conservatives. In an e-mail, Mann said: "I think it's very unfortunate that fossil fuel industry-funded climate change deniers ... continue to harass U.Va., NASA, and other leading academic and scientific institutions with these frivolous attacks."

Academic Minute: Passive Hearing, Active Listening

In [today's Academic Minute](#), Rensselaer Polytechnic Institute's Pauline Oliveros examines the difference between passive hearing and active listening. Find out more about the Academic Minute [here](#).

Movers and Shakers: Columbia College Chicago, Grinnell College, Loyola U. Chicago, Simmons College, U. of New Haven

- Judy A. Beal, interim dean of the School of Nursing and Health Sciences at Simmons College, [has been named](#) to the job on a permanent basis.
- Beth Malloran, assistant vice president for development at the University of Michigan at Ann Arbor, [has been appointed](#) as vice president for development and alumni relations at Grinnell College.
- Ronald S. Harichandran, chair of the department of civil and environmental engineering at Michigan State University, [has been selected](#) as dean of the Tagliatela College of Engineering at the University of New Haven, in Connecticut.
- Onye Ozuzu, associate chair and director of dance in the department of theatre and dance at the University of Colorado at Boulder, [has been named](#) chair of the dance department at Columbia College Chicago.
- Carol Rozansky, professor of education at the University of Nebraska at Omaha, [has been chosen](#) as chair of the education department at Columbia College Chicago.
- Darrell P. Wheeler, associate dean for research and community partnerships at Hunter College of the City University of New York, [has been selected](#) as dean of the School of Social Work at Loyola University Chicago.



Kast, Richard (rck4p)

From: Dr. Schnare <schnareat@gmail.com>
Sent: Thursday, May 26, 2011 2:47 PM
To: Kast, Richard (rck4p)
Subject: Quick note

Rick:

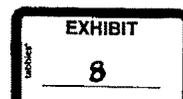
Please let your colleagues know that the noise that has arisen since Tuesday is just noise. I look forward to discussing with you how we can bring our disparate philosophies together into a sensible approach to disclose that which it is proper to disclose, without visiting harm on the academic community. I've been thinking about how to do that, and before our side begins to sift through the excluded documents, I'd like to take some time to come down to the school and sit with you and faculty representatives to discuss these issues. Maybe it won't result in anything, but I hold out hope that it will.

Nice to meet you in person and hope you have a safe holiday weekend.

David.

--

David W. Schnare, Esq. Ph.D.
The Law Center at ATI



Kast, Richard (rck4p)

From: Kast, Richard (rck4p)
Sent: Friday, May 27, 2011 3:26 PM
To: 'Dr. Schnare'
Subject: RE: Quick note

David:

Thanks for the note. While we are used to the hyperbole and error that has pervaded much of the reporting on this matter, some of what you characterize as "noise" after Tuesday's court hearing was particularly disturbing in its implication that the Protective Order did not exist or was of no moment. I would appreciate your reassurance that you and Mr. Horner remain fully aware of the requirements for confidentiality and nondisclosure imposed by the Court, and will do what you can to dispel the misinformation that provided the basis for such articles as the one that appeared in "The Washington Times." As I'm sure you can imagine, there has been a good deal of discussion here after that article about whether we need to seek further assurances from the Court to be able to continue to have faith in the process agreed to Tuesday.

I hope you have a good holiday weekend as well. I will be in touch next week.

- Rick

From: Dr. Schnare [mailto:schnareat@gmail.com]
Sent: Thursday, May 26, 2011 2:47 PM
To: Kast, Richard (rck4p)
Subject: Quick note

Rick:

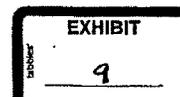
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Nice to meet you in person and hope you have a safe holiday weekend.

David.

--

David W. Schnare, Esq. Ph.D.
 The Law Center at ATI



Kast, Richard (rck4p)

From: ATImail <schmareati@gmail.com>
Sent: Friday, May 27, 2011 4:15 PM
To: Kast, Richard (rck4p)
Subject: Re: Quick note

Rick,

The most disturbing reporting suggested that we would use any knowledge we gain to game the system.

I responded to one blog, explaining that Horner and I are honorable men that are professionally bound to honor both the letter and the spirit of the law and our personal commitments. Further, I made a strong point on this to one reporter. None of that made it into print, sadly. Nevertheless, please reassure your colleagues that I will countenance no abrogation of our duty to the court and to UVA. Finally, it just is not how I do law.

Best
d

D W Schnare

On May 27, 2011, at 3:25 PM, "Kast, Richard (rck4p)" <rck4p@eservices.virginia.edu> wrote:

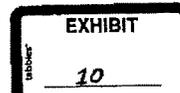
David:

Thanks for the note. While we are used to the hyperbole and error that has pervaded much of the reporting on this matter, some of what you characterize as "noise" after Tuesday's court hearing was particularly disturbing in its implication that the Protective Order did not exist or was of no moment. I would appreciate your reassurance that you and Mr. Horner remain fully aware of the requirements for confidentiality and nondisclosure imposed by the Court, and will do what you can to dispel the misinformation that provided the basis for such articles as the one that appeared in "The Washington Times." As I'm sure you can imagine, there has been a good deal of discussion here after that article about whether we need to seek further assurances from the Court to be able to continue to have faith in the process agreed to Tuesday.

I hope you have a good holiday weekend as well. I will be in touch next week.

- Rick

From: Dr. Schnare [mailto:schnareati@gmail.com]
Sent: Thursday, May 26, 2011 2:47 PM



409

To: Kast, Richard (rck4p)
Subject: Quick note

Rick:

Please let your colleagues know that the noise that has arisen since Tuesday is just noise. I look forward to discussing with you how we can bring our disparate philosophies together into a sensible approach to disclose that which it is proper to disclose, without visiting harm on the academic community. I've been thinking about how to do that, and before our side begins to sift through the excluded documents, I'd like to take some time to come down to the school and sit with you and faculty representatives to discuss these issues. Maybe it won't result in anything, but I hold out hope that it will.

Nice to meet you in person and hope you have a safe holiday weekend.

David.

--

David W. Schnare, Esq. Ph.D.

The Law Center at ATI

Kast, Richard (rck4p)

From: Dr. Schnare <schnareati@gmail.com>
Sent: Wednesday, June 01, 2011 12:14 PM
To: Kast, Richard (rck4p)
Cc: Chris Horner
Subject: Re: Proposed meeting

Rick:

Thanks for your timely response. Both Mr. Horner and I take our responsibilities to the Court very seriously, but understand the sensitivities at issue in this highly public matter. To that end, Mr. Horner will send you an email documenting his full understanding of the responsibility he took on when he signed the attachment to the protective order and his continuing commitment to that.

On a second point, although it was my suggestion, we would like to pull back from one aspect of this meeting. The principle decision-making parties to this matter are the Rector, for whom the Provost is standing in, and those who provide advice to the Provost, including the general counsel (and staff) who are the attorneys of record, as well. This list does not include the Chair of the Faculty Senate, and as such, we would rather no one attend in that role.

I am free most of next week. I am not sure whether Mr. Horner will be available to attend, but if he is, he will provide you dates when he is available.

Best regards,
David

On Wed, Jun 1, 2011 at 11:36 AM, Kast, Richard (rck4p) <rck4p@eservices.virginia.edu> wrote:

David:

I have discussed your proposal with the General Counsel. We are willing to arrange a meeting but he has asked that we first receive reassurance from Mr. Horner that he too understands and appreciates the requirements imposed by the Protective Order. I'm sure that you believed you were responding for him as well in your previous response on this issue but the General Counsel would like to hear from Mr. Horner directly.

Regarding the requested meeting, we would propose that besides me, the following would be in attendance: Paul Forch, the General Counsel; Madelyn Wessel, another lawyer in our office who has been involved with the issues raised by your request; the University Provost Milton Adams; and also the Chair-Elect to the Faculty Senate (the Chair is currently out of town). We can proceed to arrange this when you let me know what dates might work for you over the next week or so.

Let me know if this sounds useful.



Kast, Richard (rck4p)

From: chornarlaw@aol.com
Sent: Wednesday, June 01, 2011 12:49 PM
To: schnareat@gmail.com; Kast, Richard (rck4p)
Subject: Re: Proposed meeting

Dear Rick,

Please assure the general counsel that that is indeed my signature on the Protective Order bearing my name, executed in your presence in Prince William County.

Although this Order will not take meaningful effect until certain events transpire – sooner rather than later is, as you know, our preference – if s/he has any concerns about my adherence to it, please do not hesitate to have him or her contact me directly.

As to the meeting David suggests, I am afraid that I am unavailable to attend anything in-state until between 7th and 18th June. I have every confidence that David can manage in my absence, running any possible formal agreement(s) past me before ATI signs off.

Yours faithfully,
Chris Horner

-----Original Message-----

From: Dr. Schnare <schmareat@gmail.com>
To: Kast, Richard (rck4p) <rck4p@eservices.virginia.edu>
Cc: Chris Horner <CHornerLaw@aol.com>
Sent: Wed, Jun 1, 2011 12:13 pm
Subject: Re: Proposed meeting

Rick:

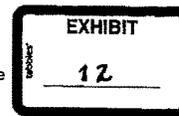
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Best regards,
David

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Regarding the requested meeting, we would propose that besides me, the following would be in attendance: Paul Forch, the General Counsel; Madelyn Wessel, another lawyer in our office who has been involved with the issues raised by your request; the University Provost Milton Adams; and also the Chair-Elect to the Faculty Senate (the Chair is currently out of town). We can proceed to arrange this when you let me know what dates might work for you over the next week or so.

Let me know if this sounds useful.

- R

From: Dr. Schnare [mailto:schnareati@gmail.com]
Sent: Tuesday, May 31, 2011 8:49 AM
To: Kast, Richard (rck4p)
Subject: Proposed meeting

Rick:

I am angered and upset at the mostly irrational and surely uncivil discussion going on (especially on influential internet blogs) with regard to the differences between UVA and GMU in handling recent FOIA requests, and ATI has done little to help in that regard. In contrast, and as the Director of our law center, I am committed to a civil and sensible resolution of our dispute with you and would like to come down to Charlottesville to meet with you, the general counsel, the President and the President of the Senate Faculty in a private and off-the-record session -- one that would fall within the protections of a settlement negotiation, the content of which would not be released to the public by either side.

I believe we have some common ground on protection of academic activities, and I believe we might find a way to draw a fuzzy line between that which must be protected and that which deserves none. This matter will go to court. Bad facts make bad law, so I would like to work with you to ensure we have clear examples for the court, ones that show the distinction between our different points of view. To make that happen, we need to share our points of view, which is the purpose of the meeting.

Please extend my request to those named and let me know when would be a convenient time to schedule a meeting. If you decide not to take up this opportunity, please let me know.

Respectfully,
David.

--

David W. Schnare, Esq. Ph.D.
The Law Center at ATI

..

--

David W. Schnare, Esq. Ph.D.
The Law Center at ATI

Kast, Richard (rck4p)

From: Dr. Schnare <schsnareat@gmail.com>
Sent: Tuesday, May 31, 2011 8:49 AM
To: Kast, Richard (rck4p)
Subject: Proposed meeting

Rick:

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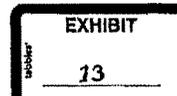
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Please extend my request to those named and let me know when would be a convenient time to schedule a meeting. If you decide not to take up this opportunity, please let me know.

Respectfully,
David.

--

David W. Schnare, Esq. Ph.D.
The Law Center at ATI



April 14, 2011

VIA Fax & E-Mail To:
434-924-3792
president.sullivan@Virginia.EDU

Teresa A. Sullivan, President
University of Virginia
Madison Hall
P.O. Box 400224
Charlottesville, VA 22904-4224

Dear President Sullivan:

We understand that in January 2011, the American Tradition Institute Environmental Law Center, Virginia Delegate Robert Marshall, and one other Virginia resident affiliated with the Competitive Enterprise Institute filed a request with the University of Virginia under the state's Freedom of Information Act (FOIA). The request is substantially similar to the Civil Investigative Demands issued by Virginia Attorney General Kenneth Cuccinelli to the University of Virginia for a variety of records related to Professor Mann's research, and, like the CIDs, this request encompasses a broad array of materials produced and exchanged by Professor Mann in the course of his work as a professor and scholar working on topics related to global climate change.

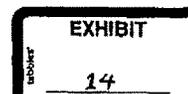
Although this request was made several months ago, it appears to bear similarities to the FOIA requests recently served upon the University of Wisconsin-Madison and the labor studies departments at the University of Michigan, Michigan State University, and Wayne State University, seeking e-mails exchanged by professors in the course of their scholarly work.

As you may know, after careful consideration of the FOIA requests, including a review of the emails for any violations of Wisconsin law or university policy (of which it found none), the University of Wisconsin-Madison conducted a balancing test and concluded that it could appropriately exempt "private email exchanges among scholars that fall within the orbit of academic freedom and all that is entailed by it." As Chancellor Biddy Martin explained in her statement of April 1, 2011:

Academic freedom is the freedom to pursue knowledge and develop lines of argument without fear of reprisal for controversial findings and without the premature disclosure of those ideas. . .

When faculty members use email or any other medium to develop and share their thoughts with one another, they must be able to assume a right to the privacy of those exchanges, barring violations of state law or university policy. Having every exchange of ideas subject to public exposure puts academic freedom in peril and threatens the processes by which knowledge is created. The consequence for our state will be the loss of the most talented and creative faculty who will choose to leave for universities where collegial exchange and the development of ideas can be undertaken without fear of premature exposure or reprisal for unpopular positions.¹

¹ Chancellor Martin's statement is available on the University of Wisconsin-Madison's website, at <http://www.news.wisc.edu/19190>. In addition, see <http://www.news.wisc.edu/19196> for a letter from the office of the general counsel at the University of Wisconsin setting out the specific exemptions and the university's justification for invoking each.



The undersigned organizations, dedicated both to academic freedom and the exchange of scholarly and scientific ideas and to the critically important ideals of government transparency that are embodied by FOIA, urge the University of Virginia to follow Chancellor Martin's lead in balancing the interests in public disclosure against the public interest in academic freedom, which the University of Virginia has recognized in its faculty handbook as "an essential ingredient of an environment of academic excellence."

In addition, the Virginia FOIA statute expressly provides an exemption for "data, records or information of a proprietary nature produced or collected by or for faculty or staff of public institutions of higher education . . . in the conduct of or as a result of research on medical, scientific, technical or scholarly issues . . . where such data, records or information has not been publicly released, published, copyrighted or patented." Furthermore, the federal Family Educational Rights and Privacy Act compels the university to keep private communications related to students and implies similar protections for potential students. The undersigned organizations therefore also urge the University of Virginia to carefully consider whether the materials sought fall within these statutory exemptions.

As the United States Supreme Court said in the seminal case of *Sweezy v. New Hampshire*, "The essentiality of freedom in the community of American universities is almost self-evident. . . . To impose any straitjacket upon the intellectual leaders in our colleges and universities would imperil the future of our Nation. . . . Scholarship cannot flourish in an atmosphere of suspicion and distrust. Teachers and students must always remain free to inquire, to study and to evaluate, to gain new maturity and understanding; otherwise our civilization will die."

