CLIMATE CHANGE: EXAMINING THE PROCESSES USED TO CREATE SCIENCE AND POLICY

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

THURSDAY, MARCH 31, 2011

Serial No. 112–09

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

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PRINTING OFFICE
65–306PDF WASHINGTON : 2011

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HON. RALPH M. HALL, Texas, *Chair*

F. JAMES SENSENBRENNER, JR., Wisconsin
LAMAR S. SMITH, Texas
DANA ROHRABACHER, California
ROSCOE G. BARTLETT, Maryland
FRANK D. LUCAS, Oklahoma
JUDY BIGGERT, Illinois
W. TODD AKIN, Missouri
RANDY NEUGEBAUER, Texas
MICHAEL T. McCAUL, Texas
PAUL C. BROUN, Georgia
SANDY ADAMS, Florida
BENJAMIN QUAYLE, Arizona
CHARLES J. "CHUCK" FLEISCHMANN, Tennessee
E. SCOTT RIGELL, Virginia
STEVEN M. PALAZZO, Mississippi
MO BROOKS, Alabama
ANDY HARRIS, Maryland
RANDY HULTGREN, Illinois
CHIP CRAVAACK, Minnesota
LARRY BUCSHON, Indiana
DAN BENISHEK, Michigan
VACANCY

EDDIE BERNICE JOHNSON, Texas
JERRY F. COSTELLO, Illinois
LYNN C. WOOLSEY, California
ZOE LOFGREN, California
DAVID WU, Oregon
BRAD MILLER, North Carolina
DANIEL LIPINSKI, Illinois
GABRIELLE GIFFORDS, Arizona
DONNA F. EDWARDS, Maryland
MARCIA L. FUDGE, Ohio
BEN R. LUJÁN, New Mexico
PAUL D. TONKO, New York
JERRY McNERNEY, California
JOHN P. SARBANES, Maryland
TERRI A. SEWELL, Alabama
FREDERICA S. WILSON, Florida
HANSEN CLARKE, Michigan

CONTENTS

Thursday, March 31, 2011

Appendix II: Additional Material for the Record

CLIMATE CHANGE: EXAMINING THE PROCESSES USED TO CREATE SCIENCE AND POLICY

THURSDAY, MARCH 31, 2011

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

The Committee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6301
(202) 225–6371
www.science.house.gov

Climate Change: Examining the Processes Used to Create Science and Policy

Thursday, March 31, 2011
10:00 a.m. to 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. J. Scott Armstrong, Professor of Marketing, the Wharton School, University of Pennsylvania.

Dr. Richard Muller, Professor of Physics, University of California, Berkeley and Faculty Senior Scientist, Lawrence Berkeley Laboratory

Dr. John Christy, Director, Earth System Science Center, University of Alabama in Huntsville

Mr. Peter Glaser, Partner, Troutman Sanders, LLP

Dr. Kerry Emanuel, Professor of Atmospheric Science, Massachusetts Institute of Technology

Dr. W. David Montgomery, Economist

HEARING CHARTER

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

Climate Change: Examining the Processes Used to Create Science and Policy

THURSDAY, MARCH 31, 2011
10:00 A.M. TO 12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

PURPOSE

On Thursday, March 31, 2011 at 10:00 a.m. the House Committee on Science, Space, andTechnology will hold a hearing to examine processes used to generate key climate change science and information used to inform policy development and decision-making.

WITNESSES

- **Dr. J. Scott Armstrong,** Professor of Marketing, the Wharton School, University of Pennsylvania.
- **Dr. Richard Muller,** Professor of Physics, University of California, Berkeley and Faculty Senior Scientist, Lawrence Berkeley Laboratory
- **Dr. John Christy,** Director, Earth System Science Center, University of Alabama in Huntsville
- **Mr. Peter Glaser,** Partner, Troutman Sanders, LLP
- **Dr. Kerry Emanuel,** Professor of Atmospheric Science, Massachusetts Institute of Technology
- **Dr. W. David Montgomery,** Economist

BACKGROUND

All aspects of modern life operate within a known range of climate conditions. That range of variability requires that all sectors, from agriculture to transportation, have a measure of resiliency built into them. Our ability to adapt to changing climate conditions is predicated on our ability to better account for risk and prepare proportionate responses to those risks. Advancements in climate science may reduce uncertainty and provide a better idea about the risks we face, thus allowing for more informed decisions to be made that impact the quality of our lives.

Weather and Climate

Weather is defined as the state of the atmosphere with respect to wind, temperature, cloud cover, moisture, pressure, etc. at a given point in time. Climate is defined as the composite or generally prevailing weather conditions of a region averaged over a period of years or more. [1] In addition, spatial elements such as latitude, terrain, altitude, proximity to water and ocean currents affect the climate. The difference between weather and climate is a measure of time. Whereas weather consists of short-term changes in the atmosphere, climate is determined by cycles of variability that operate within timescales that span from millennia (i.e. ice ages) to months (i.e. seasons).

Scientific Process, Integrity, and Debate

Since the dawn of science, man has tried to describe and measure the natural world. Through an iterative process of data collection, formulation of hypotheses, and testing and refining these hypotheses, a knowledge base of information is built that yield theories and allow for predictive models to be built that describe them.

[1] http://www.nws.noaa.gov/glossary/

Experiments are conducted to test these hypotheses, theories and models. As new observations are incorporated throughout the process, the theories must be able to assimilate these new data or change to accommodate new facts. Confidence in a theory grows only if it is able to survive a rigorous testing process, it is supported by multiple and independent lines of evidence, and competing explanations can be ruled out. The American Physical Society statement on ethics and values states that:

"The success and credibility of science are anchored in the willingness of scientists to:

1. Expose their ideas and results to independent testing and replication by others. This requires the open exchange of data, procedures and materials.
2. Abandon or modify previously accepted conclusions when confronted with more complete or reliable experimental or observational evidence.

Adherence to these principles provides a mechanism for self-correction that is the foundation of the credibility of science. [2]

The creation of government regulations is dictated by several statutes, including the law that provides agencies the authority regulate some chemical or action as well as the Administrative Procedure Act (APA). While the APA provides guidelines as to what steps should be taken by agencies when promulgating rules, the statutes that give specific authority may also require additional measures to ensure a fair and impartial process. Furthermore, agencies have the discretion to allow for greater public participation, longer public comment periods, or even a greater burden of proof depending on the level of impact a given rule is projected to have.

Whether it is scientific method or regulatory procedure, process is defined as a systematic series of actions that are broadly known and well understood. Given the potential widespread impacts on the U.S. economy, climate change policy has received a level of scrutiny and analysis that rival some of the most important debates the U.S. has engaged in. As such, it is vital that the processes upon which climate change science and policy are based be widely accepted, understood, and adhered to.

In November of 2009, thousands of emails were leaked from the University of East Anglia's Climate Research Unit (CRU). These emails-many of which involved world-leading scientists in positions of influence with respect to key scientific assessments relied upon by policymakers-revealed significant communications suggesting a lack of adherence to basic principles of scientific conduct, openness, and information sharing. The controversy regarding the leaked emails-dubbed "ClimateGate" in the media-called into question the processes used in the Intergovernmental Panel on Climate Change (IPCC) as well as the processes used to create models and data that support claims that anthropogenic emissions of greenhouse gases have caused changes in the Earth's climate that is beyond natural variability. The significance of and concern regarding the emails has been heightened by the fact that CRU is one of the primary institutions that provide data and information to the IPCC, raising questions regarding the integrity of the models, data and processes, and ultimately the key scientific conclusions upon which climate policies are based.

Modeling Uncertainty

Increased computing capacity, a greater understanding of the atmosphere, and access to better data has allowed weather forecasting to evolve over the last century to become a vital part of daily life. The ability to forecast hours and days into the future is constantly improved as models used are validated by the observational data. Climate models, however, are not just weather models run for longer periods of time. Generally, climate models are more complex since they are dealing with longer time scales, larger geographic areas, and a greater number of complicated and interactive factors.

General circulation models (GCMs) are mathematical models of the general circulation of a planetary atmosphere or ocean. GCMs that model the climate as a whole are actually an amalgamation of several different models, including atmospheric models, ocean circulation models, land surface models, and sea ice models . [3] Each one of these models is built with mathematical equations that describe the physical world as it is understood. However, not all the observable physical processes are able to be described or explained by an equation. For example, clouds are not well modeled in the GCM, creating a very large question of uncertainty regard-

[2] http://www.aps.org.policy/statements/99__6.cfm

[3] U.S. Climate Change Science Program, Synthesis and Assessment Product 3.1. *Climate Models: An Assessment of Strengths and Limitations.* July 2008.

ing climate sensitivities,[4] i.e. could higher temperatures result in more clouds that then reflect more incoming radiation or do the clouds act as an additional warming layer preventing radiation from escaping the Earth's atmosphere.

While it has been well known for years that climate change modeling is difficult, imprecise and yielding results that are subject to interpretation, there has been increasing evidence that these models have not been developed and used according to accepted modeling and forecasting processes and tenants. As mentioned above, the scientific method requires that models be subjected to rigorous testing and experimentation in order to validate their results. Such testing and validation is necessary to generate confidence in the models as useful projective tools.

Data quality

Although the U.S. government began collecting weather data as early as 1814, the first systematic collection of data and issuance of warnings began in 1870 after President Ulysses S. Grant signed into law a bill that established what is now the National Weather Service. Technology has advanced from individual measurements of temperature and wind to the current use of satellites to measure many aspects of Earth's climate. This continuous data record provides the ability to observe the changes in weather patterns over time, and contributes to efforts to better predict future changes.

In any scientific pursuit, data is the key ingredient that informs scientists as to whether or not the hypothesis being tested is supported or wrong. Bad quality data may demonstrate a hypothesis is supported, when in fact, the data may obscure the fact that the hypothesis is incorrect. High quality data, however, generates confidence that the results of an experiment represent the truth of the scientific inquiry. Therefore, the quality of data is paramount to production of good science.

In recent years, there have been questions regarding not only the quality of the data collected but also the processes used for normalization (in order to compare "apples to apple"). The quality of data collected from instruments that have not been maintained or whose placement violates government positioning procedures has not been established. Furthermore, the process used for quality assurance has come under question as well, prompting several data quality projects across the country to test the quality of the data used in climate change science.

IPCC Process

The IPCC was established by the United Nations Environment Programme and the World Meteorological Organization to provide the world with scientific assessments of the current state of knowledge in climate change. Although billed as a scientific organization, the IPCC does not conduct science; it only compiles science from existing scientific literature.

The issuance of the third (2001) and fourth (2007) assessment reports have been accompanied by increasing questions regarding the process used by the IPCC. Specifically, transparency, conflicts of interest, political interference, the characterization of uncertainty, and the use of non-peer reviewed data and information are all areas of the IPCC process that have caused concern among scientists, academics and policy makers. [5] Although there have been many recommendations as to how to reform the process in order to restore confidence in the assessment results, and the IPCC has stated it would adopt many of these reforms, there has been no evidence as of yet whether or not these reforms will sufficiently address the shortcomings in the process.

If the IPCC assessments are to be used in the U.S. as a resource for the U.S. Climate Change Science Program and as a justification for changing U.S. government policies, the processes and procedures employed by the IPCC must meet the rigorous standards for integrity, objectivity and quality control that is imposed on other scientific information (i.e., requirements under the Data Quality Act). The aforementioned process issues mentioned and the questions raised about them demonstrate a need to determine whether or not the IPCC standards meet the necessary thresh-

---

[4] Zhang, Y., Klein, S.A., Boyle, J. and Mace, G.G. 2010. Evaluation of tropical cloud and precipitation statistics of Community Atmosphere Model version 3 using CloudSat and CALIPSO data. Journal of Geophysical Research 115: doi:10.1029/2009JD012006.

[5] InterAcademy Council, Committee to Review the Intergovernmental Panel on Climate Change. *Climate Change Assessments: Review of the processes and procedures of the IPCC.* October, 2010. *http://reviewipcc.interacedemycouncil.net/report/Climate %20Change %20Assessments, %20Review%20of%20the%20Process%20&%20Procedures%20of %20the%20IPCC.pdf*

old to qualify as a resource for the U.S. government. Questions remain as to whether or not the reforms adopted by the IPCC will actually meet those standards.

EPA Endangerment

In December 2009, the Environmental Protection Agency (EPA) finalized its endangerment finding, officially declaring the emission of greenhouse gases by mankind to be a danger to public health and welfare. Upon making this determination, the EPA became obligated under the Clean Air Act to regulate greenhouse gases, particularly carbon dioxide, under other parts of the bill, namely, the Prevention of Significant Deterioration (PSD) and Title V permitting of stationary sources.

The process used to make the endangerment finding under section 202(a) of the Clean Air Act allows for significant agency discretion. The scientific basis the Agency used for its determination is detailed in the Technical Support Document (TSD). More than half of the references in the TSD are from the IPCC or from government reports that relied heavily on the IPCC as a resource. The concerns mentioned above regarding the integrity of the modeling results, the quality of the data used, and the IPCC process itself, raise questions about the robustness of the information used to make the endangerment determination, thus calling the finding into question.

Chairman HALL. Okay. The Committee on Science, Space, and Technology will come to order. And I say to all of you good morning and welcome to today's hearing entitled Climate Change: Examining the Processes Used to Create Science and Policy. In front of you are packets containing the written testimony, biographies and Truth in Testimony Disclosures for today's witnesses. I recognize myself for five minutes for an opening statement.

I want to welcome everyone here today for this hearing on climate change processes.

When I became Chairman of this Committee, I stated that I wanted to bring up folks to testify on climate change science and policy because I believe there have been a lot more questions than answers. The current Administration has been moving full speed ahead with regulations and policy initiatives that it justifies based on the available science. Since these actions have the potential to severely damage our economy, there should be extra care in making sure they are truly necessary and appropriate.

Science is not perfect. It is a process of trial and error. And scientists are not infallible; they are just as human as any of us. As policy makers, we are tasked with making difficult decisions, sometimes when not all the answers are known. In cases such as these, we must rely upon the processes by which the information we do have is generated, and we must rely upon the fact that the people generating that information have adhered to these processes.

The leaked emails from the University of East Anglia's Climate Research Unit in November of 2009 revealed that the scientists most vocal about the effects humans were having on the climate were not following accepted scientific practices. When these emails came to light, the Administration proclaimed that the science generated by a corrupt process was still robust and still justified the policy measures it was taking.

For many of us here, these emails were evidence that the trust in the underlying process was misplaced. I may not be a scientist, but as a politician, I can tell you when someone is trying to pull the wool over our eyes.

There is an old saying. Caesar's wife must be beyond reproach. This is to say that even if there has been no evidence of wrongdoing, the supposition of wrongdoing is enough to undermine the trust in an entire enterprise.

The legitimate questions that have been raised about the processes used to generate climate change science and policy have thus far been cast aside. The reluctance to engage in conversations with people who have doubts or question the veracity of climate science is at the heart of the wrongdoing that undermines trust in climate change science.

In a hearing last November, I stated that reasonable people have serious questions about our knowledge of the state of the science, the evidence, and what constitutes a proportional response. The hearing today will explore how basic and widely accepted scientific processes have been applied in building the foundation of climate science that we rely upon to make decisions. I look forward to returning the debate back to the methodical, deliberative, balanced and transparent discussion it ought to be.

I thank the witnesses for being here.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH HALL

I want to welcome everyone here today for this hearing on climate change processes.

When I became Chairman of this Committee, I stated that I wanted to bring up folks to testify on climate change science and policy because I believe there have been a lot more questions than answers. The current Administration has been moving full speed ahead with regulations and policy initiatives that it justifies based on the available science. Since these actions have the potential to severely damage our economy, there should be extra care in making sure they are truly necessary and appropriate.