Please do not hesitate to call upon us if we can be of assistance in your assessment of this FOIA request and your balancing of the twin values of academic freedom and government transparency.

Sincerely Yours,

Alliance for Justice
 American Association of University Professors
 American Civil Liberties Union of Virginia
 Center for Inquiry
 Climate Science Watch
 Council of Environmental Deans and Directors
 National Coalition Against Censorship
 National Council for Science and the Environment
 People For the American Way
 Robert O'Neil, Director of the Thomas Jefferson Center for the Protection of Free Expression
 The Ornithological Council
 Union of Concerned Scientists

cc:
 Richard Kast, Associate General Counsel
 Carol Wood, Associate Vice President for Public Affairs



Lawrence Livermore National Laboratory

Dr. Benjamin D. Santer
 Program for Climate Model Diagnosis and Intercomparison TEL: (925) 423-3364
 PCMDI, Lawrence Livermore National Laboratory FAX: (925) 422-7675
 P.O. Box 808, Mail Stop 1-103 email: santer1@llnl.gov
 Livermore, CA 94550

August 15, 2011

Dr. Teresa A. Sullivan, President
 University of Virginia
 Madison Hall
 P.O. Box 400224
 Charlottesville, VA 22904

Dear Dr. Sullivan,

I am extremely concerned by the ongoing efforts of the American Tradition Institute (ATI) to obtain access to personal email correspondence between Professor Mann and over 30 other climate scientists. I am one of those "other climate scientists", and so have direct personal interest in this issue.

Let me briefly introduce myself. I am a climate scientist at Lawrence Livermore National Laboratory in California. I have devoted my entire scientific career to the study of the nature and causes of climate change. In the mid-1990s, I was Convening Lead Author of Chapter 8 ("Detection of Climate Change and Attribution of Causes") of the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). After several years of evaluating the then-available scientific evidence, and after rigorous peer and Government reviews, Chapter 8 concluded that "the balance of evidence suggests a discernible human influence on global climate".

Subsequent to publication of the Second Assessment Report (SAR) in 1996, I spent several years defending the science behind the "discernible human influence" finding – and the process by which this finding had been reached. I also had to respond to public challenges to my integrity and the credibility of my own scientific research. Such challenges have continued to this date.

In 2001, the IPCC published its Third Assessment Report (TAR). The research conducted by Professor Mike Mann and his colleagues was prominently featured in the TAR. Professor Mann's work showed that the warming of Earth's surface during the second half of the 20th century was highly unusual in the context of our best scientific understanding of temperature fluctuations over



the last millennium. This was a key scientific advance relative to the IPCC Second Assessment Report.

Since 2001, Professor Mann has encountered the same challenges I experienced after publication of the IPCC's SAR. The "playbook" is all-too familiar.¹ It begins with attempts to attack the science. If the science is unshakable, the next step is to attack the integrity of the scientific messengers. The motives and integrity of the messengers are questioned. The final step in the "playbook" is overt intimidation. Political pressure is applied. Legal harassment begins. An entire community receives the clear and chilling message: "You could be next."

Professor Mann's research has been subjected to extraordinary scientific scrutiny. His findings are robust. Over a dozen research groups around the world have independently replicated the principal features of the Mann *et al.* "hockey stick" – the reconstruction of hemispheric- and global-scale temperature variations over the last 1-2 millennia. In 2006, after a thorough review of the scientific underpinning of the "hockey stick", the U.S. National Academy of Sciences confirmed that "...the Northern Hemisphere was warmer during the last few decades of the twentieth century than during any comparable period over the preceding millennium."²

The ATI's request to access Professor Mann's personal email correspondence is not based on any legitimate scientific concerns. As noted above, the quality and credibility of Professor Mann's research has already been affirmed by the highest scientific authority in the nation – the U.S. National Academy of Sciences.

Professor Mann has spent most of his career trying to advance our scientific understanding of the nature and causes of climate change. The ATI has no interest in advancing scientific understanding. They seek to sift through potentially thousands of emails, searching for any information that might be taken out of context. In the aftermath of "Climategate", we have seen many examples of how innocent phrases can be removed from their contextual framework, and are then publicly portrayed as examples of suspect behavior. We know how this playbook works.

In summary, Professor Mann's only "transgression" is that he has performed cutting-edge research in the public and national interest. His research has given scientists and policymakers an invaluable long-term context for the late-20th century changes in Earth's surface temperature. Mike Mann has shown great courage and resilience under extreme pressure. I am proud to call him a colleague and a friend.

¹This calculated strategy was recently described by Naomi Oreskes and Erik Conway in *Merchants of Doubt*, a book which was nominated for the 2010 Los Angeles Times Book Prize in the "Science and Technology" category.

²National Research Council, 2006: *Surface Temperature Reconstructions for the Last 2,000 Years*. National Academies Press, Washington D.C., 196 pp.

I respectfully urge you to reconsider your decision to allow the ATI access to Professor Mann's email correspondence with scientific colleagues. I do not believe this decision is consistent with the University of Virginia's illustrious history as a strong proponent of academic freedom.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Ben Santer", with a long horizontal flourish extending to the right.

Dr. Ben Santer

Member, U.S. National Academy of Sciences
Fellow, American Geophysical Union
Distinguished Scientist, U.S. Dept. of Energy Office of Biological and Environmental Research
John D. and Catherine T. MacArthur Fellow



Global Change Institute
 Director
 Professor Ove Hoegh-Guldberg
 CRICOS PROVIDER NUMBER 300258

August 13, 2011

Professor Teresa A. Sullivan
 President, University of Virginia
 Charlottesville VA 22904
 United States of America

Re: The University of Virginia's agreement with the American Tradition Institute

Dear Professor Sullivan,

I am writing with extreme disquiet over the University of Virginia's agreement with the American Tradition Institute to allow exempt e-mail correspondence and other documents to be exposed to parties that have shown their clear intent to harass internationally respected scientists such as Professor Michael Mann.

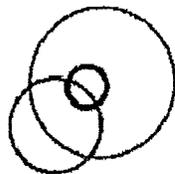
Surely this is not the national or international reputation you should be pursuing for your university? Exposing your students and researchers to these conditions will ultimately destroy the ability for anyone at your university to indulge in free and frank correspondence. Apart from the serious deviation that this will cause from the core principles of academic freedom, I expect that your decision will have extremely negative consequences for your institution in terms of its ability to attract talented students and leading researchers.

Professor Michael Mann is one of the world's leading climate scientists and it seems particularly objectionable that your university has given in to the unethical requests of an Institute that has shown its clear intent to prevent the science of climate change from being openly discussed and recognised. I would urge you to reconsider the steps you have taken or else suffer a major blow to your reputation.

Hopefully, you will see the serious error that you have made and will reverse your decision immediately. My colleagues and I will be watching your decision carefully, and look forward to your reply.

Sincerely,

Professor Ove Hoegh-Guldberg
 Queensland's Smart State Premier's fellow



LAMONT-DOHERTY
EARTH OBSERVATORY

THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

30 August 2011

To: Dr. Teresa Sullivan, President
University of Virginia
Madison Hall
P.O. Box 400224
Charlottesville, VA 22904

Dear Dr. Sullivan,

I am writing due to my great concern regarding the ongoing attempts of the American Tradition Institute (ATI) to obtain access to the personal email letters between Dr. Michael E. Mann and other climate scientists, including myself.

My research over the past three decades includes the use of tree-ring reconstructions for the past millennium to infer past temperature trends and the magnitude of recent anthropogenic impacts on climate. I am a paleoclimatologist and Associate Director at the Lamont-Doherty Earth Observatory, part of Columbia University in New York.

These are personal emails that are not relevant to valid scientific concerns, and will likely be taken out of context. Please reconsider your decision to allow the ATI access to these personal emails.

Thank you very much for your consideration.

A handwritten signature in cursive script that reads "Rosanne D'Arrigo".

Rosanne D'Arrigo,

Senior Research Scientist, TRL-LDEO
Associate Director, Biology and Paleo-Environment Division, LDEO
Tree-Ring Laboratory, Lamont-Doherty Earth Observatory
Palisades, NY 10964



National Center for Atmospheric Research
Climate and Global Dynamics Division
Climate Analysis Section

Kevin E. Trenberth
trenberth@ucar.edu, <http://www.cgd.ucar.edu/cas/trenberth.html>
 P. O. Box 3000 • Boulder, CO 80301
 Tel: 303-497-1318 • Fax: 303-497-1333

August 28, 2011

Dr. Teresa A. Sullivan, President
 University of Virginia
 Madison Hall
 P.O. Box 400224
 Charlottesville, VA 22904

Dear Dr. Sullivan,

Along with other scientists, I am very concerned by the ongoing efforts of the American Tradition Institute (ATI) to obtain access to personal email correspondence between Professor Mann and over 30 other climate scientists. As one of those "other climate scientists", I have a direct personal interest in this issue.

I am a distinguished senior scientist at NCAR. I have been extensively involved into climate research; I have been prominent in the scientific assessments of the Intergovernmental Panel on Climate Change (IPCC), and a leader of the World Climate Research Programme. I currently chair the GEWEX (Global Energy and Water Cycle Experiment) Scientific Steering Group, for example. You can find a lot more about my work and credentials on my web site, listed above. I have coauthored a couple of articles with Dr. Mann. I was a Coordinating Lead Author of Chapter 3 of the last IPCC WG I report with Professor Phil. Jones from the Climatic Research Unit of the University of East Anglia. It was Jones' email that was hacked under what is sometimes derogatorily called "climategate" in which Dr. Mann and my emails were also featured. The story of how one of my emails went viral and was distorted is given at <http://www.cgd.ucar.edu/cas/Trenberth/statement.html>.

The moral is that even innocent emails can be taken out of context and distorted. This has also happened with Dr. Mann in an even more pronounced way – not because he did anything wrong but simply because he did high profile and important research, that has implications for political actions. Several investigations have cleared Dr. Mann in spite of intense scrutiny.

I respectfully urge you to reconsider your decision to allow the ATI access to Professor Mann's email correspondence with me and other scientific colleagues. I do not believe this decision is consistent with the University of Virginia's very distinguished history as a strong proponent of academic freedom.

Sincerely

A black and white image of a handwritten signature in cursive script, which reads "Kevin E. Trenberth".

Kevin E Trenberth

Fellow American Association Advancement of Science,
 Fellow American Geophysical Union
 Fellow American Meteorological Society
 Honorary, Fellow Royal Society New Zealand.

The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research under sponsorship of the National Science Foundation.



**UNIVERSITY of
MASSACHUSETTS
at Amherst**

Morrill Science Center
611, North Pleasant Street
AMHERST, MA 01003-9297

Prof. Raymond S. Bradley

**DEPARTMENT OF
GEOSCIENCES**

Tel: 413-545-0745
Fax: 413-545-1200

rbradley@geo.umass.edu

August 28th, 2011

Dr. Teresa A. Sullivan, President
University of Virginia
Madison Hall
P.O. Box 400224
Charlottesville, VA 22904

Dear President Sullivan,

I am writing to express my deep concerns about the request of the American Tradition Institute (ATI) to obtain personal email correspondence between Professor Michael Mann and other climate scientists. As I have worked with Mike Mann for many years, following his postdoc research here at the University of Massachusetts, no doubt many of these emails include correspondence to and from me. I do not know what the legal basis is for their request, but I certainly do not give my permission for the release of any email correspondence that involves me. I consider this a breach of confidentiality and an attack on academic freedom. I should note that this request is not unique. Similar efforts have been made by other politically-motivated organisations, to (*inter alia*) the University of Massachusetts and the University of Arizona. These requests were resisted. Given that this strategy of dredging through email for anything that might be taken out of context and used for political purposes could develop into a much larger problem, with enormous implications for all aspects of academic freedom, I urge you to forcefully reject the ATI request. I feel sure that the legal counsels of my institution and those of other Universities would stand together with the University of Virginia in opposing these intrusive requests.

I am sure that you are aware of the on-going harassment of climate scientists (most prominently Mike Mann) by a large number of individuals and organisations such as the ATI. This is part of a larger campaign to confuse the public about the important issues of climate change, and intimidate climate scientists who have been at the cutting edge of this research. Mike Mann is one of those who has been singled out for particular abuse. I have recently documented this deliberate strategy in my book, "**Global Warming and Political Intimidation**" (University of Massachusetts Press, 2011). The ATI request follows the same playbook that was applied to Ben Santer, Phil Jones and other leading climatologists.

I end my book by quoting from the argument made by your University when it filed a response to the suit brought by Virginia Attorney-General Cuccinelli—another example of political intimidation. In rejecting his request you stated,

"Academic freedom is essential to the mission of our Nation's institutions of higher learning and a core First Amendment concern. As Thomas Jefferson intended, the University of Virginia has a long and proud tradition of embracing the "illimitable freedom of the human mind" by fully endorsing and supporting faculty research and scholarly pursuits. Our Nation also has a long and proud tradition of limited government framed by enumerated powers, which Jefferson ardently believed was necessary for a civil society to endure.....Unfettered debate and the expression of conflicting ideas without fear of reprisal are the cornerstones of academic freedom; they consequently are carefully guarded First Amendment concerns."

Indeed, ***"the unfettered debate and the expression of conflicting ideas without fear of reprisal are the cornerstones of academic freedom"***. The ATI request is an assault on these values and I urge you to reject their request and stand firm in defense of the free exchange of ideas without the fear of harassment such as this.

Sincerely,

A black rectangular box containing a white, handwritten signature that reads "Ray Bradley".

Raymond S. Bradley
Distinguished Professor
Director, Climate System Research Center

Dr. Eugene R. Wahl
 Paleoclimatology Branch/World Data
 Center for Paleoclimatology
 NOAA's National Climatic Data Center
 325 Broadway, Code E/CC23
 Boulder, CO 80305-3328

Dr. Teresa A. Sullivan, President
 University of Virginia
 Madison Hall
 P.O. Box 400224
 Charlottesville, VA 22904

September 18, 2011

Dear Dr. Sullivan,

Please allow me to introduce myself. I am a scientist specializing in paleoclimatology, the study of past climates. I write in regard to my familiarity with, and direct relation to, attempts by the American Tradition Institute (ATI) to obtain the personal email correspondence of Dr. Michael Mann with a group of over 40 scientists and other individuals, of whom I am one.

I would like to offer three perspectives in order to help contextualize the situation, and in the process to make a plea for you to carefully consider the decisions you may be required to make in relation to allowing ATI access to the messages and other materials in question -- to help maintain the long tradition of academic freedom at the University of Virginia.