Science is not perfect. It is a process of trial and error. And scientists are not infallible; they are just as human as any of us. As policy makers, we are tasked with making difficult decisions, sometimes when not all the answers are known.

In cases such as these, we must rely upon the processes by which the information we do have is generated. And we must rely upon the fact that the people generating that information have adhered to those processes.

The leaked emails from the University of East Anglia's Climate Research Unit in November of 2009 revealed that the scientists most vocal about the effects humans were having on the climate were not following accepted scientific practices. When these emails came to light, the Administration proclaimed that the science generated by a corrupt process was still robust, and still justified the policy measures it was taking.

For many of us here, these emails were evidence that the trust in the underlying process was misplaced. I may not be a scientist, but as a politician, I can tell when someone is trying to pull the wool over my eyes.

There is an old saying—Caesar's wife must be beyond reproach. That is to say that even if there has been no evidence of wrong doing, the supposition of wrong doing is enough to undermine the trust in an entire enterprise.

The legitimate questions that have been raised about the processes used to generate climate change science and policy have thus far been cast aside. The reluctance to engage in conversations with people who have doubts or question the veracity of climate science is at the heart of the wrong doing that undermines trust in climate change science.

In a hearing last November, I stated that reasonable people have serious questions about our knowledge of the state of the science, the evidence, and what constitutes a proportional response. The hearing today will explore how basic and widely accepted scientific processes have been applied in building the foundation of climate science that we rely upon to make decisions. I look forward to returning the debate back to the methodical, deliberative, balanced and transparent discussion it ought to be.

I thank the witnesses for being here, and I now recognize Ranking Member Johnson for five minutes for an opening statement.

Chairman HALL. I now recognize Ranking Member Johnson for five minutes for an opening statement. The Chair now recognizes Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman. Mr. Chairman, am I to assume that these witnesses are under oath today?

Chairman HALL. I didn't understand you.

Ms. JOHNSON. Are the witnesses under oath today?

Chairman HALL. They are.

Ms. JOHNSON. Thank you. Thank you very much. I appreciate you holding this hearing today. Political opinions on climate change vary greatly and nowhere more than here in the U.S. Congress. As one who accepts the overwhelming scientific consensus around climate change, I welcome the opportunity for this Committee to hear a number of perspectives on climate change.

However, I believe this hearing will fall far short of providing a meaningful discourse on the subject. I am disappointed in the very broad scope of this hearing which arguably ranges beyond the ju-

risdiction of this Committee without sufficient numbers of witnesses to do the topics justice.

I believe that a subject as complex as we are attempting to cover today warrants at the very least multiple panels, if not multiple hearings. To hope to adequately cover everything from basic science to regulatory policy in one 2-hour hearing strikes me as too ambitious if not a little negligent.

Likewise I am disappointed by the makeup of the panel today. By that I mean, no disrespect to these men or the quality of their work. However, we Democrats have been accused of ignoring a large subset of the climate science community that in varying degrees does not subscribe to the conclusions of the IPCC or otherwise does not accept the climate is changing, and that it is largely due to human activity.

We have been told that these scientists' voices have been squashed by a wide-ranging conspiracy and that under the new House leadership, they would finally have a platform to dispel the alarmists' mistruth about the science of global climate change.

I look at this panel today and I must ask, well, where are they? Where are the masses of legitimate expert witnesses that will corroborate to the assertion that climate change is an unproven theory or worse yet a hoax? I don't see them today. Instead the witnesses before the Science, Space, and Technology today include a business school professor of marketing, an economist, and an energy industry lawyer. We also have three legitimate scientists, but it is worth noting that not one of them refutes the notion that the global climate is changing and that humans are a factor.

The necessary oversight can be done right. For instance, in the last Congress, Energy and Environment Subcommittee Chairman Baird sensed that time was running out in the waning days of the 111th Congress to have a balanced hearing on the subject and held a 4-hour hearing with three panels covering three separate issues within climate change and with a Republican witness on each panel.

We could have reasonable discussions and disagree on the monetary costs of taking action and the devastating impacts of complacency, but science will not allow us to run from the facts no matter how inconvenient these facts may be. To be fair, there is a danger in saying that science is settled and that our knowledge of climate change is conclusive. On the contrary, with the risk of this magnitude, the job of science will never be done. It will continue to evolve. We know that climate is changing and that we have our hand on the thermostat, but we must always keep looking for new answers, replacing opinions with data and projections and observations.

We must continue to innovate in how we predict, measure, prevent, and adapt to climate change. That is the nature of science and of the stewardship of our planet. Congress should acknowledge that we are not experts and that allowing partisan politics to dictate the scientific understanding of climate change is cynical, shortsighted, and by definition, ignorant.

I implore my colleagues to recognize the value of research and resist efforts to defund and destroy the very scientific community that will give us answers. We may not agree as to where the uncer-

tainties within climate science lie, but we can all understand that vast and avoidable uncertainties will remain if we stop the progress of climate science.

This may be the scientific and policy challenge of the millennium, and we have a responsibility to the Nation and to the world to lead.

The former Ranking Member, Republican Member of Energy and Environment Subcommittee, Bob Inglis, eloquently conveyed his dismay at the recklessness of climate skepticism by comparing it to the diagnosis of a sick child. If 98 doctors prescribe one treatment and two doctors prescribe a different treatment, who are you going to follow?

This Committee has to decide between two choices when it comes to global climate change. We can allow the world's scientists to continue to conduct extensive research and improve our knowledge of this phenomenon, or we can just wait and watch it happen and hope for the best. Climate change is a cancer, and we don't cure cancer by refusing to test for it, calling the doctor a liar, and refusing to consider any treatment. We would never stop looking for the cure.

While I look forward to today's testimony and what will undoubtedly be a lively discussion, I must say that I sincerely hope that this Committee is not beginning and ending its record on climate science in the 112th Congress with this hearing. We have so much more work to do.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. I appreciate you holding this hearing today. Political opinions on climate change vary greatly, and nowhere more than here in the U.S. Congress. As one who accepts the overwhelming scientific consensus around climate change, I welcome the opportunity for this committee to hear a number of perspectives on climate science. However, I believe this hearing will fall far short of providing a meaningful discourse on the subject.

I am disappointed in the very broad scope of this hearing, which arguably ranges beyond the jurisdiction of this Committee, without sufficient numbers of witnesses to do the topics justice. I believe that a subject as complex as we are attempting to cover today warrants, at the very least, multiple panels, if not multiple hearings. To hope to adequately cover everything from basic science to regulatory policy in one 2-hour hearing strikes me as too ambitious, if not a little negligent.

Likewise I am disappointed by the makeup of the panel today. By that I mean no disrespect to these men or the quality of their work. However, for years we, Democrats, have been accused of ignoring a large subset of the climate science community that, in varying degrees, does not subscribe to the conclusions of the IPCC or otherwise does not accept that the climate in changing, and that is largely due to human activity. We have been told that these scientists' voices have been quashed by a wide-ranging conspiracy, and that under the new House leadership they would finally have a platform to dispel the alarmists' mistruths about the science of global climate change.

I look at this panel today and I must ask, ″Well, where are they?″ Where are the masses of legitimate expert witness that will corroborate the assertion that climate change is an unproven theory, or worse, a hoax? I don't see them here today.

Instead, the witnesses before the Science, Space and Technology Committee include a Business School professor of Marketing, an Economist, and an energy industry Lawyer. We also have three legitimate scientists, but it is worth noting that not one of them refutes the notion that the global climate is changing and that humans are a factor.

The necessary oversight can be done right. For instance, in the last Congress, Energy and Environment Subcommittee Chairman Baird sensed that time was run-

ning out in the waning days of the 111th Congress to have a balanced hearing on the subject and held a 4-hour hearing with three panels covering three separate issues within climate change, and with a Republican witness on each panel.

We can have reasonable discussions and disagree on the monetary costs of taking action and the devastating impacts of complacency. But Science will not allow us to run from the facts, no matter how inconvenient these facts may be.

To be fair, there is a danger in saying that the science is settled, and that our knowledge of climate change is conclusive. On the contrary, with a risk of this magnitude, the job of science will never be done. It will continue to evolve.

We know that the climate is changing, and that we have our hand on the thermostat. But we must always keep looking for new answers, replacing opinions with data, and projections with observations. We must continue to innovate in how we predict, measure, prevent and adapt to climate change. That is the nature of science and of our stewardship of our planet.

Congress should acknowledge that we are not the experts, and that allowing partisan politics to dictate the scientific understanding of climate change is cynical, short-sighted, and, by definition, ignorant. I implore my colleagues to recognize the value of research, and resist efforts to defund and destroy the very scientific community that will give us answers. We may not agree as to where the uncertainties within climate science lie, but we can all understand that vast and avoidable uncertainties will remain if you stop the progress of climate science.

This may be the scientific and policy challenge of the millennium, and we have a responsibility to the nation and the world to lead.

The former Ranking Republican Member of the Energy and Environment Subcommittee, Bob Inglis, eloquently conveyed his dismay at the recklessness of climate skepticism by comparing it to the diagnosis of a sick child - if 98 doctors prescribe one treatment, and 2 doctors prescribe a different treatment, who are you going to follow?

This Committee has to decide between two choices when it comes to global climate change: we can allow the world's scientists to continue to conduct extensive research and improve our knowledge of phenomenon, or we can just wait to watch it happen and hope for the best. Climate changes is a cancer, and we don't cure cancer by refusing to test for it, calling the doctor a liar, and refusing to consider any treatment. We never stop looking for the cure.

While I look forward to today's testimony and what will undoubtedly be lively discussion, I must say that I sincerely hope that this Committee is not beginning and ending its record on climate science in the 112th Congress with this hearing. We have so much more work to do.

Chairman HALL. Okay. At this time, first, if there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The information follows:]

Chairman HALL. And I want to introduce the witnesses that we don't consider anything but legitimate and witnesses that haven't been here before because we have asked them to be here before and that has been turned down.

Our first witness is Dr. J. Scott Armstrong, Professor of Marketing at the Wharton School, University of Pennsylvania. Dr. Armstrong is an expert in forecasting and has literally written the book on the principles of forecasting. He is the founder of several and currently serves as editor more than half-a-dozen peer review journals.

Our second witness is Dr. Richard Muller, a Professor of Physics at the University of California, Berkeley and is a Faculty Senior Scientist at the Lawrence Berkeley Laboratory. Dr. Muller is the author of over 100 peer-reviewed publications and views of particle physics, geophysics, applied physics and astrophysics. He is currently chair of the Berkeley Earth Surface Temperature Project which is attempting to create a new global surface temperature data set.

Our third witness is Dr. John Christy, Director of the Earth System Science Center and Distinguished Professor of Atmospheric Science at the University of Alabama in Huntsville. Dr. Christy is the Alabama State climatologist where he has built his own climate data sets. Dr. Christy was the lead author in the Intergovernmental Panel on Climate Change Third Assessment Report in 2001 and a contributing author in 1992, 1994, 1995 and 2007.

Our fourth witness is Mr. Peter Glaser, a partner with Troutman Sanders, LLP. He practices in the energy and environmental law fields and is the chair of the firm's climate change practice team. He specializes in environmental regulation and litigation, particularly in the area of air quality and global climate change.

Our fifth witness is Dr. Kerry Emanuel, a Professor of Atmospheric Science in the Massachusetts Institute of Technology. Dr. Emanuel's research interests focus on tropical meteorology and climate with a specialty in hurricane physics. He is the author or co-author of over 100 peer-reviewed publications and was elected to the National Academies of Science in 2007.

Our final witness is Dr. David Montgomery, an independent economist and consultant and formerly the co-head of the Energy and Environment Practice at Charles River Associates. Dr. Montgomery is an expert on economic issues associated with climate change policy, and he was the principal lead author of the Second Assessment Report of the Intergovernmental Panel on Climate Change. He was also Assistant Director of the U.S. Congressional Budget Office—Assistant Secretary for Policy in the U.S. Department of Energy. He also taught economics at California Institute of Technology and Stanford University.

As our witnesses should know, spoken testimony is limited to five minutes. Do your best to stay there. You are not held there, and if you need to go a little further, you need to cut it a little short, that is up to you, after which the Members of the Committee are going to have five minutes each. We will hold ourselves to that five minutes. You have leeway of course because we appreciate you being here. You have prepared yourself to come here. You are here, and we want to accord you everything that we can to get the benefit from your appearance here, and the Members of the Committee get their chance to ask you questions about where you come from, how you got there, and what you have for us.

So I recognize our first witness, Dr. J. Scott Armstrong, Professor at the Wharton School, University of Pennsylvania.

STATEMENT OF DR. J. SCOTT ARMSTRONG, PROFESSOR OF MARKETING, THE WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA

Dr. ARMSTRONG. Thank you, Chairman Hall, and Ranking Member Hall and Ranking Member Johnson. It is a pleasure to be here to testify. That is odd. This worked perfectly before we started here.

Chairman HALL. Is it not working now?

Dr. ARMSTRONG. Not working. If everybody has a copy of it, I can just go through while you look on your copy.

Chairman HALL. You got an expert looking over your shoulder right now.

Dr. ARMSTRONG. All right. Here we go again. I am back to five minutes, am I? No, it is not working.

Chairman HALL. No, we haven't even started you yet. When I say go, you go.

Dr. ARMSTRONG. All right. Thank you. Thanks for talking about my credentials. I started in 1968 when I graduated from MIT and specialized in forecasting methods, and it wound up recently as you mentioned with Principles of Forecasting, a handbook I did with 39 other experts around the world. So it is 50 years of experience so far. If everybody can just get out the slides, I will just go through from that. The slides aren't going to be as good because I had some fly-ins here, but the first thing is to start out with what we all agree with, and what we agree with is that climate changes. What we aren't sure about is what is the optimal temperature?

In conclusion, the most appropriate evidence-based forecast is that there will be no long-term warming claim. Secondly, even if we have a scientific forecasting approach that supported global warming on a long-term basis, there is no logical basis for action.

Now, I am going to tell you how I got there. To adopt policies related to global warming, you need three things. The first is to show the forecast that there is a substantial, dangerous, long-term temperature change, absent with any regulations. Second is to show that this long-term change is going to cause harmful effects versus alternative policies such as doing nothing. Third is that you have cost-effective policies that will deal with any harmful effects. It is like a three-legged stool so that if any one of these legs is missing, then you have a problem.

The next slide, and again it would be much nicer if we could get this system working here—no, it is not working. Forget it. The next slide shows the support that we have for these three elements of the leg, and I put them in that little box. You know, it is an important problem. We have been searching, we are trying to find what evidence we have on each of those three legs identified, and that little box contains all of the scientific forecasts we have been able to find. It is an empty box.

So the warming alarm is based on faulting forecasting method. The IPCC forecast uses judgments to develop a model. They then run the model. They make judgments on the outcomes, and basically they are known as scenarios. Scenarios are not an appropriate method for forecasting. They have a role, but forecasting is not one of them. There are stories about the future, whether told in text or whether told by computer.

We did an audit of the 2007 IPCC forecasting procedures using the principles from this book. There are 140 of them. We concluded that the IPCC violated 72 of the 89 relevant principles. Some of them were pretty serious, like using biased procedures to collect data. You should use unbiased procedures and to be conservative when you have uncertainty.

An example of the policy section, you know, making policy based on global warming, we looked at the polar bear population forecasting. Two government reports indicated there would be a sharp decline in the population of polar bears. Our forecasting audit revealed failure to use 87 percent of the relevant principles. They failed to provide, for example, full disclosure of the data. Long-term

forecasts were used with only five years of data. They want to make long-term forecasts.

The global warming forecast models have not been validated for predictability. We couldn't find any evidence on that, so we did it ourselves. We used the period from 1850 through 2007, and we found that—we used a method called successive updating. We compared the error of our method, which is that there will be no change, with the IPCC forecast. And how large was the IPCC forecast? Well, on average, over the 10,750 forecasts that we checked, the IPCC forecast was 7.7 times larger. For the long-term forecast, 91 to 100 years, it had 12.6 times larger error than we have from assuming no change.

So forecasting global warming lacks any scientific basis. Now, given that the critical legs of the stool cannot be supported and that improper procedures have been used, in particular the lack of objectivity and the lack of full disclosure, we have concluded that this is basically an anti-scientific political movement. Has anything happened like this before, an anti-scientific political movement? So we started what we call the analogous project. We are looking for alarms over serious things that are happening that might be averted at great cost. The analogous study, some of the alarms we got were things like DDT and cancer, eugenics movement, population growth and famine starting with Malthus and then moving through computer models at MIT and global warming—it was global cooling alarm.

Government intervention was called for in 25 of the 26 analogous situations that we identified. They called for increased taxes, increased spending and restrictions on individual liberties. Now how accurate were these analogous forecasts? Well, of the 26 analogous situations, 19 of the forecasts were categorically wrong, seven were wrong in degree and we were yet to find an analogous situation where the forecasts were correct.

Next thing we asked was does government intervention help? Actually, there were 23 cases where they used government intervention, and harm was caused in 20 of those cases, and the policies were ineffective in three of the cases. And we found no cases in which the policies were effective.

Summary of findings from the studies on alarming forecasts of dangerous manmade global warming are the temperature forecasting procedures are improper, the policy forecasting procedures are improper, the forecast failed in a validation study and none of the analogous alarms have been found to be correct. The thing about these alarming forecasts, it goes way back. It goes way back to Macaulay in 1930. Julian Simon, my friend and colleague in 1990 talked about all these alarms, that the manmade is going to cause the end of the civilization, and he forecasted in the early '90s that this global warming thing will blow over quickly. So that was one of his bad forecasts.

The conclusion then is that the—I have to get to this last slide. [Slide]

Dr. ARMSTRONG. The conclusions were again—one more.

Chairman HALL. Just move along with it. You didn't have a fair opportunity because of the malfunction, and that is our fault. But we let you go well over. I would hope you could conclude.

Dr. ARMSTRONG. Okay. Thanks. Recommendation number one is end government funding for climate change research. Recommendation number two is end government funding for research associated with global warming, things like alternative energy, CO_2 reduction, habitat loss, things like that. Recommendation number three, end government programs and repeal regulations predicated on global warming. Recommendation number four, end global support for organizations that lobby or campaign predicated on global warming.

Thank you for giving me extra time.

[The prepared statement of Mr. Armstrong follows:]

PREPARED STATEMENT OF DR. J. SCOTT ARMSTRONG, PROFESSOR OF MARKETING, THE WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA

WITH KESTEN C. GREEN, UNIVERSITY OF SOUTH AUSTRALIA, AND WILLIE SOON, HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS

Abstract

The validity of the manmade global warming alarm requires the support of scientific forecasts of (1) a substantive long-term rise in global mean temperatures in the absence of regulations, (2) serious net harmful effects due to global warming, and (3) cost-effective regulations that would produce net beneficial effects versus alternatives policies, including doing nothing.

Without scientific forecasts for all three aspects of the alarm, there is no scientific basis to enact regulations. In effect, the warming alarm is like a three-legged stool: each leg needs to be strong. Despite repeated appeals to global warming alarmists, we have been unable to find scientific forecasts for any of the three legs.

We drew upon scientific (evidence-based) forecasting principles to audit the forecasting procedures used to forecast global mean temperatures by the Intergovernmental Panel on Climate Change (IPCC)—leg "1" of the stool. This audit found that the IPCC procedures violated 81% of the 89 relevant forecasting principles.

We also audited forecasting procedures, used in two papers, that were written to support regulation regarding the protection of polar bears from global warming—leg "3" of the stool. On average, the forecasting procedures violated 85% of the 90 relevant principles.

The warming alarmists have not demonstrated the predictive validity of their procedures. Instead, their argument for predictive validity is based on their claim that nearly all scientists agree with the forecasts. This count of "votes" by scientists is not only an incorrect tally of scientific opinion, it is also, and most importantly, contrary to the scientific method.

We conducted a validation test of the IPCC forecasts that were based on the assumption that there would be no regulations. The errors for the IPCC model long-term forecasts (for 91 to 100 years in the future) were 12.6 times larger than those from an evidence-based "no change" model.

Based on our own analyses and the documented unscientific behavior of global warming alarmists, we concluded that the global warming alarm is the product of an anti-scientific political movement.

Having come to this conclusion, we turned to the "structured analogies" method to forecast the likely outcomes of the warming alarmist movement. In our ongoing study we have, to date, identified 26 similar historical alarmist movements. None of the forecasts behind the analogous alarms proved correct. Twenty-five alarms involved calls for government intervention and the government imposed regulations in 23. None of the 23 interventions was effective and harm was caused by 20 of them.

Our findings on the scientific evidence related to global warming forecasts lead to the following recommendations:

1. End government funding for climate change research.
2. End government funding for research predicated on global warming (e.g., alternative energy; CO2 reduction; habitat loss).
3. End government programs and repeal regulations predicated on global warming.
4. End government support for organizations that lobby or campaign predicated on global warming.

Introduction

Knowledge of Roman vineyards in Britain and Viking diary farms in Greenland together with plots of temperature proxy data over hundreds, thousands, and hundreds-of-thousands of years provide evidence that the Earth's climate varies, so the existence of climate change is not a matter of dispute. Global warming alarmist analysis is concentrated on the years from 1850, a period of widespread direct temperature measurement, increasing industrialization, and increasing concentrations of carbon dioxide in the atmosphere. As with other periods, during this period one can retrospectively identify upward trends and downward trends, depending on the starting and ending dates one chooses. Over the whole period that we examined, 1850 through 2007, global annual temperature proxy series constructed for the Intergovernmental Panel on Climate Change (IPCC) show a small upward trend of about 0.004°C per year. There is some dispute over the veracity of the proxy temperature series (Christy, et al. 2010). For our analyses, however, we treat the data as if they were correct. In particular, we use the U.K. Hadley Centre's "best estimate" series, HadCRUt3 [1] as described in Brohan et al. (2006).

We approach the issue of alarm over dangerous manmade global warming as a problem of forecasting temperatures over the long term. The global warming alarm is not based on what *has* happened, but on what *will* happen. In other words, it is a forecasting problem. And it is a very complex problem.

To address this forecasting problem we first describe the basis of the scientific principles behind forecasting. We then examine the processes that have been used to forecast the onset of dangerous manmade global warming and the validation procedures used to demonstrate predictive validity. We then summarize our validation study.

We limit our discussion to forecasting. Those who are interested in the relevant aspects of climate science can find summaries in Robinson, Robinson and Soon (2007) and in Idso and Singer (2009).

Based on our analyses, especially with respect to the violations of the principles regarding objectivity and full disclosure, we conclude that the manmade global warming alarm is an anti-scientific political movement. In an ongoing study, we identified analogous alarms and report on the forecasts behind the alarms and outcomes.

The basis of scientific forecasting

Research on proper forecasting methods has been conducted for roughly a century. Progress increased over the past four decades, as researchers emphasized experiments that were designed to test the effectiveness of alternative methods under varied conditions. Forecasting research has led to many surprising conclusions.

To make this knowledge useful to forecasters in all domains, I, along with an international and inter-disciplinary group of 39 co-authors and 123 reviewers, expert in various aspects of forecasting, summarized the evidence as a set of principles. A principle is a conditional action, such as "forecast conservatively in situations of uncertainty." There are now 140 forecasting principles. The principles are described and the evidence for them is fully disclosed in the Principles of Forecasting handbook (Armstrong 2001). The principles are also provided on the forecastingprinciples.com site (ForPrin.com), on which we invite researchers to contribute evidence either for or against the principles.

In practice, nearly everyone believes that their situation is different and that the principles do not apply. I suggest to such people that they conduct experiments for their own situation and publish their findings, especially if they contradict the principles, and by doing so advance the science of forecasting. There can never be enough situation-specific evidence for some people but, given the evidence that many common forecasting practices are invalid, it would be in unwise to reject the principles without strong evidence for doing so.

Conditions that apply in forecasting climate change

The global warming alarm is based on a chain of three linked elements, each depending on the preceding element, and each element is highly complex due to the number of variables and the types of relationships. It is much like a three-legged stool. Each leg involves much uncertainty (Idso and Singer 2009). The alarm requires:

1. a substantive long-term rise in global mean temperatures in the absence of regulations,

[1] Obtained from http://hadobs.metoffice.com/hadcrut3/diagnostics/global/nh+sh/annual; notes on series at http://www.metoffice.gov.uk/hadobs/hadcrut3/.

2. serious net harmful effects due to global warming, and

3. cost-effective regulations that would produce net beneficial effects versus alternatives such as doing nothing.

Effective policy-making requires scientific forecasts for all three elements. Without proper forecasts, there can be no sound basis for making policy decisions. Surprisingly, then, despite repeated appeals to global warming alarmists, we have been unable to find scientific forecasts for any of the three elements.

Of course, there have been many forecasts based on what we refer to as unaided expert judgment (i.e., judgments made without the use of evidence-based forecasting principles). For example, in 1896 the Swedish Nobel Prize winner in chemistry, Svante Arrhenius, speculated about the effect of increases in atmospheric carbon dioxide (C02) and concluded that higher concentrations would cause warming. His conclusion was drawn from an extrapolation of observational data.[2] Arrhenius's idea attracted little attention at the time, perhaps because he expected benefits from warming, rather than an impending disaster.

As noted, the forecasting principles provide advice about how to forecast given the conditions. Here the evidence yields a finding that is surprising to many researchers: use simple methods when forecasting in a complex and uncertain situation. This was a central theme in my 1978 book, *Long-range Forecasting*. Those involved in forecasting dangerous manmade global warming have violated the "simple methods" principle.

Audit of methods used to forecast dangerous manmade global warming

Kesten Green surveyed climate experts (many of whom were IPCC authors and editors) to find the most credible source for forecasts on climate change. Most respondents referred to the IPCC report and some specifically to Chapter 8, the key IPCC chapter on forecasting (Randall et at. 2007).

Kesten Green and I examined the references to determine whether the authors of Chapter 8 were familiar with the evidence-based literature on forecasting. We found that none of their 788 references related to that body of literature. We could find no references that validated their choice of forecasting procedures. In other words, the IPCC report contained no evidence that the forecasting procedures they used were based on evidence of their predictive ability.

We then conducted an audit of the forecasting procedures using Forecasting Audit Software, which is freely available on forprin.com. Kesten Green and I independently coded the IPCC procedures against the 140 forecasting principles, and then we discussed differences in order to reach agreement. We also invited comments and suggestions from the authors of the IPCC report that we were able to contact in hope of filling in missing information. None of them replied with suggestions and one threatened to lodge a complaint if he received any further correspondence. We described the coding procedures we used for our audit in Green and Armstrong (2007a).

We concluded from our audit that invalid procedures were used for forecasting global mean temperatures. Our findings, described in Green and Armstrong (2007a), are summarized in Exhibit 1. Based on the available information, 81% of the 89 relevant principles were violated. There were an additional 38 relevant principles, but the IPCC chapter provided insufficient information for coding and the IPCC authors did not supply the information that we requested.

Exhibit 1: Audit of the IPCC forecasting procedures

Principles were:	IPCC Chapter 8
Violated	60
Apparently violated	12
Properly applied	17
Insufficient information	38
Total relevant principles	**127**

Much of the problem revolves around the use of computer modelers' scenarios as a forecasting method. As stated correctly by Trenberth (2007), a leading spokesperson for the IPCC researchers, the IPCC provides scenarios, not forecasts. Sce-

[2] See description on Wikipedia and original paper at globawarmingart.com/images/1/18/Arrhenius.pdf.

narios are not a valid forecasting method (Gregory & Duran 2001), but simply descriptions of their authors' speculations about what might happen in the future.

Warming forecasts and polar bears

We also examined two forecasts that were developed to support proposed policy changes. The reports assumed that there would be global warming as predicted by the IPCC. We examined the two reports that presented forecasts in line with the stated goal, mentioned on the first page of the report "to support US Fish and Wildlife Service Polar Bear Listing decision"—which we coded as a violation of objectivity. Our procedures were similar to those in our audit of the IPCC forecasts except that we also obtained coding by a climate scientist who has published papers on climate change in the Arctic. On average, these two reports violated 85% of the 90 relevant principles. For example, long-term forecasts were made using only five years of selected data (Armstrong, Green & Soon 2008).

Exhibit 2: Audit of forecasting procedures used in two papers on polar bear populations

Principles were:	Amstrup (2007)	Hunter (2007)
Violated	41	61
Apparently violated	32	19
Properly applied	17	10
Insufficient information	26	15
Totals	**116**	**105**

One key violation was that they did not provide full disclosure of the data in their paper, and they refused our requests for the data. They also refused to answer our questions about key aspects of their procedures, which were not fully described in their papers. They refused to provide peer review of our paper prior to publication. At our request, the editor of the journal invited them to provide commentary. They missed the deadline and our paper was published with commentary by other authors and with our replies to the commentaries. We were surprised when their commentary appeared in the journal some months later without us having being offered an opportunity to respond. In their commentary, the polar bear scientists claimed "every major point in Armstrong et al. (2008) was wrong or misleading." You can read their commentary in Amstrup, et al. (2009) and form your own opinion.

Tests of predictive validity by global warming alarmists

For important problems, it is important to test the predictive validity of the forecasting methods used. Validation tests are normally done by simulating the conditions involved in making actual forecasts (called ex ante forecasts) by, for example, withholding some data and forecasting what that data will be. Thus, if one wanted to test the accuracy of a method for forecasting 50 years from now, one would make a series of 50-year-ahead forecasts using the method of interest and one or more competitive alternative methods, in order to compare the accuracy of the forecasts from the different methods.

We were unable to find any ex ante comparisons of forecasts by the alarmists.

In the spirit of doing a systematic evaluation of forecasts, in 2007 I invited former Vice President Gore to join with me in a test as to the whether forecasts by man-made global warming alarmists would be more accurate than forecasts from a no-change model. Each of us would contribute $10,000 to go to the winner's favorite charity. The period of the bet was to be 10 years so that I would be around to see the outcome. Note that this is a short time period, such that the probability of my winning is only about 70%, based on our simulations. Had we used 100 years for the term of the bet, I would have been almost certain to win. Mr. Gore eventually refused to take the bet (the correspondence is provided on theclimatebet.com). So we proceeded to track the bet on the basis of "What if Mr. Gore had taken the bet" by using the IPCC 0.03°C per-year projection as his forecast and the global average temperature in 2007 as mine. The status of this bet is being reported on theclimatebet.com.

Claims of predictive validity by alarmists

The claim by alarmists that nearly all scientists agree with the dangerous man-made global warming forecasts is not a scientific way to validate forecasts. In addition, the alarmists are either misrepresenting the facts or they are unaware of the literature. International surveys of climate scientists from 27 countries, obtained by Bray and von Storch in 1996 and 2003, summarized by Bast and Taylor (2007), found that many scientists were skeptical about the predictive validity of climate

models. Of more than 1,060 respondents, 35% agreed with the statement "Climate models can accurately predict future climates," while 47% percent disagreed. More recently, nearly 32,000 scientists have disputed the claim of "scientific consensus" by signing the "Oregon Petition." [3]

Perhaps in recognition that alarmist claims of predictive validity cannot sustain scrutiny, expressions of doubt about the alarm are often parried with an appeal to the so-called precautionary principle. The precautionary principle is an anti-scientific principle designed to silence people who have reached different conclusions. Alarmists, such as James Hansen of NASA, have even suggested publicly that people who reach different conclusions about global warming have committed crimes against the state (reported in Revkin 2008). Such attempts to suppress contrary evidence were ridiculed by George Orwell in his book *1984:* The Ministry of Truth building was inscribed with the motto "Ignorance is truth." For a closer examination of the precautionary principle from a forecasting perspective, see Green and Armstrong (2009).