First, I have read the letter on this matter from Dr. Benjamin Santer of Lawrence Livermore National Laboratory, and concur with it. In particular, I believe Dr. Santer has clearly and succinctly laid out the strategic nature of the attacks both he and Dr. Mann have undergone for their path-breaking work and results that have been prominently featured in the Intergovernmental Panel on Climate Change (IPCC) Second and Third Assessment Reports. As Dr. Santer points out, development of climate science is not furthered by the ATI request, which in fact has a clear negative impact on the scientific community, at the very least in terms of engendering fear. Dr. Santer mentions the 2006 report by the National Academy of Science that affirmed the quality and credibility of Dr. Mann's work. Subsequent to his letter, the Inspector General of the National Science Foundation found no basis in relation to a variety of questions related to Dr. Mann and his work while he has been at the Pennsylvania State University, after his tenure with the University of Virginia.

Second, I would like to emphasize a point that often goes neglected in relation to Dr. Mann's scientific contributions. This is the fact that Dr. Mann's research focus has largely targeted more fundamental questions than global and hemispheric average temperatures. In particular, Dr. Mann has done path-breaking work in the development of what are termed "climate field reconstructions" (CFRs): understandings of past climate that allow systematic comparison of the spatial expression of climate in one part of the planet with that in other parts. CFR differs fundamentally from attempts to make compilations of past climate patterns from "point source"

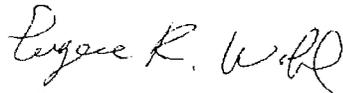
data, which are developed at specific locations without direct connection to how this information relates to larger-scale patterns. CFR has been an important breakthrough in paleoclimate science, and Dr. Mann has been one of the key leaders in its development, including while he was at the University of Virginia. Even more fundamentally, Dr. Mann has been at the forefront of applying CFR results to critical questions about centennial- and millennial-scale climate variability over the past 2000 years: in particular, concerning the behavior of the El Niño-La Niña/Southern Oscillation (ENSO) system in the tropical Pacific and Indian Ocean regions, whose variability has global-scale impacts.

Third, I would like to mention that I was directly involved in a thorough-going evaluation of the early CFR work of Dr. Mann and his colleagues that lay behind the Northern Hemisphere temperature reconstruction which was prominently cited in the IPCC Third Assessment Report. I and my colleague, Dr. Caspar Ammann, looked carefully into a set of methodological criticisms published regarding Dr. Mann's and his colleagues' work. We found these criticisms to be largely without basis, and identified that the components we found to be potentially meaningful had only very small impact, and no meaningful effect, on the results. In conclusion, we found "no evidence for removing the MBH [Mann and co-authors Raymond Bradley and Malcolm Hughes] Northern Hemisphere temperature reconstruction from the list of important climate reconstructions of the past six centuries, on the basis of alleged "flaws" in its use of proxy data or underlying methodology." [Climatic Change (2007) 85: 33–69] To my understanding, it is primarily on the basis of this work that I am included in the ATI list, even though it was still only in the early stages of editor's review at the time Dr. Mann left the University of Virginia. It is for this reason that I find Dr. Santer's analysis that leads to the sentence, "You could be next," consistent with my own experience.

In closing, I urge you to consider this matter within the larger context of academic freedom, and freedom of thought and expression generally, which are critical to advancing scientific knowledge and to making the best use of that knowledge for the benefit of society. I do not believe the May 24, 2011 agreement between the University and ATI properly emphasizes this crucial privacy interest in its relation to the equally important need for accountability of public institutions and employees.

Thank you very much for consideration of these perspectives, which I write with deep respect for your role as President of the University of Virginia.

Sincerely,



Dr. Eugene R. Wahl

The perspectives expressed in this letter are mine as an individual, and do not necessarily represent those of the National Oceanic and Atmospheric Administration (NOAA).

Kast, Richard (rck4p)

From: pm <citizenschallenge@gmail.com>
Sent: Sunday, August 21, 2011 2:05 PM
To: rck4p@virginia.edu
Cc: president.sullivan@Virginia.EDU; fs4f@virginia.edu
Subject: Open letter regarding the ATI witch hunt targeting Michael Mann

Mr. Kast,
 Your agreement with American Tradition Institute and the University is most disappointing. I would be nice to see you do more to protect academic freedom in the face of a wanton political witch hunt that has learning about our climate as it's lowest priority.

Please don't roll over for them.

With disappointment and despair,
 Sincerely,

Peter Miesler

 Open Letter to
 Teresa A. Sullivan, President
 University of Virginia
 Madison Hall
president.sullivan@Virginia.EDU

Honorable President Sullivan,
 I'm just a little guy watching this cynical attack on academia that has been playing out between AG Cuccinelli and now the American Tradition Institute vs. the University of Virginia from the sidelines.

You certainly know the facts better than I do so I won't presume to add anything to that. Still considering these sorts of attacks on science are happening with greater frequency I feel compelled to share some frank personal observations regarding the important precedent you will be setting as you move forward.

Have you given due consideration to the type, that is motivation, of the desired search being attempted? What about Americans, including scientists, historic respect for personal freedom and privacy? Isn't that worth defending with vigor?

Academics are thinkers, most are also gregarious, that is, with those who are intellectually compatible. Personal discussions and musing... tossing out wild conjectures... investigating problems from every angle... playing devil's advocate... sharing information and mistakes... chewing on and digesting every scrap of information they come across. Then they go to work following established protocols in their scientific field and publications.

Like most motivated self-aware individuals they do their best work possible. Their goals are accuracy in their observations, leading to an educated realistic understanding, striving to continue filling in missing details and building upon their current knowledge.

Moreover there are many of them, always looking over each others shoulders, checking and cross checking, looking for and following new leads, or gaps, or perceived mistakes in others work. Given the global community of competing scientists there are many checks and balances at work that despite all the blogosphere/media trash-talk simply have not been shown to be broken.

It is telling that the Cuccinelli, ATI, et al. have presented no actual indication of actual fraud. They simply have faith that if they dig deep enough they will find something... anything, to help them "nail" Mann. What's right about that?

May I ask: Why are personal emails and working notes suddenly important for discovery regarding the voracity of the published global temperature records? Specially considering the many varied independent studies that support Mann et al's basic temperature reconstruction with a high degree of consistency.

It's this flaw in ATI/Cuccinelli's logic that they should be pressed on. What are they trying to find that is relevant to the scientific debate? They have produced nothing, instead resembling bullies who resent the scientists work thus resort to witch-hunts for information that has no bearing on science, but might offer some useful dirt anyways.

Why would you consent to such an unwarranted intrusion at your university?

You represent the University of Virginia, I like to imagine a proud university, a bastion of thought, intellectual freedom, and unfettered learning, yet sounds like you are getting ready to allow obviously politically dedicated folks... mind you, folks with a passionate sense of mission for stopping any Global Warming awareness, into the closets and dresser drawers of anyone whom they have a grudge against? What's up with that?

Where is the defense of scientific integrity in that?

Sincerely,

Peter Miesler
Durango, Colorado
citizenschallenge@gmail.com
<http://citizenschallenge.blogspot.com>



April 21, 2011

American Association of University Professors
1133 Nineteenth Street, NW
Suite 200
Washington, D.C. 20036-3655

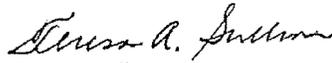
Dear Messrs. and Mmes.:

This will respond to your letter of April 14, 2011, submitted on behalf not just of the AAUP, but also the Alliance for Justice, the ACLU of Virginia, the Center for Inquiry, Climate Science Watch, the Council of Environmental Deans and Directors, the National Coalition Against Censorship, the National Council for Science and the Environment, People for the American Way, Robert O'Neil as Director of the Thomas Jefferson Center for the Protection of Free Expression, the Ornithological Council, and the Union of Concerned Scientists.

As you know, as evidenced by its opposition to the Civil Investigative Demands issued by Virginia's Attorney General, the University of Virginia is quite conscious of the academic freedom interests about which you express concern. Academic freedom issues are certainly part of the analytic framework the University's Office of General Counsel is bringing to its review of documents potentially responsive to the request about which you inquire. It is my understanding that all available exemptions in Virginia's Freedom of Information Act will be claimed in our response. We are also keenly aware of the constraints imposed on disclosure by the Family Educational Rights and Privacy Act, and other provisions of federal and state law to which Virginia's Freedom of Information Act is explicitly subject.

While the University is, of course, committed to complying with the requirements of law, I wish to reassure you that this commitment will be carried out to the fullest extent possible consistent with the interests of faculty in academic freedom and scholarship.

Very truly yours,


Teresa A. Sullivan
President

TAS:rk
cc: Mr. Richard Kast
Ms. Carol Wood



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'Hockey Stick' Creator Michael Mann Seeks Court's Help to Ensure No Inquiry, No 'Exoneration'

Published September 6, 2011 at 11:40 am

Dr. Michael Mann, lead author of the discredited "hockey stick" graph that was once hailed by the UN Intergovernmental Panel on Climate Change as the "smoking gun" of the catastrophic man-made global warming theory, has asked to intervene in American Tradition Institute's Freedom of Information Act lawsuit that seeks certain records produced by Mann and others while he was at the University of Virginia, for the purpose of keeping them hidden from the taxpayer.

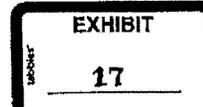


Latest News

ATI has produced a three-part video series that explains why Colorado. Part One explains why wind power is not clean or unconstitutional; Part Three explains what the possible outcome

What's Happening Now
[ATI Video Channel](#)

<http://www.atinstitute.org/>



UNIVERSITY
OF VIRGINIA
OFFICE of the GENERAL COUNSEL

Via Electronic Mail

August 31, 2011

David W. Schnare, Esq.
Christopher Horner, Esq.
The Law Center at the American Tradition Institute
2020 Pennsylvania Avenue, N.W. # 186
Washington, D.C. 20006

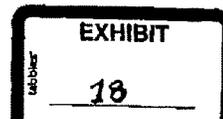
**RE: The American Tradition Institute, et al. v.
The Rector and Visitors of the University of Virginia
Civil Docket No. CL 11-3236**

Dear Dr. Schnare and Mr. Horner:

You will recall that there were expressions of concern after the entry of the Order on Protection of Documents ("Protective Order"), and the corollary Agreements Concerning Confidentiality ("Confidentiality Orders") signed by you in this case, that your interests as parties to this litigation would outweigh your ethical duties as counsel. I raised these concerns at the time and you each assured me that you were fully aware of the duties imposed by the Confidentiality Orders and would rigidly comply with them. A new concern has now arisen that I would appreciate your responding to.

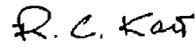
This concern focuses on the meaning of Section C (2) of the Protective Order which would permit disclosure of documents shared with you as counsel for the limited purposes set forth in the order to "[a]ny other court of competent jurisdiction pursuant to lawful process or order." The specific concern focuses on the possibility that some other entity, whether public or private, might issue or seek to issue a civil investigative demand ("CID"), subpoena, or other demand or request for the documents held pursuant to the Protective Order. It is clear that such a CID, subpoena, or other demand or request would not come within the language of this exception to the Protective Order. To reassure those who have raised this issue, however, I would appreciate each of you signing and returning a copy of this letter to me to indicate that: (1) you agree that the language of the Protective Order would not enable disclosure of these confidential materials or information pertaining thereto pursuant to a CID, subpoena, or other demand or request not directly issued by a court of competent jurisdiction, and (2) should you receive such a CID, subpoena, or other demand or request you would immediately give notice to us and would take no action to comply until we had a reasonable opportunity to challenge the CID, subpoena, or other demand or request as not in compliance with the Protective Order.

Madison Hall • P.O. Box 400225
Charlottesville, VA 22904-4225
Phone: 434-924-3586



I would appreciate receiving your responses no later than Friday, September 2nd. Thank you for your consideration of this request.

Sincerely,



Richard C. Kast
Associate General Counsel and
Special Assistant Attorney General

I agree with the above:

David W. Schnare

Date: _____

Christopher Horner

Date: _____



Environmental Law Center
at the American Tradition Institute

September 2, 2011

Via Electronic Mail

Richard C. Kast
Office of the General Counsel
University of Virginia
Madison Hall – P.O. Box 400225
Charlottesville, VA 22904-4225

Re: ATI v. UVA – CL 11-3236

Dear Mr. Kast:

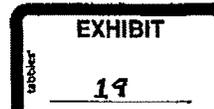
We are in receipt of your letter of August 31, 2011, to which this is a response. In your letter you refer to Section C(2) of the Protective Order issued under the subject litigation, raising a concern that some other entity, whether public or private, might issue or seek to issue a civil investigative demand (“CID”), subpoena, or other demand or request for the documents held pursuant to the Protective Order.

As you are fully aware, Section C of the Protective Order authorizes the University of Virginia (“UVA”) to disclose exempt information to two of ATI’s counsel, in this case, me and Mr. Horner, and the scheduling order requires UVA to produce the documents to us on a date certain. Section C of the Protective Order also authorizes disclosure of exempt information “only in connection with this action” and “may be disclosed only as necessary in connection with this action to the individuals set forth below”, which includes any other court of competent jurisdiction pursuant to lawful process or order.

Frankly, we are perplexed by your concern. The language in the protective order is extremely clear. It specifically disallows release of the exempt information to anyone, including the Attorney General and any court of competent jurisdiction, unless the release is “in connection with this action.” The only courts of competent jurisdiction contemplated under the Protective Order and in connection with this action would be the two Virginia appellate courts that might be asked to review the decisions of lower courts on this matter. As UVA is a party to this matter, it would have notice of any such disclosure long before it was made. Further, as required under the Protective Order, Section D, the parties have a duty to use as little exempt information as possible in any pleading, motion, exhibit or other paper filed with the court and any such exempt information must be filed under seal, thus providing still another layer of protection to the exempt information, even to courts of competent jurisdiction beyond the Circuit Court.

We are perplexed because we are confident you have already advised your clients that if the Attorney General issues a CID to us, or we receive some other demand for the exempt documents under a lawful process or order from any court other than the one before which the

Environmental Law Center at the American Tradition Institute • 2020 Pennsylvania Ave. NW #186
Washington, D.C. 20006 • www.atinstitute.org



parties now stand, Mr. Horner and I have no option but to refuse to disclose the exempt information, making reference to the Protective Order.

Mr. Horner and I have no duty or need to make any further attestation regarding this matter. Your demand is not merely unnecessary, it continues a pattern of behavior that has on some occasions expressly and, on others, impliedly called our professionalism and honor into question. That notwithstanding, however, if you insist on still another demonstration of our sincerity to act in a continuingly professional manner, we will provide that. First, however, we require you to openly admit in writing what you have repeatedly admitted in personal conversations and what you have never denied in public or in court, to wit, that you have advised those who reviewed the documents to "broadly apply" the exemptions available under the Virginia Freedom of Information Act. Once we receive that admission, Mr. Horner and I will be happy provide additional attestation that we have every intent to follow the Protective Order to the letter.

Sincerely,

A handwritten signature in black ink, appearing to read "DWSchnare", written over a horizontal line.