Experts' opinions about what will happen have repeatedly been shown by research to be of no value in situations that are complex and uncertain. In 1980, I surveyed the evidence on the accuracy of experts' judgmental forecasts and found that experts were no better at forecasting about complex and uncertain situations than were novices (Armstrong 1980). Bemused at the resistance to this evidence, I proposed my Seer-sucker Theory: "No matter how much evidence exists that seers do not exist, seers will find suckers." More recently, Tetlock (2005) presented the findings of 20 years of research over the course of which he obtained over 82,000 forecasts from 284 experts on "commenting or offering advice on political and economic trends," which represented complex and uncertain problems. Consistent with earlier research, he found that the experts' forecasts were no more accurate than novices' and naive model forecasts.

Our validation test of IPCC forecasting model

We conducted a validation test of the IPCC forecast of 0.03°C per-year increase in global mean temperatures. We did this starting roughly with the date used for the start of the Industrial Revolution, 1850. As it happens, that was also the start of the collecting of temperature from weather stations around the world. We used the U.K. Met Office Hadley Centre's annual average thermometer data from 1850 through 2007. Note that the IPCC forecast had the benefit of using these data in preparing the forecasts. Thus, it had an advantage over the no-change model.

To simulate the forecasting situation, we needed unconditional (ex ante) forecasts. We obtained these for the years from 1851 through 2007. The period was one of exponentially increasing atmospheric CO_2 concentrations, which are the conditions that the IPCC modelers assumed for their "business as usual" model forecasts of 0.03°C per-year increase in global mean temperatures. We used the process of "successive updating" to obtain a total of 10,750 forecasts for horizons from 1 to 100 years ahead starting with forecasts for 1851 through 1950, then for 1852 through 1951, and so on. Relative forecasting errors are provided in Exhibit 3.

Exhibit 3

Ratio of errors in IPCC (2007) forecasts to errors in "no change" model forecast from 1851 through 2007

Forecast horizon	Error Ratio	# of Forecasts
Rolling (1-100 years)	7.7	10,750
1-10 years	1.5	1,205
91-100 years	12.6	305

Note that the errors do not differ substantially in the short term (e.g., forecasting horizons from 1 through 10 years). As a consequence, the chances that I will win my l0-year bet with former Vice President Gore are not overwhelming. The IPCC model forecast errors for forecasts 91 to 100 years in the future, however, were 12.6 times larger than those for our evidence-based "no change" model forecasts. [4] In an extension, we also examined a no-change model that used ten-year periods (instead of annual data) to forecast subsequent ten-year periods, updating this to make a forecast each year. The results were quite similar to those in Exhibit 3.

Exhibit 3 shows relative errors, but it is also important for policy makers to look at absolute errors. Absolute errors for the no-change model are presented in Exhibit

---

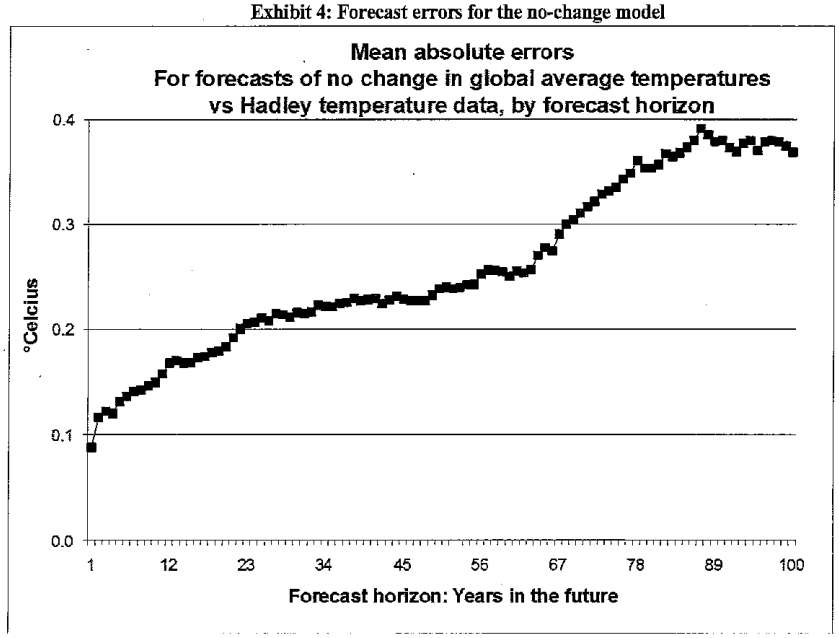
[3] See petitionproject.org for details.

[4] Note that, had adjustments been made to reflect the heat island effect, the shifting base of weather stations, unsubstantiated revisions in historical temperature records, the error ratio of the IPCC forecasts (relative to our no-change model) would have been much higher.

4. The accuracy of forecasts from the no-change model is such that even perfectly accurate forecasts of global mean temperatures would not provide much help to policymakers. For example, the mean absolute errors for 50-year-ahead no-change forecasts averaged only 0.24°C.

The alarmists claim that validation tests cannot be done because things have changed. Such claims are commonly, but illogically, made by people who believe that their situation is new or so different from other situations, and cannot be related to the past.

Exhibit 4: Forecast errors for the no-change model



Conclusions from our analysis of the procedures used to forecast alarming manmade global warming

Global warming alarmists have used improper procedures and, most importantly, have violated the general scientific principles of objectivity and full disclosure. They also fail to correct their errors or to cite relevant literature that reaches unfavorable conclusions. They also have been deleting information from Wikipedia that is unfavorable to the alarmists' viewpoint [5] (e.g., my entry has been frequently revised by them). These departures from the scientific method are apparently intentional. Some alarmists claim that there is no need for them to follow scientific principles. For example, the late Stanford University biology professor Stephen Schneider said, "each of us has to decide what is the right balance between being effective and being honest." He also said, "we have to offer up scary scenarios" (October 1989, Discover Magazine interview). Interestingly, Schneider had been a leader in the 1970s movement to get the government to take action to prevent global cooling. ClimateGate also documented many violations of objectivity and full disclosure committed by some of the climate experts that were in one way or another associated with the IPCC.

The alarmists' lack of interest in scientific forecasting procedures [6] and the evidence from opinion polls (Pew Research Center 2008) have led us to conclude that global warming is a political movement in the U.S. and elsewhere (Klaus 2009). It is a product of advocacy, rather than of the scientific testing of multiple hypotheses.

---

[5] http://network.nationalpost.com/np/blogs/fullcomment/archive/2009/12/18/370719.aspx.

[6] http://blogs.telegraph.co.uk/news/jamesdelingpole/l00017393/climategate-the-final-nail-in-the-coffin-of-anthropogenic-global-warming/ and http://wattsupwiththat.com/2010/lO/15/another-wikipedia-editor-has-been-climate-topic-banned/.

Forecasts of outcomes of the manmade global warming alarmist movement

Using a process known as "structured analogies," we predicted the likely outcome of the global warming movement. Our validation test of structured analogies method was provided in Green and Armstrong (2007b).

Global warming alarmism has the characteristics of a political movement In an ongoing study, we have been searching for situations that are "alarms over predictions of serious environmental harm that could only be averted at great cost." We have searched the literature, contacted various researchers—especially those who believe in the global warming alarm. We have also posted appeals on email lists and on websites such as publicpolicyforecasting.com. We repeat this appeal here.

To date, we have identified 26 analogous alarmist situations in the past Kesten Green and I independently coded the alarms. We coded them for:

1. Forecasting method.
2. Did the proposed action involve substantive government intervention?
3. Accuracy of forecasts was rated on a -1 to +1 scale (-1 = wrong direction, 0 = no, or minor, effect; +I = accurate)
4. Did substantive government intervention take place, or not?
5. Outcome of government policies to date on the value of their net benefit on a -I to +I scale
6. Persistence of government policies, to-date, on a 0 to 2 scale (0 = reversed; I = no or little change; 2 = strengthened)

We will be preparing descriptions of the analogies that will include the following elements and references to sources of information:

1. Forecasts of impending catastrophe
2. Methods used to forecast the catastrophe
3. Actions called for (actions by government or by others)
4. Salient endorsements of the forecast by scientists and politicians
5. Challenges to the forecast
6. Outcomes of each conflict over the alarming forecast and calls for action, including forecast accuracy

We have posted full disclosure of our procedures at publicpolicyforecasting.com, and have sent announcements to websites and individual requests to people to comment. Thumbnail descriptions are available for nine of the 26 situations (indicated by italics in Exhibit 5) at publicpolicyforecasting.com.

Exhibit 5: Analogies to the alarm over dangerous manmade global warming
(Thumbnail descriptions available for italicized analogies)

	Analogy	Year
1	Population growth and famine (Malthus)	1798
2	Timber famine economic threat	1865
3	Uncontrolled reproduction and degeneration (Eugenics)	1883
4	*Lead in petrol and brain and organ damage*	1928
5	Soil erosion agricultural production threat	1934
6	*Asbestos and lung disease*	1939
7	Fluoride in drinking water health effects	1945
8	*DDT and cancer*	1962
9	Population growth and famine (Ehrlich)	1968
10	Global cooling; through to 1975	1970
11	Supersonic airliners, the ozone hole, and skin cancer, etc.	1970
12	Environmental tobacco smoke health effects	1971
13	*Population growth and famine (Meadows)*	1972
14	*Industrial production and acid rain*	1974
15	*Organophosphate pesticide poisoning*	1976
16	*Electrical wiring and cancer, etc.*	1979
17	CFCs, the ozone hole, and skin cancer, etc.	1985
18	Listeria in cheese	1985
19	Radon in homes and lung cancer	1985
20	Salmonella in eggs	1988
21	*Environmental toxins and breast cancer*	1990
22	Mad cow disease (BSE)	1996
23	Dioxin in Belgian poultry	1999
24	*Mercury in fish effect on nervous system development*	2004
25	Mercury in childhood inoculations and autism	2005
26	Cell phone towers and cancer, etc.	2008

Exhibit 6 provides an example:

Exhibit 6: Example of a thumbnail description of an analogy to the global warming alarm

Title: DDT and cancer

Date: Started in 1962

Forecast of impending disaster: Based on a book, Rachel Carson's *Silent Spring*, DDT was claimed to be a dangerous cancer-causing chemical. Publication of the book was followed by what some called a national hysteria. The alarm over forecasts of DDT's harmful effects combined concerns about the health and wellbeing of people with concerns about other species. Papers by scientists purported to demonstrate harmful effects on people from DDT exposure.

Forecasting method: A scenario based on the author's speculations from various pieces of information about the effects of DDT. There was no direct evidence that DDT harmed people.

Actions called for: Governments were asked to ban exports of DDT and World Bank loans would be banned to countries that used DDT.

Endorsements of and challenges to the forecast: Leading scientists from institutions (such as Stanford University), politicians (such as Senator Al Gore,) and a report by a commission appointed by President Carter. The reports of the dangers were widely covered by the mass media.

Outcomes of the conflict: The U.S. Environmental Protection Agency (EPA) banned the use of DDT following an 80-day hearing in 1972. Europe and Africa, under pressure from international agencies, did too. No actual harmful effects on humans have been found to result from DDT. Millions of people have died from mosquito-born diseases such as malaria. The EPA decision was based on two studies of animals: the first could not be replicated and the second used a flawed experimental design.

Sources: Edwards (2004); Waite (1994)

Here are our preliminary findings. None of these alarming forecasts were correct. Twenty-five of them called for government intervention. In the 23 cases where interventions occurred, none were effective. The policy changes caused harm in 20 of the cases.

The findings will change as the project progresses and as we identify new analogies, provide more and better description of the analogies, and obtain codings from others, especially from experts in the various areas.

We were not surprised by the outcomes, as none of the alarms were based on scientific forecasts. They typically began with stories and progressed from there with appeals to scientific support. Another reason that we were not surprised is that others had anticipated our findings. For example, after compiling a list of analogous situations in 1990, Julian Simon said, "As soon as one predicted disaster doesn't occur, the doomsayers skip to another, why don't [they] see that, in the aggregate, things are getting better? Why do they always think we're at a turning point—or at the end of the road?" And considerably earlier, in 1830, Thomas Babington Macaulay concluded, "On what principle is it that when we see nothing but improvement behind us, we are to expect nothing but deterioration before us?"

As with our other publications related to climate change, we have received no funding, so we expect this study to drag on. The good news is that it will allow an opportunity for researchers to provide peer review and to suggest further improvements in our study—or, better, to conduct independent studies of analogies.

Recommendations

To help ensure objectivity, government funding should not be provided for climate-change forecasting. Kealey (1996) summarized evidence on the dangers of bias in government-funded research. The government should instead rely on independent forecasters.

As we have noted, simple methods are appropriate for forecasting for climate change. Large budgets are therefore not necessary. Private individuals have been willing to invest much time and effort in examining the global warming alarm without external rewards. In fact, a number of them have engaged in research on the global warming alarm at great personal cost. The cost has been at least in part because governments have almost universally sponsored scientists who have supported the manmade global warming alarm and these scientists have, as a consequence, attained considerable power over learned societies, journals, funding, and universities. With the power has come influence over news media that, by nature, are at-

tracted to stories such as environmentalist alarms that grab the attention of audiences.

The burden rightly falls on government to obtain scientific proof that a policy will lead to superior outcomes before increasing the burden of laws and regulations. It is not defensible to use anti-scientific procedures such as asking scientists or scientific organizations to "vote" on policy recommendations, even when the experts are provided with excellent information. This is especially true, given the evidence that expert opinions are useless for complex problems such as climate change.

Instead, government should look for strict standards of objectivity in the evidence. Thus, we suggest that government should use information for each of the legs on the three-legged stool that underlies the global warming alarm: warming, effects of warming, and outcomes of alternative proposed policy changes, including "don't just do something, stand there!" The following should be included for each leg:

1. evidence, rather than experts' opinions,
2. research from scientists with diverse views,
3. research that involves testing of multiple reasonable hypotheses,
4. use of scientific (evidence-based) forecasting methods
5. full disclosure of data and research methods,
6. criticism, replications, and extensions, and
7. testimony from scientists who have nothing to gain from the acceptance of their evidence.

References

Amstrup, Steven C., et al. (2009), "Rebuttal of "Polar bear population forecasts: A public-policy forecasting audit" Interfaces, 39 (4), 353–369. Amstrup, S. C., B. G. Marcot, D. C. Douglas (2007), Forecasting the rangewide status of polar bears at selected times in the 21st Century. Administrative Report, USGS Alaska Science Center, Anchorage, AK. Armstrong, J. S. (1978; 1985), Long-Range Forecasting: From Crystal Ball to Computer. New York: Wiley-Interscience.

Armstrong, J. S. (1980), "The Seer-sucker Theory: The value of experts in forecasting," Technology Review, 83 (June/July), 18–24. Armstrong, J. S (2001), Principles of forecasting. Norwell, MA: Kluwer Academic Publishers.

Armstrong, J. S., Green, K. C., & Soon, W. (2008), "Polar bear population forecasts: A public-policy forecasting audit," Interfaces, 38, No.5, 382—405. [Includes commentary and response]

Bray, D. & von Storch, H. (2007). Climate scientists' perceptions of climate change science. GKSS--Forschungszentrum Geesthacht GmbH.

Brohan, P., Kennedy, J. J., Hartis, I., Tett, S.F.R & Jones, P.D. (2006). Uncertainty estimates in regional and global observed temperature changes: a new dataset from 1850. J. Geophys. Res, 111, D12106, doi: 10.1 029/2005JD006548.