David W. Schnare
Director

The Environmental Law Center

UNIVERSITY
of VIRGINIA
OFFICE of the GENERAL COUNSEL

Via Electronic mail
September 20, 2011

David W. Schnare, Esq.
The Law Center at the American Tradition Institute
2020 Pennsylvania Avenue, N.W. # 186
Washington, D.C. 20006

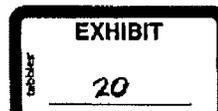
Re: The American Tradition Institute v The Rector and Visitors of the University
of Virginia Civil Action No. CL-11-3236

Dear David:

I am writing to follow up on the email I sent a week ago suggesting that we consider a change in the protective order and process for selecting samples to be used in our briefing of the relevant FOIA exclusions in the present case. Now that the Court has stayed delivery of the documents the University believes to be exempt pending the hearing on November 1st, it seemed timely for me to raise this issue with you again in an attempt to resolve the matter. We do believe the issues raised by Dr. Mann and others in the scientific and scholarly community are significant and merit the Court's consideration. Therefore, we plan to move to reopen certain aspects of the Order as was specifically provided for in Section G ("Right to Seek Modification") if we are unable to reach an accommodation through informal collaboration with you.

The key issues that have been raised center on the dual roles that you and Chris play as both lawyers and founding members of ATI, and the fact that the very documents we believe are not subject to disclosure will nonetheless be provided to you in their entirety in your role as lawyers. No one need contend that either of you would violate the order to comprehend the concern that the order affords you access to emails from members of our faculty and researchers around the world that under our view of the case are clearly entitled to be protected as confidential and private records under the Virginia FOIA. It is also worth noting that Michael Mann and many other scientists have communicated to us their belief that the disclosure of the exempt documents to you and Chris pursuant to the protective order seriously undercuts the entire purpose of Va. Code § 2.2-3705.4 (4) and violates both his privacy interests and the privacy interests of all of the other scientists mentioned in those documents.

In our phone call and in my email, we asked you to consider a potential alternative that we think would be both fair and practical. I want to summarize that suggestion more fully, especially as our own process of review over the last three months has shown us the magnitude of the task that the present order will entail for both parties. Although there are many, many duplicates, the total number of documents we have identified as exempt are over twelve



thousand. Most of these documents are multi-page. My rough estimate is that we are talking about 40,000+ "pages" of textual material.

Our proposal would be to allow us to work through these records and identify an example or two of each type/major topic of exchange found there that we believe to be exempt. We propose to remove personal identifying information from the message, but leave all other material intact to give you a robust understanding of the context and specific content. We would describe our understanding of the message categories (e.g. "email exchange relating to the drafting and planning of a grant proposal;" or, "email exchange relating to manuscript submitted to a scholarly journal;" or, "email exchange discussing response to climate science skeptics;" or "email exchange regarding topics to be debated at scientific meeting"). You could review the list of categories and the samples and suggest other topics or issues you wanted to see a sample exchange on if such exists. We would represent to you as attorneys that the examples were a fair and complete set enabling both parties to make vigorous arguments about the status of such exchanges under the Virginia FOIA.

It would also be possible to build into this process an independent review by a neutral person or magistrate appointed by the Court if you were concerned that Rick and I should not decide on our own whether the examples we offered were comprehensive. That individual could have access to the entire document pool, enabling them to verify (probably through random sampling) that the examples you had received and the categories described were appropriate. And of course, the Court would also be able to review anything it wanted to in camera. It is clear that the Virginia Supreme Court would expect a record containing all of the contested materials under the *Virginian-Pilot* and *Bland* decisions.

As we suggested, this is ultimately an appellate case testing two very different theories about what rights are protected (or not) under the Virginia FOIA. It is hard for us to conceive why anyone would need or want to sort through 40,000 duplicative pages to make compelling arguments on what are finite substantive appellate issues.

Although it is not recent, in searching for possible alternative mechanisms to cull documents for the purposes of argumentation and appellate review in freedom of information cases, we found *Vaughn v. Rosen*, 484 F.2d 820 (D.C. Cir. 1973) and its sequelae most instructive. Vaughn involves a protracted battle under the Federal Freedom of Information Act in which the D.C. Circuit expressed considerable sympathy to the needs of plaintiffs in your position:

In light of this overwhelming emphasis upon disclosure, it is anomalous but obviously inevitable that the party with the greatest interest in obtaining disclosure is at a loss to argue with desirable legal precision for the revelation of the concealed information. Obviously the party seeking disclosure cannot know the precise contents of the documents sought; secret information is, by definition, unknown to the party seeking disclosure. In many, if not most, disputes under the FOIA, resolution centers around the factual nature, the statutory category, of the information sought.

In a very real sense, only one side to the controversy (the side opposing disclosure) is in a position confidently to make statements categorizing information, and this case provides a classic example of such a situation. Here the Government contends that the documents contain information of a personal nature the disclosure of which would constitute an invasion of certain individuals' privacy. This factual characterization may or may not be accurate. It is clear, however, that appellant cannot state that, as a matter of his knowledge, this characterization is untrue. Neither can he determine if the personal items, assuming they exist, are so inextricably bound up in the bulk of the documents that they cannot be separated out. The best appellant can do is to argue that the exception is very narrow and plead that the general nature of the documents sought make it unlikely that they contain such personal information.

The court then observed:

[T]he trial court, as the trier of fact, may and often does examine the document in camera to determine whether the Government has properly characterized the information as exempt. Such an examination, however, may be very burdensome, and is necessarily conducted without benefit of criticism and illumination by a party with the actual interest in forcing disclosure. In theory, it is possible that a trial court could examine a document in sufficient depth to test the accuracy of a government characterization, particularly where the information is not extensive. But where the documents in issue constitute hundreds or even thousands of pages, it is unreasonable to expect a trial judge to do as thorough a job of illumination and characterization as would a party interested in the case.

The court went on to order a "system of itemizing and indexing" of all the documents and remanded the case to the district court for the government to implement the process set forth in the opinion.

On remand, however, the government told the judge that given the numbers of documents involved, compliance with the indexing procedures recommended by the Court of Appeals would take "10,257.1 man-hours or 4.93 man-years, at a total cost to the Government of \$96,176.00. Accordingly, the district court held, a "realistic solution to the dilemma posed by the Court of Appeals . . . became imperative." *Vaughn v Rosen*, 383 F. Supp. 1049, 1052 (D.D.C. 1974).

The solution arrived at, by agreement between the parties, was the submission by the government of nine representative samples of the information sought with identifying details deleted. The parties agreed that the court's decision on the nine representative samples would be determinative as to all of the documents sought. I think it is worth mentioning that the number of documents described in this case was approximately "2,448, filling seventeen standard-size, five-drawer cabinets;" far less than the document count in our present situation. Although my hunch is that the per-document page count was likely more in *Vaughn*, the fact that the plaintiff (and the court) agreed to a very small representative selection given the magnitude of the page count involved seems quite applicable here.

I believe we all agree that our case presents significant and unique questions of substantive and ultimately, appellate law. Clear examples of the types of communications in contest would be very easy to identify from the thousands of emails identified by us as exempt. We hope you would be willing to discuss this alternative solution as I think it would save all of us a considerable amount of time better spent arguing these genuinely important issues on their merits.

Sincerely,



Madelyn Wessel
Associate General Counsel

cc: Peter Fontaine, Esq.

Kast, Richard (rck4p)

From: Dr. Schnare <schnareatl@gmail.com>
Sent: Thursday, September 29, 2011 12:54 PM
To: Wessel, Madelyn (mfw2y)
Cc: Kast, Richard (rck4p)
Subject: Re: Follow-up Conversation

Madelyn:

Frankly, we've had a particularly upsetting family crisis this past week and I am having a very hard time concentrating on those things beyond the family that demand my instant attention. Among other things, tomorrow is my last day as an employee of the U.S. EPA, and I've had to close out a large caseload as well as deal with all manner of federal records matters.

Let's find time to talk next week. Suffice it to say, I've been intimately familiar with Vaughn for many years. As Rick may recall, I asked him quite some time ago whether he would be willing to prepare a Vaughn log. He declined. In any case, I understand what you want to do and I have given thought as to how to do it as it is not unlike what we would have had to do, although we would have examined every email and surely have identified every one we believed demanded exclusion - more or less the reverse of your approach.

Let me review your proposal. As you might imagine, my time next week (and forever thereafter, one hopes) will be my own. Propose a day and time.

David.

On Thu, Sep 29, 2011 at 12:41 PM, Wessel, Madelyn (mfw2y) <mfw2y@eservices.virginia.edu> wrote:

Dear David:

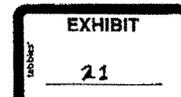
Do you have time in the near future to discuss the proposal I sent you last week regarding an alternative review/culling process for the documents we consider exempt? Rick and I both have time at the end of today, if you happen to be available, or on Monday or Tuesday.

Let us know your availability.

Madelyn

Madelyn Wessel

Associate General Counsel



University of Virginia

P.O. Box 400114

Charlottesville, VA 22904-4114

Tel: 434-982-2941

FAX: 434-924-1431

wessel@virginia.edu

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David W. Schnare, Esq. Ph.D.
Director
The Environmental Law Center at ATI

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Kast, Richard (rck4p)

From: Kast, Richard (rck4p)
Sent: Thursday, September 29, 2011 2:20 PM
To: 'Dr. Schnare'; Wessel, Madelyn (mfw2y)
Subject: RE: Follow-up Conversation

David:

We are both sorry to hear about your family crisis and hope things are resolving for your family.

On the *Vaughn* issue, what I rejected was, of course, the log/indexing approach that was found to be wholly unrealistic and unworkable on remand due to the volume of documents involved, which we are also facing here. What we are proposing is inspired by the approach that was actually taken and worked in *Vaughn*.

Finally, I must say that I am surprised and frankly disturbed by your revelation that you are just now leaving the EPA. You told me when we first met before the initial court appearance in Prince William County Circuit Court on May 24th that you had formerly been with the EPA and were then, and had been for a while, a private, public-interest lawyer. We had recently heard that perhaps you were still with the EPA and wanted to discuss this issue with you as it was so different from what you had told me and was a cause of concern to us on many levels. We should discuss this further when we talk. Madelyn and I are free at the following times next week and I hope one will work for you: Mon., 10/3 11:30-3:00 (11:30 would be ideal); Tue., 10/4 3:00-4:00; Wed., 10/5 9:00-12:00.

- R

From: Dr. Schnare [mailto:schnareati@gmail.com]
Sent: Thursday, September 29, 2011 12:54 PM
To: Wessel, Madelyn (mfw2y)
Cc: Kast, Richard (rck4p)
Subject: Re: Follow-up Conversation

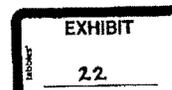
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Let me review your proposal. As you might imagine, my time next week (and forever thereafter, one hopes) will be my own. Propose a day and time.

David.



441

On Thu, Sep 29, 2011 at 12:41 PM, Wessel, Madelyn (mfw2y) <mfw2y@eservices.virginia.edu> wrote:

Dear David:

..

Do you have time in the near future to discuss the proposal I sent you last week regarding an alternative review/culling process for the documents we consider exempt? Rick and I both have time at the end of today, if you happen to be available, or on Monday or Tuesday.

Let us know your availability.

Madelyn

Madelyn Wessel
Associate General Counsel
University of Virginia
P.O. Box 400114
Charlottesville, VA 22904-4114
Tel: [434-982-2941](tel:434-982-2941)
FAX: [434-924-1431](tel:434-924-1431)
wessel@virginia.edu

--

David W. Schnare, Esq. Ph.D.
Director
The Environmental Law Center at ATI

Kast, Richard (rck4p)

From: Dr. Schnare <schinareal@gmail.com>
Sent: Thursday, September 29, 2011 2:32 PM
To: Kast, Richard (rck4p)
Cc: Wessel, Madelyn (mfw2y)
Subject: Re: Follow-up Conversation

Rick:

I have had authority from the agency to do pro bono public interest law for over 5 years now. That is what I represented to you. I never mention my EPA duties when I am doing non-EPA work and I have never used EPA facilities for private work. Whenever we have been together, I have taken leave. The two lives are completely separate. I don't see how that poses any problem, but if you think it is worth discussion, please explain.

As for the phonecall, let's do it at 11:30 Monday as that appears to be the time you most would like to do this.

David:

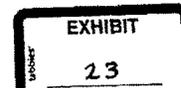
On Thu, Sep 29, 2011 at 2:19 PM, Kast, Richard (rck4p) <rck4p@eservices.virginia.edu> wrote:

David:

We are both sorry to hear about your family crisis and hope things are resolving for your family.

On the *Vaughn* issue, what I rejected was, of course, the log/indexing approach that was found to be wholly unrealistic and unworkable on remand due to the volume of documents involved, which we are also facing here. What we are proposing is inspired by the approach that was actually taken and worked in *Vaughn*.

Finally, I must say that I am surprised and frankly disturbed by your revelation that you are just now leaving the EPA. You told me when we first met before the initial court appearance in Prince William County Circuit Court on May 24th that you had formerly been with the EPA and were then, and had been for a while, a private, public-interest lawyer. We had recently heard that perhaps you were still with the EPA and wanted to discuss this issue with you as it was so different from what you had told me and was a cause of concern to us on many levels. We should discuss this further when we talk. Madelyn and I are free at the following times next week and I hope one will work for you: Mon., 10/3 11:30-3:00 (11:30 would be ideal); Tue., 10/4 3:00-4:00; Wed., 10/5 9:00-12:00.



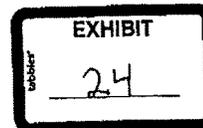
In The Matter Of:
THE AMERICAN TRADITION INSTITUTE v.
RECTOR AND VISITORS

Court
September 16, 2011

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1 V I R G I N I A
2 IN THE CIRCUIT COURT OF PRINCE WILLIAM COUNTY
3 -----X
4 THE AMERICAN TRADITION INSTITUTE :
5 AND THE HONORABLE DELEGATE :
6 ROBERT MARSHALL, :
7 Plaintiffs, :
8 - versus - : CASE NO. CL11003236
9 RECTOR AND VISITORS OF THE :
10 UNIVERSITY OF VIRGINIA. :
11 Defendants. :
12 -----X
13 Manassas, Virginia
14 Friday, September 16, 2011
15 The above-entitled action came on to be heard
16 before the Honorable Gaylord L. Finch, Jr., a judge in
17 and for the Circuit Court for Prince William County, in
18 Courtroom 4, Prince William County Judicial Center, 9311
19 Lee Avenue, Manassas, Virginia, 20110, beginning at
20 approximately 10:24 a.m., when there were present on
21 behalf of the respective parties.
22

1 APPEARANCES:

2 On behalf of the Plaintiffs:

3 DAVID W. SCHNARE, ESQUIRE, PH.D.,
4 Director, Environmental Law Center
5 American Tradition Institute
6 2020 Pennsylvania Avenue, NW
7 Suite 186
8 Washington, D.C., 20006
9 Email: David.S@atinstitute.org
10 (571) 243-7975

11 On behalf of the Defendants:

12 ROBERT M. COOPER, ESQUIRE
13 Stephens, Boatwright, Primeau, Cooper &
14 Coleman, P.C.
15 9255 Lee Avenue
16 Manassas, Virginia 20110
17 Email: Coop@manassaslaw.com
18 (703) 361-8246

19 AND

20 PETER J. FONTAINE, ESQUIRE
21 Cozen, O'Connor
22 457 Haddonfield Road

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Suite 300
Cherry Hill, New Jersey 08002
Email: Pfontaine@cozen.com
(856) 910-5043

On behalf of the University of Virginia:

RICHARD C. KAST, ESQUIRE
MADELYN F. WESSEL, ESQUIRE
Office of the General Counsel
P.O. Box 400114
Charlottesville, Virginia 22904
Email: Wessel@Virginia.edu
(434) 982-2941

C O N T E N T S

THE PROCEEDINGS

Page 4

E X H I B I T S

None.