Christy, J. R., B. Hennan, R. Pielke, Sr., P. Klotzbach, R. T. McNider, J. J. Hnilo, R. W. Spencer, T. Chase and D. Douglass, 2010: What do observational datasets say about modeled tropospheric temperature trends since 1979? Remote Sensing, 2(9), 2148–2169.

Edwards, J. Gordon (2004), "DDT: A case study in scientific fraud," Journal of American Physicians and Surgeons, 9 (3), 83–88.

Green, K. C. & Armstrong, J. S. (2007a), "Global warming: Forecasts by scientists versus scientific forecasts," Energy and Environment, 18, No. 7+8,995–1019.

Green, K. C. & Armstrong, J. S. (2007b), "Structured analogies for forecasting," International Journal of Forecasting, 23, 365–376.

Green, K. C. & Armstrong, J. S. (2008), "Uncertainty, the precautionary principle and climate change," Available on-line at publicpolicyforecasting.com and other web sites.

Green, K. C. & Armstrong J. S. (2011), "Effects of the global warming alarm: A forecasting project using the structured analogies method," Working Paper. Latest version available at http://kestencgreen.com/green&armstrong-agw-analogies.pdf.

Green, K. C., Armstrong, J. S. & Soon W. (2009), "Validity of Climate Change Forecasting for Public Policy Decision Making," International Journal of Forecasting, 25,826–832.

Gregory, W. L. & Duran, A. (2001), "Scenarios and acceptance of furecasts." In J.S. Armstrong, Principles of Forecasting. Kluwer Academic Publishers (Springer).

Hunter, C. M., H. Caswell, M. C. Runge, S. C. Amstrup, E. V. Regehr, I. Stirling (2007), "Polar bears in the Southern Beaufort Sea II: Demography and population growth in relation to sea ice conditions." Administrative Report, USGS Alaska Science Center, Anchorage, AK.

Idso, C. & Singer, S. F. (2009). Climate Change Reconsidered: The Report of the Nongovernmental International Panel on Climate Change. Chicago: The Heartland Institute.

Kealey, Terence (1996), The Economic Laws of Scientific Research. Hampshire, UK: Macmillan Press.

Randall, D. A., et al eds. (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY, USA: Cambridge University Press.

Revkin, A. (2008). "Are big oil and big coal climate criminals?" The New York Times: Dot Earth, June 23. Available from http://dotearth.blogs.nytimes.com/2008/06/23/are-big-oil-and-big-coal-climate-criminals/

Robinson, A. B, Robinson, N. E., and Soon, W. (2007). Environmental effects of increased carbon dioxide. Journal of American Physicians and Surgeons, 12, 79–90.

Schneider, S. H. (1989). As quoted in an interview in Discover Magazine, October. Available at http://stephenscbneider.stanford.edu/Publications/PDF__PaperslDetroitNews.pdf

Tetlock, P. E. (2005), Expert Political Judgment. Princeton, NJ: Princeton University Press. Trenberth, Kevin E. (2007), "Global warming and forecasts of climate change", Nature.com's Climate Feedback: the climate change blog. Available at http://blogs.nature.com/climatefeedback/2007/07/global__warming__and__forecasts__o.html.

Waite, Donald E. (1994). "Myths and facts about DDT," in D. E. Waite, Environmental Health Hazards, Environmental Health Consultant; Columbus, Ohio.

Author and collaborators

J. Scott Armstrong (Ph.D., MIT, 1968), a Professor at the Wharton School of Management, University of Pennsylvania, is the author of Long-range Forecasting, the creator of forecastingptinciples.com, and editor of Principles of Forecasting (Kluwer 2001), an evidence-based summary of knowledge on forecasting methods. He is a founder of the Journal of Forecasting, the International Journal of Forecasting, and the International Symposium on Forecasting. He has spent 50 years doing research and consulting on forecasting (details at http://jscottarmstrong.com). Dr. Armstrong has also published over 30 papers on peer review and the scientific method. He can be reached at Armstrong@wharton.upenn.edu.

Contributions to this report were made by:

Kesten C. Green (PhD.) of the International Graduate School of Business at the University of South Australia is a Director of the International Institute of forecasters and is co-director with Scott Armstrong of the Forecasting Principles public service Internet site (ForPrin.com). He has been responsible for the development of two forecasting methods that provide forecasts that are substantially more accurate than commonly used methods. (Kesten.Green@unisa.edu.au)

Willie Soon (PhD.) is an astrophysicist and a geoscientist at the Solar, Stellar, and Planetary Sciences division of the Harvard-Smithsonian Center for Astrophysics. He is also the receiving editor in the area of solar and stellar physics fur the journal New Astronomy. He has 20 years of active researching and publishing in the area of climate change and all views expressed are strictly his own. (vanlien@earthlink.net)

Conclusions from studies on forecasting climate change

Testimony for Hearing on Climate Change; "Examining the processes used to Create Science and Policy"

Subcommittee on Energy and Environment: Committee on Science, Space and Technology

Professor J. Scott Armstrong
The Wharton School, U of Pennsylvania
March 31, 2011

J. Scott Armstrong's credentials for forecasting

Received his PhD from MIT (thesis dealt with forecasting methods)

A founder of

- International Symposium on Forecasting (1981)
- *Journal of Forecasting* (1982)
- *International Journal of Forecasting* (1985)
- forecastingprinciples.com (1997)

Author of

- *Long-range Forecasting* (1978)
- *Principles of Forecasting* (2001)

50 years of experience as a researcher and consultant on forecasting methods.

The climate always changes – The policy issues revolve around forecasting long-term trends

Policy makers need evidence from scientific forecasting for policy actions related to global warming:

1. substantial long-term rise in global mean temperature absent regulations,

2. serious net harm due to global warming, and

3. cost effective regulations that would reduce net benefits versus alternative policies, including doing nothing.

This is a 3-legged stool. A lack of scientific forecasts to support on any one of these areas would negate policy making.

To date, there are no scientific forecasts on any of these areas.

Warming alarm based on faulty forecasting

The United Nations' Intergovernmental Panel on Climate Change (IPCC) relies on experts' judgments to develop computer climate models. These, along with judgmental revisions, produce "scenarios."

> Scenarios are "stories about the future". They are not a proper way to forecast. (Gregory and Duran 2001)

Our audit showed that the authors of the 2007 IPCC report violated 72 of the 89 relevant forecasting principles (Green & Armstrong 2007).

Many of the violations were critical (Examples: Use unbiased procedures to collect data; be conservative if there is uncertainty.)

Policy forecasts (e.g., the polar bear alarm) also based on faulty forecasting

Two government reports forecasted a *sharp decline* in the polar bear population.

Our audit showed that the reports followed only 13% of relevant forecasting principles) (Armstrong, Green & Soon 2008).

Example 1: Failed to provide full disclosure of the data.

Example 2: Long-term forecasts were made using only five years of selected data.

Using a simple evidence-based method, we forecasted a modest short-term *increase* in the polar bear population then a leveling.

Global warming forecasts lack predictive validity

Ratio of errors in IPCC (2007) forecasts vs. "no change model" from 1850 through 2007

Forecast horizon	Error Ratio	# Forecasts
Rolling (1-100 years)	7.7	10,750
1-10 years	1.5	1,205
91-100 years	**12.6**	**305**

Green, Armstrong & Soon 2009

Warming alarm has the characteristics of an anti-scientific political movement; we have been unable to identify any such forecasts that have been correct.

To date, we have identified 71 proposed analogies.

Of these, 26 are relevant to the current warming alarm.

Examples:

- DDT and cancer (1962)
- Uncontrolled reproduction and degeneration (Eugenics 1883)
- Population growth and famine (Club of Rome 1972)
- Natural resource shortages and economic collapse (Ehrlich 1968)

Source: Green & Armstrong (2011) in process, provides full disclosure and invites peer review.

Government intervention was called for in 25 of the 26 analogous situations

The government actions typically called for:

- Increased government taxes
- Increased government spending
- Restricting individual liberties

How accurate were the alarming forecasts?

Of the forecasts made in the 26 analogous situations:

- categorically wrong 19
- wrong in degree 7
- accurate 0

Did government intervention help?

Among the 23 analogous situations in which government policies were implemented:

	n
Harm was caused	20
Policies were ineffective/uncertain	3
Policies were effective	0

Summary of findings from studies on alarming forecasts of dangerous manmade global warming

1. Global mean temperature forecasting procedures are improper.
2. Policy forecasting procedures are improper. They also overlook relevant areas. There are no scientific forecasts of net beneficial effects of policies versus taking no action.
3. IPCC global warming forecasts failed in a validation study.

To date, none of the 26 analogous alarming forecasts have been correct and in no case have policy actions been effective.

Alarms based on bad forecasting are a familiar social phenomenon

"As soon as one predicted disaster doesn't occur, the doomsayers skip to another... why don't [they] see that, in the aggregate, things are getting better? Why do they always think we're at a turning point—or at the end of the road?" Julian Simon, 1990

"On what principle is it that when we see nothing but improvement behind us, we are to expect nothing but deterioration before us?" Thomas Babington Maccaulay. 1830

Recommendations

1. Efforts to forecast climate change should be conducted by experts in forecasting methods.

   Such efforts would be relatively inexpensive.

2. To ensure objectivity, government funding should not be provided for climate-change forecasting.

   If government funding were provided, strict standards should be required to ensure objectivity.

3. The burden would be on the government to provide convincing scientific proof before making policy changes.

   Experimental evidence reveals that expert opinions are useless for such problems. Thus, "voting" by scientists has no credibility.

References

- Armstrong, J. S. (1978; 1985), *Long-Range Forecasting: From Crystal Ball to Computer*. New York: Wiley-Interscience.
- Armstrong, J. S. (1980), "The Seer-Sucker Theory: The Value of Experts in Forecasting," *Technology Review*, 83 (June/July), 18-24.
- Armstrong, J. S., Green, K.C., & Soon, W. (2008), "Polar Bear Population Forecasts: A Public-Policy Forecasting Audit," *Interfaces*, 38, No. 5, 382–405. [Includes commentary and response]
- Green, K. C. & Armstrong, J. S. (2007, Global warming: Forecasts by scientists versus scientific forecasts," *Energy and Environment*, 18, No. 7+8, 995-1019.
- Green, K. C. & Armstrong J. S. (2011), "Effects of the global warming alarm: A forecasting project using the structured analogies method," Working Paper.
- Green, K. C., Armstrong, J. S. & Soon W. (2009), "Validity of Climate Change Forecasting for Public Policy Decision Making," *International Journal of Forecasting*, 25, 826-832.
- Gregory & Duran (2001)
- Tetlock, P. E. (2005), *Expert Political Judgment*. Princeton, NJ: Princeton University Press.

Chairman HALL. Thank you, and I apologize for this scientific organization not to have the facility that you needed. Maybe we will do better next time.

At this time I recognize Dr. Richard Muller, Professor at the University of California, Berkeley, and a Senior Scientist at the Lawrence Berkeley Laboratory to present your testimony. You have five minutes, sir. Thank you.

STATEMENT OF DR. RICHARD MULLER, PROFESSOR OF PHYSICS, UNIVERSITY OF CALIFORNIA, BERKELEY, AND FACULTY SENIOR SCIENTIST, LAWRENCE BERKELEY LABORATORY

Dr. MULLER. Thank you Chairman Hall and Ranking Member Johnson. In addition to those organizations, I am the founder of the Berkeley Earth study, and my testimony today does not represent the views of those organizations but are my personal views.

I begin talking about my view of global warming. Prior groups at NOAA, NASA, and in the UK estimate about a 1.2 degree Celsius land temperature rise from the early 1900s to the present. That 1.2 degree rise is what we call global warming. Their work is excellent, and the Berkeley Earth project strives to build on it.

Human caused global warming is somewhat smaller. According to the most recent IPCC report, the human component became apparent only after 1957, and it amounts to most of the 0.7 degree rise since then. I am not denying that there may have been human rise before that. Let us assume that by most human-caused global warming is about 0.6 degrees. I am not endorsing this number, I am simply stating it as a working number. The magnitude of this is a key scientific and public policy concern. Just a 0.2 degree uncertainty puts the human component between 0.4 and 0.8 degrees. It is a factor of two uncertainties. This number needs to be improved, and Berkeley Earth is working to improve the accuracy of it by using a more complete set of data and looking at biases in a new way.

Let me talk about one of these potential biases, bias in data selection. The prior groups selected for their analysis from 12 to 22 percent of the roughly 39,000 stations available. They believe their selection was unbiased. Outside groups have questioned that and claimed that the choice preferred records with large temperature increases. Such biases could be inadvertent, for example, a result of choosing long, continuous records. This needs to be looked at carefully. To avoid station selection bias, Berkeley Earth has developed techniques to work with all the available stations.

In an initial test of our software and our analysis program, Berkeley Earth chose stations just randomly from the complete sets. Such a selection of stations avoids station selection bias.

In our preliminary analysis of these stations, we found a warming trend that is shown in the figure. Berkeley Earth is the black curve, the other three groups are in color. Our result is very similar to that reported by the prior groups: a rise of about 0.7 degrees Celsius since 1957.

The Berkeley Earth agreement with the prior analysis surprised us, since our preliminary results don't yet address many of the known biases. When they do, it is possible that corrections could

bring our current agreement into disagreement. Why such close agreement between our uncorrected data and their adjusted data? One possibility is that the systematic corrections applied by the other groups turn out to be small. We don't yet know. We will find out.

Now let me address another issue, poor quality measurements. Many temperature stations in the United States are located near buildings, in parking lots, or close to heat sources. Anthony Watts and his team have shown that most of the current stations in the U.S. Historical Climatology Network would be ranked poor by NOAA's own standards, with error uncertainties up to 5 degrees Celsius.

Did such poor station quality exaggerate the estimates of global warming? Berkeley Earth has studied this issue, and we have a preliminary answer and the answer is no. Our analysis shows that over the past 50 years the poor stations in the U.S. network do not show greater warming than do the good stations. Thus, although poor station quality might affect absolute temperature, or variance in temperature, it does not appear to affect trends, and for global warming estimates, it is the trend that is important.

Without the efforts of Anthony Watts and his team, we would have only a series of anecdotal images of poor temperature stations, and we would not be able to evaluate the integrity of the data. This is a case in which scientists receiving no government funding did work crucial to understanding climate change. Similarly for the work done by Steve McIntyre. Their "amateur" science is not amateur in quality. It is true science, conducted with integrity and high standards.

I was asked how legislation could advance our knowledge of climate change. After some consideration I felt the creation of a Climate Advanced Research Project Agency or Climate-ARPA could help. Government policy needs to encourage work such as that of Watts and McIntyre. Climate-ARPA could be an organization that provides quick funding to worthwhile projects without regard to whether they support or challenge current understanding.

In summary, despite potential biases in the data, methods of analysis can be used to reduce bias effects well-enough to enable us to measure long-term Earth temperature changes. Data integrity is adequate. Based on our initial work at Berkeley Earth, I believe that some of the most worrisome biases are less of a problem than I had previously thought. Thank you.

[The prepared statement of Mr. Muller follows:]

PREPARED STATEMENT OF DR. RICHARD MULLER, PROFESSOR OF PHYSICS, UNIVERSITY OF CALIFORNIA, BERKELEY, AND FACULTY SENIOR SCIENTIST, LAWRENCE BERKELEY LABORATORY

Executive Summary

The Berkeley Earth Surface Temperature project was created to make the best possible estimate of global temperature change using as complete a record ofmeasurements as possible and by applying novel methods for the estimation and elimination ofsystematic biases. It was organized under the auspices of Novim, a non-profit public interest group. Our approach builds on the prior work ofthe groups at NOAA, NASA, and in the UK (Hadley Center—Climate Research Unit, or HadCRU).

Berkeley Earth has assembled 1.6 billion temperature measurements, and will soon make these publicly available in a relatively easy to use format. The difficult

issues for understanding global warming are the potential biases. These can arise from many technical issues, including data selection, substandard temperature station quality, urban vs rural effects, station moves, and changes in the methods and times of measurement.

We have done an initial study of the station selection issue. Rather than pick stations with long records (as done by the prior groups) we picked stations randomly from the complete set. This approach eliminates station selection bias. Our results are shown in the Figure; we see a global warming trend that is very similar to that previously reported by the other groups.

We have also studied station quality. Many US stations have low quality rankings according to a study led by Anthony Watts. However, we find that the warming seen in the "poor" stations is virtually indistinguishable from that seen in the "good" stations.

We are developing statistical methods to address the other potential biases.

I suggest that Congress consider the creation of a Climate-ARPA to facilitate the study of climate issues.

Based on the preliminary work we have done, I believe that the systematic biases that are the cause for most concern can be adequately handled by data analysis techniques. The world temperature data has sufficient integrity to be used to determine global temperature trends.

Testimony of Richard A. Muller

Thank you Chairman Hall and Ranking Member Johuson for this opportunity to testify before the Committee.

I am a Professor of Physics at DC Berkeley and Faculty Senior Scientist at the Lawrence Berkeley Laboratory. I founded the Berkeley Earth Surface Temperature project under the auspices of Novim, a non-profit public interest group. My testimony represents my personal views and not those of the above organizations.

[[Italic part for written statement only, not to be read aloud]]
I've published papers on climate change in Science, Nature, and other refereed journals; I am the author of a technical book on the subject. My papers on climate change have appeared in Nature, Science, Paleoceanography, and the Journal of Geophysical Research. I wrote a technical book on the Earth's past temperature changes: "Ice Ages and Astronomical Causes", Springer 2000. I am the author of "Physics for Future Presidents", a popular book which describes many misuses of data in climate. I was a cited referee on the report of the NRC on the hockey stick controversy. For two years I wrote an online column for MIT's Technology Review. My major awards for scientific achievement include the Alan T. Waterman Award of the National Science Foundation, the Texas Instruments Founders Prize, a MacArthur Prize Fellowship, and election to the American Academy of Arts and Sciences and to the California Academy of Sciences.

The Berkeley Earth Surface Temperature study has received a total of $623,087 in financial support from:
The Lee and Juliet Folger Fund ($20,000)
Lawrence Berkeley National Laboratory ($188,587)
William K. Bowes, Jr. Foundation ($100,000)
Fund for Innovative Climate and Energy Research (created by Bill Gates) ($100,000)
Charles G. Koch Charitable Foundation ($150,000)
The Ann & Gordon Getty Foundation ($50,000)
We have also received funding from a number of private individuals, totaling $14,500.

For more information on Berkeley Earth, see www.BerkeleyEarth.org. For more information on Novim, see www.Novim.org.

I begin by talking about

Global Warming

Prior groups at NOAA, NASA, and in the UK (HadCRU) estimate about a 1.2 degree C land temperature rise from the early 1900s to the present. This 1.2 degree rise is what we call **global warming**. Their work is excellent, and the Berkeley Earth project strives to build on it.

Human caused global warming is somewhat smaller. According to the most recent IPCC report (2007), the human component became apparent only after 1957, and it amounts to "most" of the 0.7 degree rise since then. Let's assume the **human-caused warming is 0.6 degrees**.

The magnitude of this temperature rise is a key scientific and public policy concern. A 0.2 degree uncertainty puts the human component between 0.4 and 0.8 degrees—a factor of two uncertainty. Policy depends on this number. It needs to be improved.

Berkeley Earth is working to improve on the accuracy of this key number by using a more complete set of data, and by looking at biases in a new way.

The project has already merged 1.6 billion land surface temperature measurements from 16 sources, most of them publicly available, and is putting them in a simple format to allow easy use by scientists around the world. By using all the data and new statistical approaches that can handle short records, and by using novel approaches to estimation and avoidance of systematic biases, we expect to improve on the accuracy of the estimate of the Earth's temperature change.

I'll now talk about potential.

Bias in Data Selection

Prior groups (NOAA, NASA, HadCRU) selected for their analysis 12% to 22% of the roughly 39,000 available stations. (The number of stations they used varied from 4,500 to a maximum of 8,500.)

They believe their station selection was unbiased. Outside groups have questioned that, and claimed that the selection picked records with large temperature increases. Such bias could be inadvertent, for example, a result of choosing long continuous records. (A long record might mean a station that was once on the outskirts and is now within a city.)

To avoid such station selection bias, Berkeley Earth has developed techniques to work with all the available stations. This requires a technique that can include short and discontinuous records.

In an initial test, Berkeley Earth chose stations randomly from the complete set of 39,028 stations. Such a selection is free of station selection bias.

In our preliminary analysis of these stations, we found a warming trend that is shown in the figure. It is very similar to that reported by the prior groups: a rise of about 0.7 degrees C since 1957. (Please keep in mind that the Berkeley Earth curve, in black, does not include adjustments designed to eliminate systematic bias.)

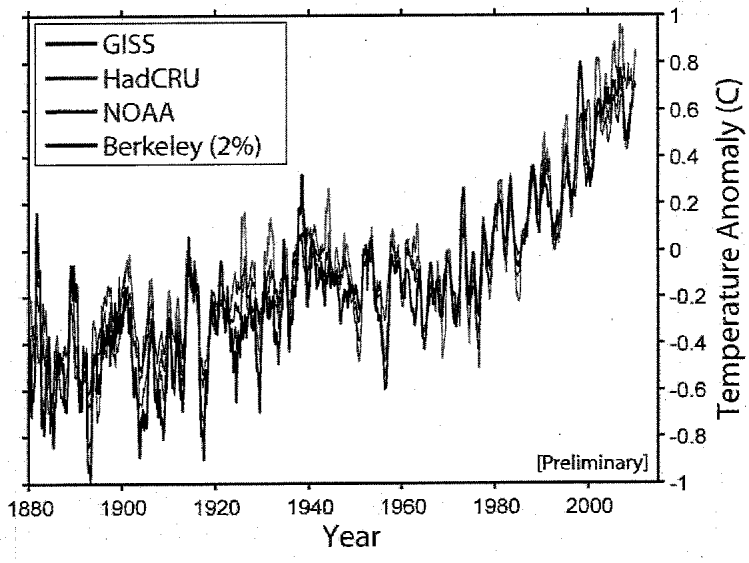


Figure: Land average temperatures from the three major programs, compared with an initial test of the Berkeley Earth dataset and analysis process. Approximately 2 percent of the available sites were chosen randomly from the complete set of 39,028 sites. The Berkeley data are marked as preliminary because they do not include treatments for the reduction of systematic bias.

The Berkeley Earth agreement with the prior analysis surprised us, since our preliminary results don't yet address many of the known biases. When they do, it is possible that the corrections could bring our current agreement into disagreement.

Why such close agreement between our uncorrected data and their adjusted data? One possibility is that the systematic corrections applied by the other groups are small. We don't yet know.

The main value of our preliminary result is that it demonstrates the Berkeley Earth ability to use all records, including those that are short or fragmented. When we apply our approach to the complete data collection, we will largely eliminate the station selection bias, and significantly reduce statistical uncertainties.

Let me now address the problem of

Poor Temperature Station Quality

Many temperature stations in the U.S. are located near buildings, in parking lots, or close to heat sources. Anthony Watts and his team has shown that most of the current stations in the U.S. Historical Climatology Network would be ranked "poor" by NOAA's own standards, with error uncertainties up to 5 degrees C.

Did such poor station quality exaggerate the estimates of global warming? We've studied this issue, and our preliminary answer is **no**.

The Berkeley Earth analysis shows that over the past 50 years the poor stations in the U.S. network do not show greater warming than do the good stations.

Thus, although poor station quality might affect absolute temperature, it does not appear to affect trends, and for global warming estimates, the trend is what is important.

Our key caveat is that our results are preliminary and have not yet been published in a peer reviewed journal. We have begun that process of submitting a paper to the Bulletin ofthe American Meteorological Society, and we are preparing several additional papers for publication elsewhere.

NOAA has already published a similar conclusion—that station quality bias did not affect estimates of global warming—based on a smaller set of stations, and Anthony Watts and his team have a paper submitted, which is in late stage peer review, using over 1000 stations, but it has not yet been accepted for publication and I am not at liberty to discuss their conclusions and how they might differ. We have looked only at average temperature changes, and additional data needs to be studied, to look at (for example) changes in maximum and minimum temperatures.

In fact, in our preliminary analysis the good stations report more warming in the U.S. than the poor stations by 0.009 ±0.009 degrees per decade, opposite to what might be expected, but also consistent with zero. We are currently checking these results and performing the calculation in several different ways. But we are consistently finding that there is no enhancement of global warming trends due to the inclusion of the poorly ranked US stations.

Berkeley Earth hopes to complete its analysis including systematic bias avoidance in the next few weeks. We are now studying new approaches to reducing biases from:

1. *Urban heat island effects. Some stations in cities show more rapid warming than do stations in rural areas.*
2. *Time of observation bias. When the time of recording temperature is changed, stations will typically show different mean temperatures than they did previously. This is sometimes corrected in the processes used by existing groups. But this cannot be done easily for remote stations or those that do not report times of observations.*
3. *Station moves. If a station is relocated, this can cause a "jump" in its temperatures. This is typically corrected in the adjustment process used by other groups. Is the correction introducing another bias? The corrections are sometimes done by hand, making replication difficult.*
4. *Change of instrumentation. When thermometer type is changed, there is often an offset introduced, which must be corrected*

Potential Legislation

I was asked what legislation could advance our knowledge of climate change. After some consideration, I felt that the creation of a Climate Advanced Research Project Agency, or Climate-ARPA, could help.

Without the efforts of Anthony Watts and his team, we would have only a series of anecdotal images of poor temperature stations, and we would not be able to evaluate the integrity of the data.

This is a case in which scientists receiving no government funding did work crucial to understanding climate change. Similarly for the work done by Steve McIn-

tyre. Their "amateur" science is not amateur in quality; it is true science, conducted with integrity and high standards. Government policy needs to encourage such work. **Climate-ARPA** could be an organization that provides quick funding to worthwhile projects without regard to whether they support or challenge current understanding.

In Summary

Despite potential biases in the data, methods of analysis can be used to reduce bias effects well enough to enable us to measure long-term Earth temperature changes. Data integrity is adequate. Based on our initial work at Berkeley Earth, I believe that some ofthe most worrisome biases are less of a problem than I had previously thought.

Chairman HALL. Thank you, sir. I want to say to Dr. Armstrong that your testimony will be in the record as you submitted it as will all the testimony. The malfunction won't cost you there.

Dr. ARMSTRONG. Thank you.

Chairman HALL. Thank you, Dr. Muller. Now I recognize Dr. Christy, Director of the Earth System Science Center at the University of Alabama in Huntsville for five minutes to present his testimony.

STATEMENT OF DR. JOHN CHRISTY, DIRECTOR, EARTH SYSTEM SCIENCE CENTER, UNIVERSITY OF ALABAMA, HUNTSVILLE

Dr. CHRISTY. Thank you, Chairman Hall, Ranking Member Johnson, Committee Members and my Congressman Brooks over here for this opportunity to be here.

I am here to address issues regarding the process by which major climate assessments have led to problems for you, our policymakers. I am John Christy, Alabama State Climatologist from the University of Alabama in Huntsville.

My research deals specifically with climate science. I am one of those few people who actually builds climate data sets from scratch to answer questions about climate variability and to test assertions people make about climate change. I was the lead author of the IPCC 2001 report and a secondary author of the others which doesn't really mean much at all when you read my written testimony.

Climate assessments like the IPCC use a process in which IPCC's selected lead authors are given significant control over the text, including the authority to judge their own work against the work of their critics. You might call this a conflict of interest. This process has led to the propagation of incorrect and misleading information in the assessments and thus should lead you to question the IPCC's general support for a catastrophic view of climate change. These reports do not represent a full-range of scientific evidence on climate, and I have three examples.

In the first case, I address the icon of the IPCC 2001, the hockey stick, and show that the hockey stick's author was the same IPCC lead author who, in my opinion, worked with a small group of cohorts and misrepresented the temperature record of the past 1,000 years by promoting his own result and neglecting studies that contradicted his and allowing amputation of a disagreeable result and the splicing of unrelated data to hide the decline. Thus, in my view, conflicting data were eliminated or massaged, and real uncertainties were not acknowledged.

In the second example from the recent IPCC 2007 report, evidence was presented by Dr. Ross McKitrick and others that indicated the popular surface temperature data sets were affected by warming, not likely to be caused by greenhouse gases. This has raised serious doubts about using surface temperatures for evidence for greenhouse warming. The IPCC authors were themselves producers of these data sets, yet as final say authors, they sat in judgment over the controversy, eventually denying McKitrick's evidence with what turned out to be apparently their own fabricated claim. I discuss more about surface temperatures in my written testimony.

In the third example, I demonstrate that in the EPA finding which declared greenhouses gas as a dangerous threat, key evidence regarding the evaluation of climate models and their ability to depict the real atmosphere was misrepresented. In IPCC-like fashion, the EPA relied on establishment scientists, giving them authority to respond to evidence which contradicted the EPA finding with assertions that were not based on reliable data or methods. The evidence shows the EPA overstated the agreement between models and observations, when in fact there was significant disagreement.

Finally, this issue has policy implications that may potentially raise the price of energy a lot and thus essentially the price of everything else. As such, in my opinion, the U.S. Congress and EPA should not rely exclusively on the United Nations' IPCC assessments and their sister assessments exclusively because the process by which they were written has been shown to produce bias, false, over-confident or misleading information about one of the most murky of sciences, climate. As I stated in my IAC testimony last year, climate science needs adult supervision, but Congress needs at least one second opinion—talking about medical ideas here—one second opinion produced by expert climate scientists but overseen by a non-activist team which includes those with experience in the scientific method, such as physicists, and those who simply understand what is important for people, such as engineers, and then those who understand the legal aspects of admissible evidence and discovery, such as attorneys.

I refer you to my written testimony submitted here and from the Energy and Power hearing three weeks ago where these points were fleshed out. Thank you for your consideration. I await your questions.

[The prepared statement of Mr. Christy follows:]

PREPARED STATEMENT OF DR. JOHN R. CHRISTY, DIRECTOR, EARTH SYSTEM SCIENCE CENTER, UNIVERSITY OF ALABAMA IN HUNTSVILLE

One Page Summary

1. Climate assessments like the IPCC have to date been written through a process in which IPCC-selected authors are given significant authority over the text, including judging their own work against work of their critics. This has led to biased information in the assessments and thus raises questions about a catastrophic view of climate change because the full range of evidence is not represented. Three examples follow.

1.A. Regarding the Hockey Stick of IPCC 2001 evidence now indicates, in my view, that an IPCC Lead Author working with a small cohort of scientists, misrepresented the temperature record of the past 1000 years by (a) promoting his own result as the best estimate, (b) neglecting studies that contradicted his, and (c)

amputating another's result so as to eliminate conflicting data and limit any serious attempt to expose the real uncertainties of these data.

1.B. In the IPCC 2007 report, Dr. Ross McKitrick presented evidence that indicated warming processes other than greenhouse gas warming affected the popular surface temperature data sets. The IPCC authors were themselves producers of these data sets, yet as "final-say" authors they sat in judgment over this controversy, eventually denying McKitrick's evidence with what turned out be (apparently) their own fabricated claim.

1.C. The EPA Finding misrepresented key evidence on the evaluation of climate models against real data. In IPCC-like fashion, the EPA gave authority to its hand-picked author team to respond to evidence which contradicted the Finding with assertions that were not based on reliable data or methods. The evidence shows the EPA overstated the agreement between models and observations when in fact there was disagreement.