1 forth, and file our brief. That takes us into December.

2 If we can get a date in early November in which
3 you will hear our motion, you will have the rest of
4 November, and a good portion of December, in which to
5 conclude whether or not he is proper at -- and he won't
6 have our brief until after you make that decision.

7 In any case, this matter has been going on for
8 over four months now.

9 Our argument regarding the protective order is
10 very simple. We are expanding this public opinion. For
11 example; ACLU, I heard Justice Wendy Sierra Sloth,
12 Republican Sloth (PH).

13 No one has ever argued that Mr. Horner and I
14 are irresponsible and would release this material. We
15 only have one person who can release that, Your Honor,
16 and that is you.

17 Now, because of some dispersions cast, we want
18 to make it clear, Your Honor. I have been a federal
19 prosecutor on environmental issues. I have had access to
20 extremely sensitive business information. If I were a
21 corrupt man, I would not be here today on cash games,
22 insider training, and retiring in Bermuda.

Kast, Richard (rck4p)

From: Dr. Schnare <schnareati@gmail.com>
Sent: Monday, October 03, 2011 9:02 AM
To: Kast, Richard (rck4p); Wessel, Madelyn (mfw2y)
Subject: Phone call agenda

Rick and Madelyn:

In preparation for our 11:30 phonccall, I'd like to suggest the following agenda.

1. You explain the "so many levels" on which you have concern, and the nature of the concern about the fact that I was an employee of EPA, operating under an outside employment waiver, prior to October 1, 2011; and, keeping in mind that while I explained that I had worked for EPA, I never made a specific statement as to my current employment other than as to my pro bono representation in the instant case and my general responsibilities for ATI, and had every good and ethical reason to say no more.
2. You explain how our *in camera* review which prohibits any public disclosure of the emails or content of the emails "undercuts the purpose of FOIA" when the purpose of the FOIA is to permit government transparency to all interested citizens per code cited here:

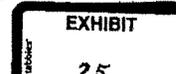
§ 2.2-3700. Short title; policy.

B. By enacting this chapter, the General Assembly ensures the people of the Commonwealth ready access to public records in the custody of a public body or its officers and employees, and free entry to meetings of public bodies wherein the business of the people is being conducted. The affairs of government are not intended to be conducted in an atmosphere of secrecy since at all times the public is to be the beneficiary of any action taken at any level of government. Unless a public body or its officers or employees specifically elect to exercise an exemption provided by this chapter or any other statute, every meeting shall be open to the public and all public records shall be available for inspection and copying upon request. All public records and meetings shall be presumed open, unless an exemption is properly invoked.

The provisions of this chapter shall be liberally construed to promote an increased awareness by all persons of governmental activities and afford every opportunity to citizens to witness the operations of government.

3. Explain how UVA is in the same position as the document custodian in *Vaughn*. In that case, the custodian was required by the court to create a log, but chose to negotiate a lesser duty. Here, you refused to, and are not required to create a log, but recognize that the same problem raised in *Vaughn* hampers justice in the instant case. In light of that, you negotiated to a lesser duty by shifting the duty to create a log to the complainant, who accepted the responsibility. Because we are willing to do the work a federal court would require a federal custodian to do, and because the documents are under seal and their contents may never be disclosed, but for a court order, you have no duty left that disposes you to seek a lesser duty and are not in the position of the Vaughn defendant.

4. Discuss what constitutes a reasonable sample of documents, what categories of documents make sense, and how to deal with specific documents we know are within the collection, but which you may not find by sampling, or otherwise choose not to include (because they would embarrass the University or Mr. Mann).



Sincerely,

--

David W. Schnare, Esq. Ph.D.
Director
The Environmental Law Center at ATI
571-243-7975

..

..



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OCT - 6 2011

OFFICE OF GENERAL COUNSEL

Mr. Peter J. Fontaine
Cozen O'Connor
457 Haddonfield Road
Suite 300
Cherry Hill, NJ 08002

Re: Freedom of Information Request #HQ-FOIA-02325-11

Dear Mr. Fontaine:

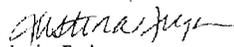
On behalf of the Environmental Protection Agency, I am writing to respond to the above referenced Freedom of Information Act request. You seek documents related to any request for Mr. David Schnare to represent the American Tradition Institute or any other entity with respect to a particular lawsuit.

Mr. Schnare, who retired from federal service effective Friday, September 30, 2011, was employed as an attorney-advisor in the Office of Enforcement and Compliance Assurance. As such, he was subject to the Standards of Ethical Conduct for Employees of the Executive Branch, 5 C.F.R. Part 2635, and the U.S. Environmental Protection Agency's supplemental regulations, 5 C.F.R. Part 6401. In order to engage in outside activity that involves the practice of a profession or that deals in significant part with any ongoing Agency program, policy or operation, Mr. Schnare was required to seek prior approval from his Deputy Ethics Official. 5 C.F.R. § 2634.801 and 5 C.F.R. §6401.103.

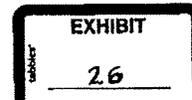
Enclosed please find the documents that EPA has related to this activity. The request for approval of the outside activity was purportedly prepared by Mr. Schnare on or about November 16, 2010, but neither his Deputy Ethics Official nor his Assistant Deputy Ethics Official has any record of receiving it or approving this request to engage in the outside activity. Although the Agency could assert the deliberative process privilege regarding the release of these documents, we see no reason to do so. There is no fee associated with your request.

Please feel free to contact me at (202) 564 1786 if you have any further questions.

Sincerely yours,


Justina Fugh
Senior Counsel for Ethics

Enclosure





Fw: fyi re David Schnare
Jeanne Duross to: Justina Fugh

09/29/2011 10:11 AM

Justina,

As we discussed, here is the request that David forwarded to Phil Brooks this morning. I have a meeting with Phil to discuss the matter and will meet with David after that.

-Jeanne

Jeanne M. Duross
Attorney-Advisor
Special Litigation and Projects Division
3111A, Ariel Rios South
U.S. EPA
(202)564-6595

May contain confidential information for internal deliberation, attorney-client information, and/or attorney work product.

----- Forwarded by Jeanne Duross/DC/USEPA/US on 09/29/2011 10:10 AM -----

From: Phillip Brooks/DC/USEPA/US
To: Jeanne Duross/DC/USEPA/US@EPA
Date: 09/29/2011 09:40 AM
Subject: fyi re David Schnare

Is this all he needed?

Phillip A. Brooks, Director
Air Enforcement Division
1200 Pennsylvania Ave. N.W.
Washington, DC 20460

Phone: (202) 564-0652
Fax: (202) 564-0015

----- Forwarded by Phillip Brooks/DC/USEPA/US on 09/29/2011 09:39 AM -----

From: David Schnare/DC/USEPA/US
To: Phillip Brooks/DC/USEPA/US@EPA
Date: 09/29/2011 09:15 AM
Subject: Re: Dove

Yes, I filed a waiver request. It's attached. At the time, ATI was called WTI.

d.



WTI outside employment request.docx

David W. Schnare, Esq. Ph.D.
202-564-4183

schnare,david@epa.gov

Phillip Brooks USA Today called asking whether you got a wai... 09/28/2011 03:38:39 PM

From: Phillip Brooks/DC/USEPA/US
To: David Schnare/DC/USEPA/US@EPA
Date: 09/28/2011 03:38 PM
Subject: Dave

USA Today called asking whether you got a waiver allowing you to represent TRI. they are requesting a copy of the waiver. Do you have a copy handy? Is there one?

Phillip A. Brooks, Director
Air Enforcement Division
1200 Pennsylvania Ave. N.W.
Washington, DC 20460

Phone: (202) 564-0652
Fax: (202) 564-0015



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Office of Enforcement and
Compliance Assurance

MEMORANDUM

Date: November 16, 2010

From: David W. Schnare, Esq. Ph.D.
Attorney-Advisor
Air Enforcement Division

Thru: Greg Fried, Acting Chief
Stationary Source Enforcement Branch
Air Enforcement Division

To: Adam Kushner, Director
Deputy Ethics Officer
Office of Civil Enforcement

Subject: Approval for Outside Employment

Pursuant to 5 C.F.R. § 6401 and 5 C.F.R. § 2635, this memorandum seeks prior approval for outside employment. In accord with the above cited code and implementing regulations, please review the following information and provide approval for participation as a *pro bono* associate of the American Traditions Institute.

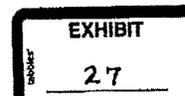
Information Required under § 6401.103

(1) Employee's name, title and grade

David W. Schnare, Attorney-Advisor GS 15/10

(2) Nature of the outside activity, including a full description of the services to be performed and the amount of compensation expected;

The American Tradition Institute is a 501(c)3 not-for-profit charitable public policy research educational and public interest law foundation. It exists to lead a national discussion about environmental issues, including air and water quality and regulation, responsible land use, natural resource management, energy development, property rights, and free-market principles of stewardship. I have been asked to serve, *pro bono*, as a



Director to the Institute and to help organize its planned law center. My duties as an Institute Director will not include fund-raising. My duties with the law center could include development of strategic plans, selection of projects and recruitment of staff. My duties would not include any representation at law of the Institute or its members. Institute and affiliated attorneys will conduct all representation of any matters at law.

(3) The name and business of the person or organization for which the work will be done (in cases of self-employment, indicate the type of services to be rendered and estimate the number of clients or customers anticipated during the next 6 months);

The American Tradition Institute, a 501(c)3 not-for-profit charitable public policy research, educational and public interest law foundation.

(4) The estimated time to be devoted to the activity;

Fifteen hours per week.

(5) Whether the service will be performed entirely outside of normal duty hours (if not, estimate the number of hours of absence from work required);

All services will be performed entirely outside normal duty hours.

(6) The employee's statement that no official duty time or Government property, resources, or facilities not available to the general public will be used in connection with the outside employment;

I will use no official duty time or Government property, resources, or facilities not available to the general public in connection with the outside employment.

(7) The basis for compensation (e.g., fee, per diem, per annum, etc.);

My participation will be completely *pro bono*.

(8) The employee's statement that he or she has read, is familiar with, and will abide by the restrictions described in 5 CFR part 2635 and Sec. 6401.102;

I have read and am familiar with, and will abide by the restrictions described in 5 CFR part 2635 and Sec. 6401.102

(9) An identification of any EPA assistance agreements or contracts held by a person to or for whom services would be provided.

The American Tradition Institute does not accept grants from or enter contracts with federal governmental units. I am unaware of any assistance agreements or contracts between EPA and the American Tradition Institute, despite a good faith effort to identify same.



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For this Record...
 Cert of Good Standing
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 Notification
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History and Documents

American Tradition Institute
 ID number: 20091091487

Business Home
 Business Information
 Business Search

Found 15 matching record(s). Viewing page 1 of 1.

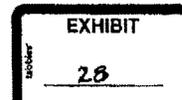
FAQs, Glossary and Information

#	Event	Date Filed	Date Posted	EffectiveDate	Document # <small>(click to view)</small>	Comment
1	Articles of Incorporation	02/11/2009	02/11/2009	02/11/2009 10:24 PM	20091091487	
2	Articles of Amendment	03/04/2009	03/04/2009	03/04/2009 05:58 AM	20091130060	
3	Articles of Amendment	06/17/2009	06/17/2009	06/17/2009 02:53 PM	20091331276	
4	Articles of Amendment	09/27/2009	09/27/2009	09/27/2009 01:13 PM	20091458465	
5	postcard notification printed 01/26/2010 to be mailed 02/01/2010	01/26/2010	01/26/2010	01/26/2010 04:23 AM		annual report due: 04/30/2010
6	Change in Status	05/01/2010	05/01/2010	05/01/2010 01:54 AM		Failure to file annual report
7	postcard notification printed 05/21/2010 to be mailed 05/01/2010	05/21/2010	05/21/2010	05/21/2010 03:08 AM		annual report due: 2010-07-31
8	Change in Status	08/01/2010	08/01/2010	08/01/2010 02:34 AM		Failure to file annual report
9	postcard notification printed 08/01/2010 to be mailed this month	08/01/2010	08/01/2010	08/01/2010 02:57 AM		failure to file annual report
10	Statement Correcting Delinquency	10/01/2010	10/01/2010	10/01/2010 06:09 PM	20101545015	
11	Articles of Amendment	12/18/2010	12/18/2010	12/18/2010 01:25 PM	20101685751	Change of Entity Name
12	Affidavit for Renewal of Personal Identifying Information	12/20/2010	12/27/2010	12/20/2010 04:01 PM	20101688144	
13	Statement of Change	12/20/2010	12/20/2010	12/20/2010 04:04 PM	20101688159	
14	Statement of Correction	03/17/2011	03/17/2011	03/17/2011 04:05 PM	20111163188	Principal address corrected.
15	postcard notification printed 09/23/2011 to be mailed 10/01/2011	09/23/2011	09/23/2011	09/23/2011 02:52 AM		periodic report due: 12/31/2011

[Return to Summary](#)

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Colorado Secretary of State
Date and Time: 02/11/2009 10:24 PM
ID Number: 20091091487
Document number: 20091091487
Amount Paid: \$50.00

Document must be filed electronically.
Paper documents will not be accepted.
Document processing fee
Fees & forms/cover sheets
are subject to change.
To access other information or print
copies of filed documents,
visit www.sos.state.co.us and
select Business Center.

\$50.00

ABOVE SPACE FOR OFFICE USE ONLY

Articles of Incorporation for a Nonprofit Corporation
filed pursuant to § 7-122-101 and § 7-122-102 of the Colorado Revised Statutes (C.R.S.)

1. The domestic entity name for the nonprofit corporation is
Western Tradition Institute

(Caution: The use of certain terms or abbreviations are restricted by law. Read instructions for more information.)

2. The principal office address of the nonprofit corporation's initial principal office is

Street address 2535 Franklin St
(Street number and name)
Denver CO 80205
(City) (State) (ZIP/Postal Code)
United States
(Province - if applicable) (Country)

Mailing address PO Box 88
(leave blank if same as street address) (Street number and name or Post Office Box information)
Denver CT 80201
(City) (State) (ZIP/Postal Code)
United States
(Province - if applicable) (Country)

3. The registered agent name and registered agent address of the nonprofit corporation's initial registered agent are

Name Reed John
(if an individual) (Last) (First) (Middle) (Suffix)

OR
(if an entity)
(Caution: Do not provide both an individual and an entity name.)