2. Warming in surface temperatures is caused by many factors other that greenhouse gases, one reason they are poor proxies to depict greenhouse warming. Bulk atmospheric temperatures, a more direct proxy, show much less warming that models predict.

3. Because this issue has policy implications that may potentially raise the price of energy significantly (and thus essentially the price of everything else), the U.S. Congress should not rely exclusively on the U.N. assessments because the process by which they were written includes biased, false, and/or misleading information about one of the most murky of sciences—climate. In my opinion, the Congress needs at least one second-opinion produced by well-credentialed climate scientists but overseen by a non-activist team which includes those with experience in the scientific method, the legal aspects of "discovery," and who simply know what is important in answering the questions at hand.

A House Science, Space and Technology Committee Examining the Process concerning Climate Change Assessments

31 March 2011

John R. Christy, The University of Alabama in Huntsville

Written Testimony

I am John R. Christy, Professor of Atmospheric Science and Director of the Earth System Science Center at the University of Alabama in Huntsville. I am also Alabama's State Climatologist. My training and research have been almost exclusively in the area of climate studies. I built my first climate dataset when I was 15 in an attempt to understand and predict the interannual variations of rainfall in the San Joaquin Valley of California. It didn't work. Even so, climate science has been a passion of mine for almost 50 years.

I have served as Lead Author of the Third Intergovernmental Panel on Climate Change (2001) and a "Key" or "Contributing" Author on the others. I was chosen to receive a Special Award by the American Meteorological Society and NASA's Medal Exceptional Scientific Achievement for my work with Dr. Roy Spencer regarding the development of satellite-based climate datasets. I was elected a Fellow of the AMS in 2002. My main research deals with building climate datasets from scratch to understand what the climate has been doing and to test assertions made about the climate system.

I normally speak to congressional committees regarding the science of climate change as I did three weeks ago to the House subcommittee on Energy and Power. Those interested in that testimony are encouraged to access it (8 March 2011.) The question I was asked to address today relates to the *process* by which past climate change assessments were generated and how the final products of such efforts may be compromised. This is the same basic topic I addressed before the Inter-Academy Council (of Sciences) or IAC in Montreal last June. Some of the discussion below is contained in that testimony (Appendix A.) Additionally, Dr. Ross McKitrick provided information to the same House subcommittee three weeks ago and I wish to attach that as well (Appendix B) since I refer to it below. Finally, one of my responses to the EPA Endangerment Finding is discussed below and thus my full comment to EPA is attached as Appendix C.

In the following I will provide some general remarks on the shortcomings of the assessment process as I've experienced it, then provide three examples of how the

process led to inaccurate information provided to policymakers, followed by a comment on temperature records and I will close with some concluding remarks.

1. General Remarks

The first basic problem with the entire issue here is that climate science is a murky science, not a classic, experimental science. As an emerging science of a complex, chaotic atmospheric and oceanic system, it is plagued by uncertainty and ambiguity in both observations and theory. Lacking classic, laboratory results, it easily becomes hostage to opinion, groupthink, arguments-from-authority, overstatement of confidence, and even Hollywood movies. (For a formalized discussion of the uncertainties and ignorance in climate science see Curry 2011.)

The most prominent assessment of climate change science is produced through the Intergovernmental Panel on Climate Change or IPCC. These U.N. reports have appeared every few years, with the main reports coming out in 1990, 1995, 2001 and 2007. Understanding the selection and role of the authors is important for policymakers who want to understand the process.

In simplified terms, IPCC Lead Authors are nominated by their countries, and down-selected by the IPCC bureaucracy with help from others (the process is still not transparent to me—who really performs this down-select?) The basic assumption is that the scientists so chosen as Lead Authors (L.A.s) represent the highest level of expertise in particular fields of climate science (or some derivative aspect such as agricultural impacts) and so may be relied on to produce the most up-to-date and accurate assessment of the science. When these assessments are done, government organizations such as the U.S. EPA often adopt the reports in total, without investigation, to guide their agendas.

In one sense, the authors of these reports are volunteers since they are not paid. However, they do not go without salaries. Government scientists make up a large portion of the author teams and can be assigned to do such work, and in effect are paid to work on the IPCC by their governments. University scientists aren't so lucky but can consider their IPCC effort as being so close to their normal research activities that salary charges to the university or grants occur. Travel expenses were paid by the IPCC for trips, in my case, to Australia, Paris, Tanzania, New Zealand, Hawaii, and Victoria, Canada. Perhaps it goes without saying that such treatment might give one the impression he or she is an important authority on climate.

As these small groups of L.A.s travel the world, they tend to form close communities which often re-enforce a view of the climate system that can be very difficult to penetrate with alternative ideas (sometimes called "confirmation bias" or "myside bias".) They become an "establishment" as I call them. With such prominent positions as IPCC L.A.s on this high profile topic, especially if they support the view that climate change is an unfolding serious disaster, they would be honored with wide exposure in the media (and other sympathetic venues) as well as rewarded with repeated appointments to the IPCC process. In my case, evidently, one stint as an L.A. was enough.

The second basic problem (the first was the murkiness of our science) with these assessments is the significant authority granted the L.A.s. This is key to understanding the IPCC process. In essence, the L.A.s have virtually total control over the material and, as demonstrated below, behave in ways that can prevent full disclosure of the information that contradicts their own pet findings and which has serious implications for policy in the sections they author. While the L.A.s must solicit input for several contributors and respond to reviewer comments, they truly have the final say.

In preparing the IPCC text, L.A.s sit in judgment of material of which they themselves are likely to be a major player. Thus they are in the position to write the text that judges their own work as well as the work of their critics. In typical situations, this would be called a conflict of interest. Thus L.A.s, being human, are tempted to cite their own work heavily and neglect or belittle contradictory evidence (see examples below.)

In the beginning, the scientists who wrote the IPCC assessment were generally aware of the new responsibility, the considerable uncertainties of climate science, and that consequences of their conclusions could generate burdensome policies. The first couple of reports were relatively cautious and rather equivocal.

In my opinion, as further assessments were created, a climate "establishment" came into being, dominating not only the IPCC but many other aspects of climate science, including peer-review of journals. Many L.A.s became essentially permanent fixtures in the IPCC process and rose to positions of prominence in their institutions as a side benefit. As a result, in my view, they had a vested interest in preserving past IPCC claims and affirming evermore confident new claims to demonstrate that the science was progressing under their watch and that financial support was well

spent. Speaking out as I do about this process assured my absence of significant contribution on recent and future reports.

Political influence cannot be ignored. As time went on, nations would tend to nominate only those authors whose climate change opinions were in line with a national political agenda which sought perceived advantages (i.e. political capital, economic gain, etc.) by promoting the notion of catastrophic human-induced climate change. Scientists with well-known alternative views would not be nominated or selected. Indeed, it became more and more difficult for dissention and skepticism to penetrate the process now run by this establishment. As noted in my IAC testimony, I saw a process in which L.A.s were transformed from serving as Brokers of science (and policy-relevant information) to Gatekeepers of a preferred point of view.

A focus evolved in the IPCC that tended to see enhanced greenhouse gas concentrations as the cause for whatever climate changes were being observed, particularly in the 2001 (Third Assessment Report or TAR) which was further solidified in 2007, (the Fourth Assessment Report or AR4.) The IAC 2010 report on the IPCC noted this overconfidence when it stated that portions of the AR4 contained "many vague statements of 'high confidence' that are not supported sufficiently in the literature, not put into perspective, or are difficult to refute.'" (This last claim relates to the problem of generating "unfalsifiable hypotheses" discussed in my recent House testimony.)

With an understanding of the power of the L.A.s in determining the content of the IPCC and thus EPA reports, I shall describe three situations, about which I am quite familiar, to support the claims made above.

1.A. An Example from IPCC Third Assessment Report (TAR 2001)—the Hockey Stick

My experience as Lead Author in the IPCC TAR, Chapter 2 "Observed Climate Variability and Change", allowed me to observe how a key section of this chapter, which produced the famous Hockey Stick icon, was developed. My own topic was upper air temperature changes that eventually drew little attention, even though the data clearly indicated potentially serious inconsistencies for those who would advocate considerable confidence in climate model projections.

First, note these key points about the IPCC process: the L.A. is allowed (a) to have essentially complete control over the text, (b) sit in judgment of his/her own work as well as that of his/her critics and (c) to have the option of arbitrarily dismissing reviewer comments since he/she is granted the position of "authority" (unlike peer-review.) Add to this situation the rather unusual fact that the L.A. of this particular section had been awarded a PhD only a few months before his selection by the IPCC. Such a process can lead to a biased assessment of any science. But, problems are made more likely in climate science, because, as noted, ours is a murky field of research—we still can't explain much of what happens in weather and climate.

The Hockey Stick curve depicts a slightly meandering Northern Hemisphere cooling trend from 1000 A.D. through 1900, which then suddenly swings upward in the last 80 years to temperatures warmer than any of the millennium when smoothed. To many, this appeared to be a "smoking gun" of temperature change proving that the 20th century warming was unprecedented and therefore likely to be the result of human emissions of greenhouse gases.

I will not debate the quality of the Hockey Stick—that has been effectively done elsewhere (and indeed there is voluminous discussion on this issue), so, whatever one might think of the Hockey Stick, one can readily understand that its promotion by the IPCC was problematic given the process outlined above. Indeed, with the evidence contained in the Climategate emails, we have a fairly clear picture of how this part of the IPCC TAR went awry. For a more detailed account of this incident with documentation, see http://climateaudit.org/2009/12/10/ipcc-and-the-trick/.

We were appointed L.A.s in 1998. The Hockey Stick was prominently featured during IPCC meetings from 1999 onward. I can assure the committee that those not familiar with issues regarding reconstructions of this type (and even many who should have been) were truly enamored by its depiction of temperature and sincerely wanted to believe it was truth. Skepticism was virtually non-existent. Indeed it was described as a "clear favourite" for the overall Policy Makers Summary (Folland, 0938031546.txt).

In our Sept. 1999 meeting (Arusha, Tanzania) we were shown a plot containing more temperature curves than just the Hockey Stick including one from K. Briffa that diverged significantly from the others, showing a sharp cooling trend after 1960. It raised the obvious problem that if tree rings were not detecting the modern warming trend, they might also have missed comparable warming episodes in the past. In other words, absence of the Medieval warming in the Hockey Stick graph

might simply mean tree ring proxies are unreliable, not that the climate really was relatively cooler.

The Briffa curve created disappointment for those who wanted "a nice tidy story" (Briffa 0938031546.txt). The L.A. remarked in emails that he did not want to cast "doubt on our ability to understand factors that influence these estimates" and thus, "undermine faith in paleoestimates" which would provide "fodder" to "skeptics" (Mann 0938018124.txt). One may interpret this to imply that being open and honest about uncertainties was not the purpose of this IPCC section. Between this email (22 Sep 1999) and the next draft sent out (Nov 1999, Fig. 2.25 Expert Review) two things happened: (a) the email referring to a "trick" to "hide the decline" for the preparation of report by the World Meteorological Organization was sent (Jones 0942777075.txt, "trick" is apparently referring to a splicing technique used by the L.A. in which non-paleo data were merged to massage away a cooling dip at the last decades of the original Hockey Stick) and (b) the cooling portion of Briffa's curve had been truncated for the IPCC report (it is unclear as to who performed the truncation.)

In retrospect, this disagreement in temperature curves was simply an indication that such reconstructions using tree ring records contain significant uncertainties and may be unreliable in ways we do not currently understand or acknowledge. This should have been explained to the readers of the IPCC TAR and specifically our chapter. Highlighting that uncertainty would have been the proper scientific response to the evidence before us, but the emails show that some L.A.'s worried it would have diminished a sense of urgency about climate change (i.e. "dilutes the message rather significantly", Folland, 0938031546.txt.)

When we met in February 2000 in Auckland NZ, the one disagreeable curve, as noted, was not the same anymore because it had been modified and truncated around 1960. Not being aware of the goings-on behind the scenes, I had apparently assumed a new published time series had appeared and the offensive one had been superceded (I can't be certain of my actual thoughts in Feb. 2000). Now we know, however, that the offensive part of Briffa's curve had simply been amputated after a new realization was created three months before. (It appears also that this same curve was apparently a double amputee, having its first 145 years chopped off too, see http://climateaudit.org/2011/03/23/13321/.) So, at this point, data which contradicted the Hockey Stick, whose creator was the L.A., had been eliminated. No one seemed to be alarmed (or in my case aware) that this had been done.

Procedures to guard against such manipulation of evidence are supposed to be in place whenever biases and conflicts of interest interfere with duties to report the whole truth, especially in assessments that have such potentially drastic policy implications. That the IPCC allowed this episode to happen shows, in my view, that the procedures were structurally deficient.

Even though the new temperature chart appeared to agree with the Hockey Stick, I still expressed my skepticism in this reconstruction as being evidence of actual temperature variations. Basically, this result relied considerably on a type of western U.S. tree-ring not known for its fidelity in reproducing large-scale temperatures (NRC 2006, pg. 52).

At the L.A. meetings, I indicated that there was virtually no inter-century precision in these measurements, i.e. they were not good enough to tell us which century might be warmer than another in the pre-calibration period (1000 to 1850.)

In one Climategate email, a Convening L.A., who wanted to feature the Hockey Stick at the time (though later was less enthusiastic), mentions "The tree ring results may still suffer from lack of multicentury time scale variance" and was "probably the most important issue to resolve in Chapter 2" (Folland, 0938031546.txt). This, in all likelihood, was a reference to (a) my expressed concern (see my 2001 comments to NRC below) as well as to (b) the prominence to which the Hockey Stick was pre-destined.

To compound this sad and deceptive situation, I had been quite impressed with some recent results by Dahl-Jensen et al., (*Science* 1998), in which Greenland iceborehole temperatures had been deconvolved into a time series covering the past 20,000 years. This measurement indeed presented inter-century variations. Their result indicated a clear 500-year period of temperatures, warmer than the present, centered about 900 A.D.—commonly referred to as the Medieval Warm Period, a feature noticeably absent in the Hockey Stick. What is important about this is that whenever any mid to high-latitude location shows *centuries* of a particularly large temperature anomaly, the spatial scale that such a departure represents is also large. In other words, long time periods of warmth or coolness are equivalent to large spatial domains of warmth or coolness, such as Greenland can represent for the Northern Hemisphere (the domain of the Hockey Stick.)

I discussed this with the paleo-L.A. at each meeting, asking that he include this exceptional result in the document as evidence for temperature fluctuations different from his own. To me Dahl-Jensen et al.'s reconstruction was a more robust estimate of past temperatures than one produced from a certain set of western U.S. tree-ring proxies. But as the process stood, the L.A. was not required to acknowledge my suggestions, and I was not able to convince him otherwise. It is perhaps a failure of mine that I did not press the issue even harder or sought agreement from others who might have been likewise aware of the evidence against the Hockey Stick realization.

As it turned out, this exceptional paper by Dahl-Jensen et al. was not even mentioned in the appropriate section (TAR 2.3.2). There was a brief mention of similar evidence indicating warmer temperatures 1000 years ago from the Sargasso Sea sediments (TAR 2.3.3), but the text then quickly asserts, without citation, that this type of anomaly is not important to the hemisphere as a whole.

Thus, we see a situation where a contradictory data set from Greenland, which in terms of paleoclimate in my view was quite important, was not offered to the readers (the policymakers) for their consideration. In the end, the Hockey Stick appeared in Figure 1 of the IPCC Summary for Policymakers, without any other comparisons, a position of prominence that speaks for itself.