Street address 2535 Franklin Street
(Street number and name)
Denver CO 80205
(City) (State) (ZIP Code)

457

Mailing address PO Box 88
 (leave blank if same as street address) (Street number and name or Post Office Box information)

Denver CO 80205
(City) (State) (ZIP Code)

(The following statement is adopted by marking the box.)

- The person appointed as registered agent above has consented to being so appointed.

4. The true name and mailing address of the incorporator are

Name Reed Dan
 (if an individual) (Last) (First) (Middle) (Suffix)

OR

(if an entity)
(Caution: Do not provide both an individual and an entity name.)

Mailing address PO Box 88
(Street number and name or Post Office Box information)

Denver CO 80201
(City) (State) (ZIP/Postal Code)

United States
(Province - if applicable) (Country)

(If the following statement applies, adopt the statement by marking the box and include an attachment.)

- The corporation has one or more additional incorporators and the name and mailing address of each additional incorporator are stated in an attachment.

5. *(If the following statement applies, adopt the statement by marking the box.)*

- The nonprofit corporation will have voting members.

6. *(The following statement is adopted by marking the box.)*

- Provisions regarding the distribution of assets on dissolution are included in an attachment.

7. *(If the following statement applies, adopt the statement by marking the box and include an attachment.)*

- This document contains additional information as provided by law.

8. *(Caution: Leave blank if the document does not have a delayed effective date. Stating a delayed effective date has significant legal consequences. Read instructions before entering a date.)*

(If the following statement applies, adopt the statement by entering a date and, if applicable, time using the required format.)
 The delayed effective date and, if applicable, time of this document is/are _____
(mm/dd/yyyy hour:minute am/pm)

Notice:

Causing this document to be delivered to the Secretary of State for filing shall constitute the affirmation or acknowledgment of each individual causing such delivery, under penalties of perjury, that the document is the individual's act and deed, or that the individual in good faith believes the document is the act and deed of the person on whose behalf the individual is causing the document to be delivered for filing, taken in conformity with the requirements of part 3 of article 90 of title 7, C.R.S., the constituent documents, and the organic statutes, and that the individual in good faith believes the facts stated in the document are true and the document complies with the requirements of that Part, the constituent documents, and the organic statutes.

This perjury notice applies to each individual who causes this document to be delivered to the Secretary of State, whether or not such individual is named in the document as one who has caused it to be delivered.

9. The true name and mailing address of the individual causing the document to be delivered for filing are

Reed	John		
<small>(Last)</small>	<small>(First)</small>	<small>(Middle)</small>	<small>(Suffix)</small>
PO Box 88			
<small>(Street number and name or Post Office Box information)</small>			
Denver		CO	80201
<small>(City)</small>		<small>(State)</small>	<small>(ZIP/Postal Code)</small>
United States			
<small>(Province - if applicable)</small>		<small>(Country)</small>	

(If the following statement applies, adapt the statement by marking the box and include an attachment.)

- This document contains the true name and mailing address of one or more additional individuals causing the document to be delivered for filing.

Disclaimer:

This form/cover sheet, and any related instructions, are not intended to provide legal, business or tax advice, and are furnished without representation or warranty. While this form/cover sheet is believed to satisfy minimum legal requirements as of its revision date, compliance with applicable law, as the same may be amended from time to time, remains the responsibility of the user of this form/cover sheet. Questions should be addressed to the user's legal, business or tax advisor(s).

WESTERN TRADITION PARTNERSHIP DISSOLUTION CLAUSE

Upon dissolution, all assets shall be distributed to an organization(s) organized and operated exclusively for charitable purposes, as specified in section 214, and which has established its tax exempt status under section 501(c)(3) of the Internal Revenue Code, or under section 23701d of the Revenue and Taxation Code.



Colorado Secretary of State
Date and Time: 03/04/2009 05:58 AM
ID Number: 20091091487
Document number: 20091130060
Amount Paid: \$25.00

Document processing fee
If document is filed on paper \$125.00
If document is filed electronically \$ 25.00
Fees & forms/cover sheets are subject to change.
To file electronically, access instructions for this form/cover sheet and other information or print copies of filed documents, visit www.sos.state.co.us and select Business Center.
Paper documents must be typewritten or machine printed.

ABOVE SPACE FOR OFFICE USE ONLY

Articles of Amendment

filed pursuant to §7-90-301, et seq. and §7-130-105 of the Colorado Revised Statutes (C.R.S.)

ID number 20091091487

1. Entity name Western Tradition Institute
(If changing the name of the corporation, indicate name BEFORE the name change)

2. New Entity name (if applicable) _____

3. *(If the following statement applies, adopt the statement by marking the box and include an attachment.)*
 Other amendments are attached.

4. If the nonprofit corporation's period of duration as amended is less than perpetual, state the date on which the period of duration expires _____
(mm/dd/yyyy)

OR

If the nonprofit corporation's period of duration as amended is perpetual, mark this box

5. *(Optional)* Delayed effective date 02/13/2009
(mm/dd/yyyy)

6. Additional information may be included pursuant to other organic statutes such as title 12, C.R.S. If applicable, mark this box and include an attachment stating the additional information.

Notice:

Causing this document to be delivered to the secretary of state for filing shall constitute the affirmation or acknowledgment of each individual causing such delivery, under penalties of perjury, that the document is the individual's act and deed, or that the individual in good faith believes the document is the act and deed of the person on whose behalf the individual is causing the document to be delivered for filing, taken in conformity with the requirements of part 3 of article 90 of title 7, C.R.S., the constituent documents, and the organic statutes, and that the individual in good faith believes the facts stated in the document are true and the document complies with the requirements of that Part, the constituent documents, and the organic statutes.

This perjury notice applies to each individual who causes this document to be delivered to the secretary of state, whether or not such individual is named in the document as one who has caused it to be delivered.

7. Name(s) and address(es) of the individual(s) causing the document to be delivered for filing

John	Reed		
<small>(Last)</small>	<small>(First)</small>	<small>(Middle)</small>	<small>(Suffix)</small>
2535 Franklin St.			
<small>(Street name and number or Post Office Box information)</small>			
Denver	CO	80201	
<small>(City)</small>	<small>(State)</small>	<small>(Postal/Zip Code)</small>	
<small>(Province - if applicable)</small>	<small>United States</small>		
	<small>(Country - if not US)</small>		

(The document need not state the true name and address of more than one individual. However, if you wish to state the name and address of any additional individuals causing the document to be delivered for filing, mark this box and include an attachment stating the name and address of such individuals.)

Disclaimer:

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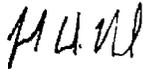
RESOLUTION APPROVING AMENDMENT OF THE ARTICLES OF INCORPORATION

WHEREAS, pursuant to the application and Bylaws of this Corporation, it is deemed desirable and in the its best interests that the following revision be taken by this corporation pursuant to this written Consent:

NOW THEREFORE, BE IT RESOLVED:

That Western Tradition Institute erred in indicating in its initial filing that it would have voting members; and that indeed, it does and shall not, but shall be governed by a Board of Directors yet to be named.

Said and done this 13th Day of February, 2009 by John Reed, incorporator.

A handwritten signature in black ink, appearing to read "J. Reed", is written over the printed name.

John D. Reed



Colorado Secretary of State
 Date and Time: 06/17/2009 02:53 PM
 ID Number: 20091091487
 Document number: 20091331276
 Amount Paid: \$25.00

Document processing fee
 If document is filed on paper \$125.00
 If document is filed electronically \$ 25.00
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 and select Business Center.
 Paper documents must be typewritten or machine printed.

ABOVE SPACE FOR OFFICE USE ONLY

Articles of Amendment

filed pursuant to §7-90-301, et seq. and §7-130-105 of the Colorado Revised Statutes (C.R.S.)

ID number 20091091487

1. Entity name Western Tradition Institute
(If changing the name of the corporation, indicate name BEFORE the name change)

2. New Entity name
 (if applicable) _____

3. *(If the following statement applies, adopt the statement by marking the box and include an attachment.)*
 Other amendments are attached.

4. If the nonprofit corporation's period
 of duration as amended is less than
 perpetual, state the date on which the
 period of duration expires _____
(mm/dd/yyyy)

OR

If the nonprofit corporation's period of duration as amended is perpetual, mark this box

5. *(Optional)* Delayed effective date _____
(mm/dd/yyyy)

6. Additional information may be included pursuant to other organic statutes such as title 12, C.R.S. If
 applicable, mark this box and include an attachment stating the additional information.

Notice:

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7. Name(s) and address(es) of the individual(s) causing the document to be delivered for filing

Nicolais	Mario	Daniel	II
<small>(Last)</small>	<small>(First)</small>	<small>(Middle)</small>	<small>(Suffix)</small>
1601 Blake St			
<small>(Street name and number or Post Office Box information)</small>			
Suite 310			
Denver	CO	80202	
<small>(City)</small>	<small>(State)</small>	<small>(Postal/Zip Code)</small>	
<small>(Province - if applicable)</small>	United States		
	<small>(Country - if not US)</small>		

(The document need not state the true name and address of more than one individual. However, if you wish to state the name and address of any additional individual(s) causing the document to be delivered for filing, mark this box and include an attachment stating the name and address of such individual(s).)

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WESTERN TRADITION INSTITUTE
2535 Franklin St
Denver, CO 80205

Addendum I, Articles of Incorporation (Non-Profit Corporation)

Article II of the bylaws for **WESTERN TRADITION INSTITUTE** provides for distribution of assets upon dissolution as follows:

ARTICLE II. PURPOSES

Section 2.1 This corporation is organized exclusively for charitable purposes defined as education, study, and dissemination of information pertaining to its field of interest, within the meaning of Section 501(c)(3) of the Internal Revenue Code, as now enacted or hereafter amended, including, for such purposes, the making of distributions to organizations that also qualify as Section 501(c)(3) exempt organizations. To this end, the corporation shall publish studies in print or on the internet, make presentations, and otherwise and in any manner participate in the educational and scientific process. All funds, whether income or principal, and whether acquired by gift or contribution or otherwise, shall be devoted to said purposes.

Section 2.2 This organization shall not engage in the advancement or defeat of political candidates or of legislation.

Article VIII of the bylaws for **WESTERN TRADITION INSTITUTE** provides for distribution of assets upon dissolution as follows:

ARTICLE VIII. MISCELLANEOUS

Section 8.0 Dissolution. Upon dissolution, all assets shall be distributed to an organization(s) organized and operated exclusively for charitable purposes, as specified in section 214, and which has established its tax exempt status under section 501(c)(3) of the Internal Revenue Code, or under section 23701d of the Revenue and Taxation Code.



Colorado Secretary of State
Date and Time: 10/01/2010 06:09 PM
ID Number: 20091091487
Document number: 20101545015
Amount Paid: \$100.00

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select Business.

\$100.00

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Statement Curing Delinquency
filed pursuant to §7-90-904 of the Colorado Revised Statutes (C.R.S)

1. For the delinquent entity, its ID number, entity name and jurisdiction of formation are

ID number 20091091487
(Colorado Secretary of State ID number)
Entity name Western Tradition Institute
Jurisdiction where formed Colorado

2. By providing the information required herein, this statement corrects all grounds for delinquency cited by the secretary of state.

3. The registered agent name and registered agent address of the registered agent are

Name
(if an individual) Reed John
(Last) (First) (Middle) (Suffix)
OR
(if an entity) _____
(Caution: Do not provide both an individual and an entity name).

The person appointed as registered agent above has consented to being so appointed.

Street address 1601 Blake Street
(Street number and name)
Suite 301
Denver CO 80201
(City) (State) (Zip Code)

Mailing address PO Box 88
(leave blank if same as street address) (Street number and name or Post Office Box information)
Denver CO 80201
(City) (State) (Zip Code)

(If the following statement applies, adopt the statement by marking the box.)

The mailing address in the records of the Secretary of State is no longer different than the street address and is no longer required.

4. The principal office address of the entity's principal office is

Street address 1601 Blake Street
(Street number and name)
Suite 301
Denver CO 80202
(City) (State) (Postal/Zip Code)
United States
(Province - if applicable) (Country - if not US)

Mailing address
(Leave blank if same as street address) PO Box 88
(Street number and name or Post Office Box information)
Denver CO 80202
(City) (State) (Postal/Zip Code)
United States
(Province - if applicable) (Country - if not US)

(If the following statement applies, adopt the statement by marking the box.)

The mailing address in the records of the Secretary of State is no longer different than the street address and is no longer required.

5. (If the following statement applies, adopt the statement by marking the box and include an attachment.)

This document contains additional information as provided by law.

6. (Caution: Leave blank if the document does not have a delayed effective date. Stating a delayed effective date has significant legal consequences. Read instructions before entering a date.)

(If the following statement applies, adopt the statement by entering a date and, if applicable, time using the required format.)

The delayed effective date and, if applicable, time of this document is/are _____
(mm/dd/yyyy hour:minute am/pm)

Notice:

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7. The true name and mailing address of the individual causing the document to be delivered for filing are

Reed John
(Last) (First) (Middle) (Suffix)
PO Box 88
(Street number and name or Post Office Box information)
Denver CO 80201
(City) (State) (Postal/Zip Code)
(Province - if applicable) (Country - if not US)

(If the following statement applies, adopt the statement by marking the box and include an attachment.)

- This document contains the true name and mailing address of one or more additional individuals causing the document to be delivered for filing.

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Colorado Secretary of State
Date and Time: 12/18/2010 01:25 PM
ID Number: 20091091487

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select Business.

\$25.00

Document number: 20101685751
Amount Paid: \$25.00

**INFORMATION
REDACTED**

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Articles of Amendment

filed pursuant to §7-90-301, et seq. and §7-130-105 of the Colorado Revised Statutes (C.R.S.)

ID number 20091091487

1. Entity name Western Tradition Institute
(If changing the name of the corporation, indicate name BEFORE the name change)

2. New Entity name
(if applicable) American Tradition Institute

3. *(If the following statement applies, adopt the statement by marking the box and include an attachment.)*
 Other amendments are attached.

4. If the nonprofit corporation's period
of duration as amended is less than
perpetual, state the date on which the
period of duration expires _____
(mm/dd/yyyy)

OR

If the nonprofit corporation's period of duration as amended is perpetual, mark this box

5. *(Optional)* Delayed effective date _____
(mm/dd/yyyy)

6. Additional information may be included pursuant to other organic statutes such as title 12, C.R.S. If
applicable, mark this box and include an attachment stating the additional information.

Notice:

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7. Name(s) and address(es) of the individual(s) causing the document to be delivered for filing

<small>(Last)</small>	<small>(First)</small>	<small>(Middle)</small>	<small>(Suffix)</small>
1601 Blake St # 301			
<small>(Street name and number or Post Office Box information)</small>			
Denver	CO	80202	
<small>(City)</small>	<small>(State)</small>	<small>(Postal/Zip Code)</small>	
<small>(Province - if applicable)</small>	United States		
	<small>(Country - if not US)</small>		

(The document need not state the true name and address of more than one individual. However, if you wish to state the name and address of any additional individuals causing the document to be delivered for filing, mark this box and include an attachment stating the name and address of such individuals.)

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20101688144 C
RFFP11
SECRETARY OF STATE
12/20/2010 04:01:40

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Statement of Removal of Personal Identifying Information
filed pursuant to § 7-90-306 of the Colorado Revised Statutes (C.R.S.)

1. My name is Mario Nicholas. I am 18 or more years of age. Pursuant to § 7-90-306, C.R.S., I am duly authorized to deliver a written request to the Colorado Secretary of State to remove personal identifying information from the publicly accessible documents and other records of the Secretary of State.

2. The ID number of the record containing a publicly accessible filed document that contains personal identifying information is 20091091487.

The entity name, trade name, or trademark description to which such record relates is
American Tradition Institute

3. The document number of the filed document that contains personal identifying information is 20101685751.

4. The type of personal identifying information requested to be removed from such document is
Name of the individual causing the document to be filed
(Caution: Do not restate the personal identifying information requested to be removed.)

5. The personal identifying information to be removed is not required by law to be included in such document or other records of the Secretary of State.

6. The location of the personal identifying information in the filed document described above is
Paragraph 7

7. I understand that this document may be filed in the publicly accessible records and I consent to such filing by the Secretary of State.

8. If the Secretary of State refuses to file this document, notice of such refusal may be delivered to the following mailing address: 1601 Blake St Suite 3310

(Street number and name or Post Office Box information)

Denver CO 80202

(City)

(State)

(ZIP/Postal Code)

(Province - if applicable)

(Country)

Notice:

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This perjury notice applies to each individual who causes this document to be delivered to the Secretary of State, whether or not such individual is identified in this document as one who has caused it to be delivered.

9. The true name and mailing address of the individual causing this document to be delivered for filing are

Nicholas Mario
(Last) (First) (Middle) (Suffix)
 1601 Blake St # 301
(Street number and name or Post Office Box information)
 Denver CO 80202
(City) (State) (ZIP/Postal Code)
(Province - if applicable) (Country)

- (If applicable, adopt the following statement by marking the box and include an attachment.)*
- This document contains the true name and mailing address of one or more additional individuals causing the document to be delivered for filing.

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**Statement of Change Changing Information Other Than Principal Office Address
 or Registered Agent Information**
 filed pursuant to §7-90-305.5 and, if applicable, §7-90-804 of the Colorado Revised Statutes (C.R.S.)

ID number: 20091091487
 1. Entity name: American Tradition Institute
 2. True name:
 (if different from the entity name) _____

Complete lines 3 - 9 as applicable. You must complete section 10.

3. Document number: 20101685751
 (required for change(s) to 4, 5, 6, 7
 and/or 8 below)
 4. Change of entity name of record (LLP, art. 61 LLLP or foreign entity only):
 New entity name: _____
 5. Change of true name of record (LLP, art. 61 LLLP, general partnership or foreign entity only):
 New true name: _____
 6. Change of jurisdiction of formation of record (foreign entity only):
 New jurisdiction of formation: _____
 7. Change of entity form of record (foreign entity only):
 New entity form: _____

8. Other change(s) not provided for above:

If other information contained in the filed document is being changed, mark this box and include an attachment stating the information to be changed and each such change.

If other information is being added or deleted, mark this box and include an attachment stating each addition or deletion.

9. (Optional) Delayed effective date: _____
(mm/dd/yyyy)

Notice:

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This perjury notice applies to each individual who causes this document to be delivered to the Secretary of State, whether or not such individual is identified in this document as one who has caused it to be delivered.

10. The true name and mailing address of the individual causing this document to be delivered for filing are

Nicholas	+ Mario	
<small>(Last)</small>	<small>(First)</small>	<small>(Middle)</small> <small>(Suffix)</small>
1601 Blake Street # 301		
<small>(Street number and name or Post Office Box information)</small>		
Denver	+ CO	80014
<small>(City)</small>	<small>(State)</small>	<small>(ZIP/Postal Code)</small>
<small>(Province - if applicable)</small>	<small>(Country)</small>	

(If applicable, adopt the following statement by marking the box and include an attachment.)
 This document contains the true name and mailing address of one or more additional individuals causing the document to be delivered for filing.

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ID Number 20091091487

Paragraph 7: to change the name of the individual causing the
document to be filled

The name should be Mario Nicholas

476



Colorado Secretary of State
Date and Time: 03/17/2011 04:05 PM
ID Number: 20091091487
Document number: 20111163188
Amount Paid: \$10.00

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\$10.00

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**Statement of Correction
Correcting the Principal Office Address**

filed pursuant to § 7-90-305 of the Colorado Revised Statutes (C.R.S.)

1. The entity ID number and the entity name, or, if the entity does not have an entity name, the true name are

Entity ID number 20091091487
(Colorado Secretary of State ID number)

Entity name or True name American Tradition Institute

2. The document number of the filed document that is corrected is 20101685751

3. The principal office address as stated in the document identified above is incorrect.

Such address, as corrected, is

Street address c/o 1601 Blake St
(Street number and name)
Suite 310
Denver CO 80202
(City) (State) (ZIP/Postal Code)
United States
(Province - if applicable) (Country)

Mailing address P.O. Box 88
(leave blank if same as street address) (Street number and name or Post Office Box information)
Denver CO 80201
(City) (State) (ZIP/Postal Code)
United States
(Province - if applicable) (Country)

4. *(If applicable, adopt the following statement by marking the box and include an attachment.)*

This document contains additional information as provided by law.

Notice:

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5. The true name and mailing address of the individual causing this document to be delivered for filing are

Nicolais	Mario	Daniel	II
<small>(Last)</small>	<small>(First)</small>	<small>(Middle)</small>	<small>(Suffix)</small>
1601 Blake St			
<small>(Street number and name or Post Office box information)</small>			
Suite 310			
<small>(Street number and name or Post Office box information)</small>			
Denver	CO	80202	
<small>(City)</small>	<small>(State)</small>	<small>(Zip/Postal Code)</small>	
<small>(Province - if applicable)</small>	United States		
	<small>(Country)</small>		

(If applicable, adopt the following statement by marking the box and include an attachment.)

- This document contains the true name and mailing address of one or more additional individuals causing the document to be delivered for filing.

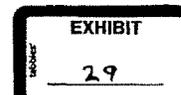
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Kast, Richard (rck4p)

From: Kast, Richard (rck4p) <rck4p@eservices.virginia.edu>
Sent: Wednesday, October 12, 2011 2:20 PM
To: Richard Kast (rck4p@Virginia.edu)
Subject: Sent from Snipping Tool

	Dr. Schnare	Thu 9/29/2011 3:42 PM	13 KB	Re: Follow-up Conversation
	Dr. Schnare	Thu 9/29/2011 2:32 PM	11 KB	Re: Follow-up Conversation
	Dr. Schnare	Thu 9/29/2011 12:54 PM	6 KB	Re: Follow-up Conversation
	Dr. Schnare	Wed 9/28/2011 2:51 PM	5 KB	Re: Sur-reply CD
	Dr. Schnare	Wed 9/28/2011 12:11 PM	2 KB	Sur-reply CD
	Dr. Schnare	Tue 9/27/2011 11:16 AM	5 KB	Freedom of Information Request
	Dr. Schnare	Wed 9/14/2011 5:04 PM	4 KB	Re: Reply Memorandum
	Dr. Schnare	Wed 9/14/2011 2:41 PM	4 KB	Re: American Tradition Institute v. UVA
	Dr. Schnare	Fri 9/9/2011 3:17 PM	2 MB	ATI v UVA CL 11-3236 Petitioners' answers :
	Dr. Schnare	Fri 9/9/2011 3:09 PM	4 KB	Re: Response Memorandum; Civil Action N
	Dr. Schnare	Fri 9/9/2011 10:48 AM	12 KB	Re: ATI v UVA CL 11-3236 Hearing Date anc
	Dr. Schnare	Thu 9/8/2011 12:08 PM	5 KB	RE: ATI v UVA Revision of the protective or
	Dr. Schnare	Thu 9/8/2011 11:09 AM	6 KB	Re: ATI v UVA CL 11-3236 Hearing Date anc
	Dr. Schnare	Tue 9/6/2011 3:19 PM	16 KB	Re: ATI v UVA CL 11-3236 Motions Practice
	Dr. Schnare	Tue 9/6/2011 3:04 PM	12 KB	Re: ATI v UVA CL 11-3236 Motions Practice
	Dr. Schnare	Tue 9/6/2011 12:04 PM	8 KB	Re: Your message
	Dr. Schnare	Tue 9/6/2011 11:05 AM	4 KB	Re: Your message
	Dr. Schnare	Tue 9/6/2011 10:51 AM	5 KB	ATI v UVA CL 11-3236 Motions Practice Con
	Dr. Schnare	Fri 9/2/2011 2:33 PM	472 KB	Re: Attached Letter
	Dr. Schnare	Wed 8/31/2011 5:01 PM	5 KB	Re: Attached Letter
	Dr. Schnare	Mon 8/29/2011 12:18 PM	9 KB	Re: Michael Mann
	Dr. Schnare	Mon 8/22/2011 2:45 PM	10 KB	Re: FOIA Request
	Dr. Schnare	Mon 8/22/2011 11:36 AM	7 KB	Re: FOIA Request
	Dr. Schnare	Fri 8/19/2011 5:50 PM	8 KB	Re: FOIA Request
	Dr. Schnare	Fri 8/19/2011 5:14 PM	4 KB	Re: FOIA Request
	Dr. Schnare	Thu 8/4/2011 10:15 AM	8 KB	Re: FOIA Request



Kast, Richard (rck4p)

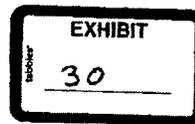
From: Kast, Richard (rck4p) <rck4p@eservices.virginia.edu>
Sent: Wednesday, October 12, 2011 2:21 PM
To: Richard Kast (rck4p@Virginia.edu)
Subject: Sent from Snipping Tool

	Dr. Schnare	Mon 7/11/2011 7:37 PM	4 KB	ATI FOIA payment
	Dr. Schnare	Mon 6/27/2011 11:40 PM	3 KB	ATI v Rectors - Order ready for entry
	Dr. Schnare	Mon 6/27/2011 11:01 AM	5 KB	Re: Order
	Dr. Schnare	Tue 6/7/2011 3:43 PM	14 KB	Re: Close out on yesterday
	Dr. Schnare	Tue 6/7/2011 8:21 AM	6 KB	Close out on yesterday
	Dr. Schnare	Wed 6/1/2011 12:14 PM	10 KB	Re: Proposed meeting
	Dr. Schnare	Tue 5/31/2011 8:49 AM	4 KB	Proposed meeting
	Dr. Schnare	Thu 5/26/2011 2:47 PM	4 KB	Quick note
	Dr. Schnare	Mon 5/23/2011 4:25 PM	3 KB	ATI schedule
	Dr. Schnare	Mon 5/23/2011 2:45 PM	7 KB	Re: ATI v Rector: Proposed Orders
	Dr. Schnare	Fri 5/20/2011 11:55 AM	53 KB	ATI v Rector: Proposed Orders
	Dr. Schnare	Fri 5/20/2011 9:48 AM	19 KB	Re: Scheduling Call ATI v Rector CL-11-323
	Dr. Schnare	Thu 5/19/2011 2:06 PM	3 KB	Draft motions
	Dr. Schnare	Wed 5/18/2011 4:31 PM	14 KB	Re: Scheduling Call ATI v Rector CL-11-323
	Dr. Schnare	Wed 5/18/2011 1:24 PM	9 KB	Re: Scheduling Call ATI v Rector CL-11-323
	Dr. Schnare	Wed 5/18/2011 10:11 AM	4 KB	Re: Scheduling Call ATI v Rector CL-11-323
	Dr. Schnare	Tue 5/17/2011 4:19 PM	4 KB	Scheduling Call ATI v Rector CL-11-323
	Dr. Schnare	Tue 5/17/2011 3:55 PM	60 KB	Re: Your FOIA Request
	Dr. Schnare	Mon 5/16/2011 2:00 PM	6 KB	Re: ATI v Rector
	Dr. Schnare	Mon 5/16/2011 12:30 PM	719 KB	ATI v Rector
	Dr. Schnare	Thu 4/7/2011 4:38 PM	51 KB	Re: Your request
	Dr. Schnare	Mon 3/28/2011 3:31 PM	4 KB	Re: FOIA Request
	Dr. Schnare	Thu 3/24/2011 3:46 PM	4 KB	Re: VFOIA to the University of Virginia -- A
	Dr. Schnare	Sun 3/6/2011 11:11 AM	302 KB	ATI March 6 letter
	Dr. Schnare	Thu 2/17/2011 8:01 PM	8 KB	Re: VFOIA to the University of Virginia -- A

From: Dr. Schnare <Schnare>		
Dr. Schnare	Phone call agenda	Mon 8/30/2011 9:42 AM 15 KB
Dr. Schnare	Re: Follow-up Conversation	Tue 8/29/2011 2:31 PM 21 KB
Dr. Schnare	Re: Follow-up Conversation	Thu 8/29/2011 11:34 AM 16 KB
Dr. Schnare	Re: Proposal regarding records selection	Wed 9/7/2011 4:13 PM 14 KB
Dr. Schnare	Re: Attached Letter	Fri 9/2/2011 2:33 PM 402 KB
From: Madelyn Wessel <Wessel>		
Dr. Schnare	Re: American Tradition Institute v. DVA	Wed 9/7/2011 2:41 PM 15 KB
Dr. Schnare	ATI v DVA Cl. 11-3126 Petitioners' answers and responses to the Mann motions	Fri 9/9/2011 3:17 PM 2 MB
Dr. Schnare	Re: Response Memorandum Civil Action No. Cl-11-3126	Fri 9/9/2011 3:29 PM 15 KB
Dr. Schnare	Re: ATI v DVA Cl. 11-3126 Hearing Date and Time	Fri 9/9/2011 10:43 AM 23 KB
Dr. Schnare	Re: ATI v DVA Cl. 11-3126 Motions Practice Communications	Tue 9/6/2011 3:19 PM 27 KB
Dr. Schnare	Re: your message	Fri 9/6/2011 11:05 AM 14 KB

Post 9/30/11

David Schnare to Madelyn Wessel



Wessel, Madelyn (mfw2y)

From: Wilkerson, Elizabeth (epw3m)
Sent: Thursday, October 13, 2011 11:01 AM
To: Wessel, Madelyn (mfw2y)
Cc: Kast, Richard (rck4p)
Subject: two Schnare emails
Attachments: 2011-02-11 phone recap.JPG; 2011-02-15 email.JPG; 2011-02-15 ATI vs R&V.JPG

Madelyn –

Here are the two emails, plus the attachment to one, that I received from David Schnare during the time period you requested. The telephone call he recaps in one email took place during normal business hours on Feb. 9, 2011.

Please let me know if you need anything further from me.

All the best,
Elizabeth

Elizabeth P. Wilkerson
Special Projects Officer
Office of Public Affairs
University of Virginia
PO Box 400229
Charlottesville, Virginia 22904-4229
(434) 924-3938 (office)
(434) 249-1415 (mobile)
(434) 924-0938 (fax)

DOCUMENT SUBMITTED BY REPRESENTATIVE DANIEL WEBSTER

What Triggers Ice Ages?

By Kirk A. Maasch
Posted 01.01.97
NOVA

During the past billion years, the Earth's climate has fluctuated between warm periods—sometimes even completely ice-free—and cold periods, when glaciers scour the continents. In this article, climate scientist Kirk Maasch offers perspective on these historic changes, including the likely causes of the last great ice age—which contrary to common knowledge, we are still in the midst of.



Hubbard Glacier in Alaska, like other glaciers worldwide, is retreating. To understand changing climate today, we need a perspective on changes of the past. [Enlarge](#) Photo credit: © MaxFXiStockphoto

THE NATURE OF ICE AGES

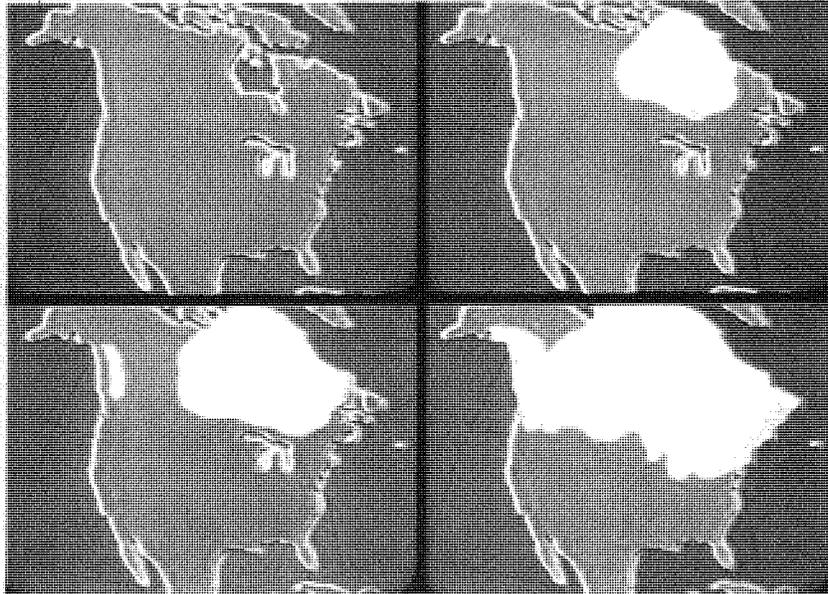
Ice ages are times when the entire Earth experiences notably colder climatic conditions. During an ice age, the polar regions are cold, there are large differences in temperature from the equator to the pole, and large, continental-size glaciers can cover enormous regions of the Earth.

Ever since the Pre-Cambrian (600 million years ago), ice ages have occurred at widely spaced intervals of geologic time—approximately 200 million years—lasting for millions, or even tens of millions of years.

For the Cenozoic period, which began about 70 million years ago and continues today, evidence derived from marine sediments provide a detailed, and fairly continuous, record for climate change. This record indicates decreasing deep-water temperature, along with the build-up of continental ice sheets. Much of this deep-water cooling occurred in three major steps about 36, 15 and 3 million years ago—the most recent of which continues today.

During the present ice age, glaciers have advanced and retreated over 20 times, often blanketing North America with ice. Our climate today is actually a warm interval between these many periods of glaciation. The most recent period of glaciation, which many people think of as the "Ice Age," was at its height approximately 20,000 years ago.

Although the exact causes for ice ages, and the glacial cycles within them, have not been proven, they are most likely the result of a complicated dynamic interaction between such things as solar output, distance of the Earth from the sun, position and height of the continents, ocean circulation, and the composition of the atmosphere.



As glaciers spread and retreat, they shape the geology of continents. [Enlarge](#) Photo credit: © WGBH Educational Foundation

CLIMATIC COOLING FROM 60 MILLION YEARS AGO TO PRESENT DAY

Between 52 and 57 million years ago, the Earth was relatively warm. Tropical conditions actually extended all the way into the mid-latitudes (around northern Spain or the central United States for example), polar regions experienced temperate climates, and the difference in temperature between the equator and pole was much smaller than it is today. Indeed it was so warm that trees grew in both the Arctic and Antarctic, and alligators lived in Ellesmere Island at 78 degrees North.

But this warm period, called the Eocene, was followed by a long cooling trend. Between 52 and 36 million years ago, ice caps developed in East Antarctica, reaching down to sea level in some places. Close to Antarctica, the temperature of the water near the surface dropped to between 5 and 8 degrees Celsius. Between 36 and 20 million years ago the Earth experienced the first of three major cooling steps. At this time a continental-scale temperate ice sheet emerged in East Antarctica. Meanwhile, in North America, the mean annual air temperature dropped by approximately 12 degrees Celsius.

We are still in the midst of the third major cooling period that began around 3 million years ago.

Between 20 and 16 million years ago, there was a brief respite from the big chill, but this was followed by a second major cooling period so intense that by 7 million years ago southeastern Greenland was completely covered with glaciers, and by 5-6 million years ago, the glaciers were creeping into Scandinavia and the northern Pacific region. The Earth was once more released from the grip of the big chill between 5 and 3 million years ago, when the sea was much warmer around North America and the Antarctic than it is today. Warm-weather plants grew in Northern Europe where today they cannot survive, and trees grew in Iceland, Greenland, and Canada as far north as 82 degrees North.

We are still in the midst of the third major cooling period that began around 3 million years ago, and its effect can be seen around the world, perhaps even in the development of our own species. Around 2 and a half million years ago, tundra-like conditions took over north-central Europe. Soon thereafter, the once-humid environment of Central China was replaced by harsh continental steppe. And in sub-Saharan Africa, arid and open grasslands expanded, replacing more wooded, wetter environments. Many paleontologists believe that this environmental change is linked to the evolution of humankind.

POSSIBLE EXPLANATIONS FOR THE PAST 60 MILLION YEARS OF COOLING

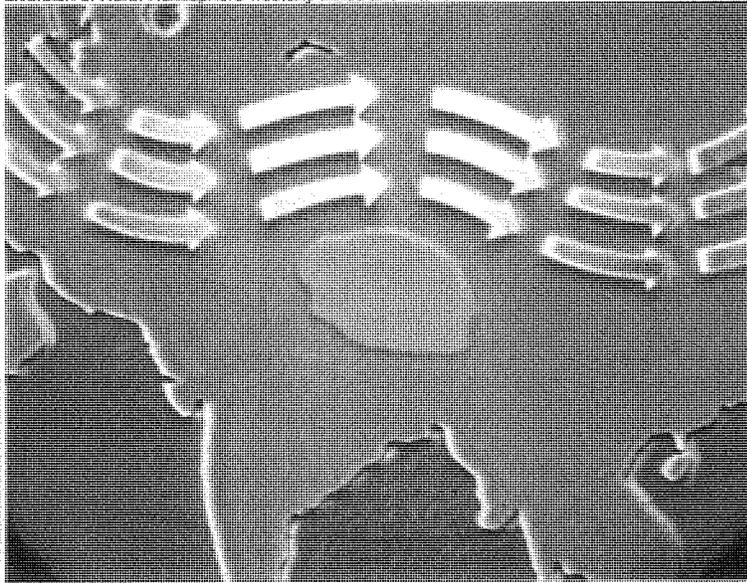
Climate change on ultra-long time scales (tens of millions of years) are more than likely connected to plate tectonics. Plate motions lead to cycles of ocean basin growth and destruction, known as Wilson cycles, involving continental rifting, seafloor-spreading, subduction, and collision. Several explanations of the latest cooling trend that involve a climate-tectonic connection are summarized below.

GEOGRAPHIC DISTRIBUTION AND SIZE OF CONTINENTS

Through the course of a Wilson cycle continents collide and split apart, mountains are uplifted and eroded, and ocean basins open and close. The re-distribution and changing size and elevation of continental land masses may have caused climate change on long time scales. Computer climate models

have shown that the climate is very sensitive to changing geography. It is unlikely, however, that these large variations in the Earth's geography were the primary cause of the latest long-term cooling trend as they fail to decrease temperatures on a global scale.

Likewise, changing topography cannot, by itself, explain this cooling trend. Computer model experiments performed to test the climate's sensitivity to mountains and high plateaus show that plateau uplift in Tibet and western North America has a small effect on global temperature but cannot explain the magnitude of the cooling trend. Plateau uplift does, however, have a significant impact on climate, including the diversion of North Hemisphere westerly winds and intensification of monsoonal circulation.



This schematic shows how westerly winds could be diverted by plateau uplift. [Enlarge](#) Photo credit: © WGBH Educational Foundation

GEOMETRY OF OCEAN BASINS

Another theory explaining these changes in climate involves the opening and closing of gateways for the flow of ocean currents. This theory suggests that the redistribution of heat on the planet by changing ocean circulation can isolate polar regions, cause the growth of ice sheets and sea ice, and increase temperature differences between the equator and the poles.

Ocean modeling experiments suggest that the ocean could not have carried enough heat to the poles to maintain the early warm climates. But atmospheric climate modeling experiments show that even if the

ocean did transport enough heat up to the coast of Antarctica to maintain sea surface temperatures at 10 to 15 degrees Celsius, the interior conditions would still be much colder—and this is contrary to the geologic record. It is possible, however, that changes in heat transport caused by variations in ocean gateways may have played a significant role in cooling trends over the last 60 million years, and, in particular, may help explain some of the relatively sudden cooling events.

ATMOSPHERIC CARBON DIOXIDE

Changes in the concentration of carbon dioxide in the atmosphere are a strong candidate to explain the overall pattern of climatic change. Carbon dioxide influences the mean global temperature through the greenhouse effect. The globally averaged surface temperature for the Earth is approximately 15 degrees Celsius, and this is due largely to the greenhouse effect. Solar radiation entering earth's atmosphere is predominantly short wave, while heat radiated from the Earth's surface is long wave. Water vapor, carbon dioxide, methane, and other trace gases in the Earth's atmosphere absorb this long wave radiation. Because the Earth does not allow this long wave radiation to leave, the solar energy is trapped and the net effect is to warm the Earth. If not for the presence of an atmosphere, the surface temperature on earth would be well below the freezing point of water.

Through a million year period, the average amount of carbon dioxide in the atmosphere is affected by four fluxes: flux of carbon due to (1) metamorphic degassing, (2) weathering of organic carbon, (3) weathering of silicates, (4) burial of organic carbon. Degassing reactions associated with volcanic activity and the combining of organic carbon with oxygen release carbon dioxide into the atmosphere. Conversely, the burial of organic matter removes carbon dioxide from the atmosphere.



The inevitable shifting of tectonic plates is also a driver of climate change. [Enlarge](#) Photo credit: © WGBH Educational Foundation

Plate collisions disrupt these carbon fluxes in a variety of ways, some tending to elevate and some tending to lower the atmospheric carbon dioxide level. It has been suggested that the Eocene, the early warm trend 55 million years ago, was caused by elevated atmospheric carbon dioxide and that a subsequent decrease in atmospheric carbon dioxide led to the cooling trend over the past 52 million

years. One mechanism proposed as a cause of this decrease in carbon dioxide is that mountain uplift lead to enhanced weathering of silicate rocks, and thus removal of carbon dioxide from the atmosphere.

In addition, the collision of India and Asia led to the uplift of the Tibetan Plateau and the Himalayas. While topography may not be enough to explain the cooling trends, another mechanism may account for changing climate. The uplift may have caused both an increase in the global rate of chemical erosion, as well as erode fresh minerals that are rapidly transported to lower elevations, which are warmer and moister and allow chemical weathering to happen more efficiently. Through these mechanisms, then, it has been hypothesized that the tectonically driven uplift of the Tibetan Plateau and the Himalayas is the prime cause of the post-Eocene cooling trend.

DOCUMENT SUBMITTED BY REPRESENTATIVE DARIN LAHOOD

the all-time global temperature record for three consecutive years¹⁴ and a number of published articles have convincingly demonstrated that global warming has continued unabated despite when one properly accounts for the vagaries of natural short-term climate fluctuations. A prominent such study¹⁵ was published by Tom Karl and colleagues in 2015 in the leading journal *Science*. The article was widely viewed as the final nail in the “globe has stopped warming” talking point’s coffin.

Last month, opinion writer David Rose of the British tabloid the *Daily Mail*—known for¹⁶ his serial misrepresentations of climate change and his serial attacks on climate scientists, published a commentary¹⁷ online attacking Tom Karl, accusing him of having “manipulated global warming data” in the 2015 Karl et al article. This fake news story was built entirely on an interview with a single disgruntled former NOAA employee, John Bates, who had been demoted from a supervisory position at NOAA for his inability to work well with others.

Bates’ allegations were also published on the blog of climate science denier Judith Curry (I use the term carefully—reserving it for those who deny the most basic findings of the scientific community, which includes the fact that human activity is substantially or entirely responsible for the large-scale warming we have seen over the past century—something Judith Curry¹⁸ disputes¹⁹). That blog post and the *Daily Mail* story have now

¹⁴ “How 2016 Became Earth’s Hottest Year on Record” by Jugal K. Patel, *New York Times*, Jan 18, 2017.

¹⁵ Karl et al, “Possible artifacts of data biases in the recent global surface warming hiatus”, *Science*, 348, pp. 1469-1472 (2015).

¹⁶ See the DeSmogBlog entry for David Rose: <https://www.desmogblog.com/david-rose>

¹⁷ “Exposed: How world leaders were duped into investing billions over manipulated global warming data” by David Rose, *The Daily Mail* (UK), Feb 4, 2017.

¹⁸ “Scott Pruitt’s office deluged with angry callers after he questions the science of global warming” by Juliet Eilperin and Brady Dennis, *Washington Post*, March 11, 2017.

¹⁹ “IPCC attribution statements redux: A response to Judith Curry” by Gavin Schmidt, *RealClimate.org*, Aug 27, 2014.

DOCUMENT SUBMITTED BY REPRESENTATIVE NEAL P. DUNN

Statement for the Record

Committee on Science, Space, and Technology

March 29, 2017

Hearing on: *Climate Science: Assumptions, Policy Implications, and the Scientific Method*

Dr. Neal Dunn

Thank you, Mr. Chairman,

This topic Scientific Integrity is one that means a great deal to me. As a medical doctor, I had to depend on good science every day. I relied on scientific studies that reported honestly results that I knew I could reproduce on my operating table or in my clinic, every day with every patient I encountered. If the science is bad, then I am putting people's lives in danger daily.

When we speak of scientific integrity, we mean science that has been conducted honestly and reported fairly with due attention to statistical reliability and bias.

To that point, science is never settled.

As soon as someone says to me "the science is settled" that tells me that person is not interested science – they want me to believe what they say and do what they tell me to do. And stop asking questions.

That's not science.

All of this reminds me of a bill that Congressman Lucas has sponsored, that I have cosponsored, that passed this committee and will hopefully be going to the floor soon. It is "The EPA Science Advisory Board Reform Act of 2017." This bill will help ensure meaningful and unbiased scientific advice by strengthening public participation, reinforcing peer review, reducing conflicts of interest, and providing opportunities for dissenting views.