So, to summarize, an L.A. was given final say over a section which included as its (and the IPCC's) featured product, his very own chart, and which allowed him to leave out not only entire studies that presented contrary evidence, but even to use another strategically edited data set that had originally displayed contrary evidence. This led to problems that have only recently been exposed. This *process*, in my opinion, illustrates that the IPCC did not provide policymakers with an unbiased evaluation of the science, whatever one thinks about the Hockey Stick as a temperature reconstruction.

This story had a couple of postscripts regarding my involvement. First, The National Academy of Sciences contacted me shortly after the TAR appeared in 2001 for my views on the IPCC process. I indicated that the process was generally a pleasant experience, but that some things still bothered me. In my written submission to the NRC I stated that I believed too much emphasis was placed on the Hockey Stick.

21 May 2001
To: Vaughan Turekian (NAS)
Subject: Question about IPCC

1000-year temperature record

This first concern arises from our chapter (2) for which I must accept as much blame as anyone. We (chapter 2 authors) are guilty of omitting information that indicated the temperature history of the past 1000 years is not as well known as is implied by the prominent figure in the SPM [Summary for Policymakers] (Fig. 1) and TS [Technical Summary] (Fig.5). At each of the Lead Authors meetings I pointed out that we should include mention of publications which strongly suggest the medieval warm period was warmer than the current century. In particular I mentioned the Dahl-Jensen et al. 1998 Science paper which I believe presents the most direct measurement of temperature and thus should be highlighted. Broeker (2001, SCIENCE) echoed the very concerns I had put forward in our meetings. In the final version of the text the Dahl-Jensen paper was not even cited in Section 2.3 -a fact I did not realize until last week when I read the report in detail (2.3 is the section on the temperature record of the past 1000 years.) Thus, its [Greenland's temperature] information was not carried forward in the TS or SPM. (The paper is only mentioned in passing regarding the warming 8 kybp in the TAR [Third Assessment Report].) I should point out that the final wording concerning the warmth of the 1990's and 1998 as "likely" the warmest of the past millennium (i.e. only 2/3 chance of being correct) tried to account for the lack of certainty in our knowledge of past temperatures. However, the very prominent placement of the time series of the last 1000 years in the TS and SPM overrules what tentativeness some of us actually intended. This is my personal view.

John R. Christy
University of Alabama in Huntsville

Secondly, I served on the 2006 NRC panel that took another look at the temperatures of the past 2000 years and noted several findings about the Hockey Stick that had come to light since I wrote the above in 2001. That report stated that it was inappropriate to use the particular type of tree rings which dominated the early

part of the Hockey Stick (p. 52), and that a key step in its mathematical method was so biased that even when a collection of random numbers were used for input, hockey stick shapes were produced (p. 91.) Overall, the NAS report concluded that methodological problems in reconstructions mean that "uncertainties of the published reconstructions have been underestimated" (p. 113.) For further critical analysis see the "Wegman Report" (Wegman et al. 2006). It is clear now, in my view, that the prominence accorded the Hockey Stick was inappropriate and that the IPCC failed to provide an accurate depiction of the state of climate science in this area.

Finally, you may hear that certain ad-hoc panels were assembled which examined these events and were claimed to have "exonerated" the scientists from major wrong doing. Please note that these reports have no true legal standing as the legal process was not followed, i.e. determining admissible evidence, discovery, cross-examination of the evidence and witnesses, the full inclusion of testimony by witnesses denigrated by these scientists, etc. A summary of this whole "exoneration" affair is given by Dr. Ross McKitrick in "response to climategate inquiries" at http://rossmckitrick.weebly.com/submissionsresponses-to-govt-inquiries.html.

1.B. IPCC apparent fabrication of claims regarding surface temperature

The next two examples are well-described in the attached document supplied by Dr. Ross McKitrick of the University of Guelph, Ontario, sent to the House subcommittee on Energy and Power in relation to their hearing three weeks ago (Appendix B). The first situation I describe deals with an apparent fabrication of information regarding surface temperatures contained in the most recent IPCC AR4 (2007) and the subsequent usage of the information by the EPA in their endangerment finding. This is a situation encountered by McKitrick himself (Appendix B.1). The second incident focuses more on EPA's mishandling of information, and I relate my own experience here (Appendix C.3.1a), but I direct you to McKitrick's commentary in Appendix B.3 as an independent analysis of the same issue.

In the first case, a point of contention arose between McKitrick, an IPCC reviewer, and the IPCC L.A.s concerning evidence published by two independent groups which documented the contamination of the surface temperature record by industrialization and land-use change (De Laat and Maurellis 2004, 2006, McKitrick and Michaels 2004.) Numerous papers, including some by myself (e.g. Christy et al. 2009), have been published in this arena, but the two groups' papers cited here specifically found patterns of warming over land that were statistically associated with patterns of socio-economic development, a correlation not predicted in model simulations of greenhouse warming. This of course would call into question the use of these surface datasets (maintained by some of the aforementioned L.A.s) as indicators of greenhouse warming of the planet.

After the close of peer review, the L.A.s inserted text into the IPCC report that described the findings pointed out by McKitrick, but then dismissed them by asserting that the correlations were due to natural circulation patterns, not industrialization, concluding that the "correlation of warming with industrial and socioeconomic development ceases to be statistically significant." This claim was subsequently quoted by the EPA Finding, and thus, as demonstrated below, tarnishes that document as well. The problem? There was no evidence to support this claim made by the L.A.s—it was simply an assertion (perhaps a belief?) evidently invented to dismiss the offensive results.

McKitrick (2010) was later published which specifically tested the IPCC claim about the role of circulation patterns as the cause of the observed distribution of warming and found the IPCC claim to be false. Thus, the IPCC assertion had evidently been a fabrication. The key point here is that the IPCC process failed policymakers by not providing the complete picture of an issue and unfortunately produced not just misleading, but false information. Given that the IPCC L.A. team (a) exerted almost total control over the text, (b) were sitting in judgment of criticisms of datasets they themselves produced, and (c) were not required to accommodate alternate views, it is not difficult to see how such a failure could occur—a failure that can have significance for climate change policy. This, again, is an example of L.A.s acting as Gatekeepers, not as Brokers. Furthermore, the Climategate emails also shed light on the behind-the-scenes attempts by the L.A.s to squelch this important information—hardly the activity associated with an open and transparent process (see Appendix B.1).

1.C. EPA "Finding" relied on an IPCC-like review process

In its Finding (Part III.C.), the EPA essentially relies on climate model output to make claims about current and future climate changes being potentially dangerous

and being caused by increases in greenhouse gases. The report, fundamentally, assumes that climate models are so precise in their depiction of the real climate that they are reliable for predictions and thus policy. In the public comment period, I was one of several who responded to this assertion with evidence to demonstrate that basic and fundamental features of climate model simulations do not effectively represent the real world.

A prominent signature of global warming due to greenhouse gases in climate models is a warming of the tropical upper atmosphere, generally between 8 and 12 km, that is much greater than the warming which models project for the surface. The signature in models is so prominent that it provides a relatively easy test against observations. Several studies have indicated that observations do not show this feature, which in turn casts doubt on climate model theory as representing greenhouse warming properly and on which the EPA Finding relied (e.g. Christy et al. 2007, Douglass et al. 2007).

In the review of the EPA draft, several responders, including me, informed the EPA that the EPA's statement about agreement between observations and models had been improperly reported. We backed up our claims with published information. However, in their response to us, the EPA's "authors" (themselves part of the establishment) in IPCC-like fashion claimed "when uncertainties in models and observations are properly accounted for, newer observational datasets are in agreement with climate model results." As far as we could tell, they did not give any serious consideration to contradictory evidence. This was another example of authors, who were utilized by the EPA, having the authority to ignore evidence that was clearly against their assertions. Rather than providing the range of views in the Finding, or at a minimum pointing out significant model uncertainty suggested by our results, the EPA authors acted as gatekeepers and mislead the readers (See Appendix C for my full review comments.)

In their response to our reviews, the EPA cited three papers which purportedly offered "new observations" to support their model vs. observations "agreement", relying mainly on Santer et al. 2008. However, these "new" upper air data sets (RAOBCORE 1.3, 1.4, and Allen and Sherwood (2005) thermal wind derivation) and two of the "new" surface data sets (ERSST v2 and v3) had been shown to contain spurious trends when tested for accuracy and these versions are not used for trend estimation any longer. Santer et al., the EPAs key citation, had done no testing of the observations as we had done. In my review, I went through the details of why Santer et al. 2008 had been incorrect in both their hypothesis test (where they neglected the pre-condition of surface trend agreement between models and observations—see bracketed note below) and with the data they used. However, the EPA simply allowed its own hand-picked authors to assert their conclusion. They did not objectively assess the conclusions of these contradictory studies or even acknowledge at a minimum that significant controversy continued on this issue. Further studies support the original comments of my review (e.g. Sakamoto and Christy, 2009, Klotzbach et al. 2009, Christy et al. 2010, McKitrick et al. 2010).

[I note here some technical points. Douglass et al. tested a hypothesis that depended on a specific condition. We addressed the question, "If models and observations have the same surface temperature trend, then do the models and observations have the same upper air trend?" In other words, we were testing the *relationship* between surface and upper air temperatures. For data 1979–2004, the answer was no. McKitrick et al. 2010 (and Santer et al. 2008) tested a broader question without the condition of surface agreement. Their question was simply, "Do upper air trends of models and observations agree?" (i.e. without the requirement that surface trends agree). Santer et al. used 1979-99, McKitrick et al. used 1979–99 and 1979–2009. Ending in 1999 was a clever way to tilt observations upward, to help them match the models' warming, due to the massive 1998 El Nĩno whose impact fades as the time series is lengthened to 2004 and 2009. Even on this more general question, McKitrick et al. 2010 found the answer to be no, i.e. models and observations do not agree, and noted the difference in methodologies in their Supplementary Note 5.]

In my comments to the EPA on this issue I knew the agency would rely on the "establishment" in IPCC-like fashion to write its response, giving their hand-picked "authors" control of the process. So I included the following paragraph:

> Warning: The EPA will be tempted to rely on scientists/appointees who are well-entrenched into a particular view of the issue of global warming to review documents such as this, and who will (a) develop clever sounding rebuttals, and (b) are afforded the luxury of the "last word" to protect the current EPA consensus. Basic scientific inquiry should encourage EPA to listen to those of us

who actually build these datasets (from scratch) as our message has equal if not greater credibility.

This plea to be objective and avoid an IPCC-like process (i.e. relying on hand-picked authors to give the last word) was to no avail. Again, this demonstrates that consensus reports like the IPCC and EPA can be resistant to dissenting scientific information in a science that is already murky. In this last case, not only were policymakers misled by the EPA's consensus document, but the promised expensive regulations that are to follow must be viewed as being based, at least in part, on misleading or flawed information. This situation occurs when an institution follows a process that accords authors with veto-oversight of scientific information, who hold one type of perspective, and who are given total control over the output in a field plagued by uncertainty.

There are other examples of the shortcomings of the assessment process (see for example, McKitrick's Appendix B.2 and my Appendix C.1, C.2 and C.3b), but these above are sufficient to show the problems with the process of generating consensus documents.

Before providing concluding remarks I will briefly address an issue requested by the committee regarding surface temperature datasets.

2. Temperature data sets

I have built temperature data sets for climate studies from satellite microwave sensors, balloon soundings, and traditional surface thermometers. My research as well as my experience as State Climatologist exposed me to problems with traditional surface measurements and led me to establish a new network of stations in Alabama with high quality, modernized instrumentation. However, these older stations provide the bulk of the measurements that are the basis of the popular surface temperature datasets today. My studies (and many others) have shown that popular land-surface temperature measurements are affected by many influences, most of them causing warming, which are unrelated to greenhouse gas increases (Christy 2002, Christy et al. 2006.) This is especially true for the daily low temperature which is utilized in the popular surface temperature datasets today (Christy et al. 2006, 2009.) As a result, these measurements, as used, are not adequate to detect what might be happening to the global climate as a result of greenhouse gas increases. (This is also related to the contamination issue raised by McKitrick described above and in my Appendix C.3.2.)

Two of the major problems with the traditional datasets today are determining the provenance of the raw data and reproducing the methodology that created the processed temperature products used in assessments. In the past, raw data were often held close to the product-producer and so results were difficult to independently investigate. "Just trust me" seemed to be the basis for acceptance by the IPCC.

There is an effort underway to create a data bank for surface temperatures that will be open and transparent, with the capability to trace the data to the original sources. From a data bank that is this comprehensive, many useful applications can be created (addressing not just climate change) with the full traceability of the product—from its original measurement with site photographs, to the final adjustments. In this way, for example, methods designed to deal with the contamination issues described above can be better studied and addressed by the community. Much of the effort of this project is led out of the National Climatic Data Center in Asheville NC.

Bulk atmospheric temperatures measured by satellites and balloons, from the surface to 35,000 ft., form a more robust parameter than surface measurements for detecting changes that might be caused by the enhanced greenhouse effect. These temperatures are also affected by transient events, like volcanoes, that tend to confuse the detection of what these extra greenhouse gases are doing to the climate. As described in my recent testimony, when these extraneous features are removed from the global bulk atmospheric temperatures, we find a rising temperature trend since 1979 that is significantly lower than what is being predicted from climate models as they try to quantify the effect of those greenhouse gases. To me, this demonstrates that the real atmosphere is not as sensitive to greenhouse gases as the climate models suggest.

3. Concluding remarks

While there are many examples of problems with the process of producing climate change assessments, I am not suggesting everything in these assessments is wrong. The point I raise here is that the *process* by which these assessments were created, whether intended or not, did not provide an expression of the full range of scientific

information (and in some cases provided incorrect information) for some key conclusions. These conclusions were then adopted without question by regulatory authorities such as the U.S. EPA. These suspect conclusions include but are not limited to, (a) the notion that the popular surface temperature datasets can serve is a detection variable of the impact of enhanced greenhouse-gas concentrations (and that it is accurately measured), (b) the belief that climate models have precisely replicated natural, unforced variability (so natural variations can be ruled out as the cause for changes that occur), and (c) an overconfident view of how sensitive the climate is to human forcing.

With the IPCC process to date, we see Lead Authors sitting in judgment of information regarding their very own scientific results and those of their critics. This creates an unhealthy conflict-of-interest situation that unfortunately shortchanges the policymakers. To make well-informed decisions, policymakers depend on receiving the full range of scientific thought and evidence on any issue, especially one as contentious, murky, and as potentially expensive as climate change. The committee should understand that the IPCC presents one version of climate change science generated by an establishment that has evolved to largely reflect a particular point of view. As shown above, this point of view attempts to dismiss information that questions the belief that greenhouse gases are the dominant cause of observed climate change (as represented mainly by a rather poor surface temperature data set) with little effort expended on (a) other explanations for change such as natural, unforced variability, (b) a critical assessment of the climate change variables utilized (including paleoclimate) or (c) a rigorous assessment of model sensitivity and fidelity to observations.

In my IAC testimony (Appendix A), I indicated that the climate "establishment" is so entrenched now, that our science is in need of "adult supervision." If a new and independent report is called for, one idea is to use a leadership team composed of non-activists that includes, (a) physicists who understand that science advances by testing falsifiable hypotheses (and not by accepting popularized, untestable sentiments), (b) research engineers who understand what's important to the issue at hand and (c) attorneys who understand the meaning of language, admissible evidence, and the legal process of discovery (transparency). With, hopefully, such objective eyes overseeing the process, the result may be much more humble and honest—revealing the lack of confidence and understanding we have on most climate issues, the lack of dramatic events attributable to humans now occurring in the climate, and the resilience of the Earth to human inputs.

References

Allen, R.J. and S.C. Sherwood. Warming maximum in the tropical upper troposphere deduced from thermal winds. *Nature Geoscience*. 2008. Published online 25 May 2008: doi: 10.1038/ngeo208.

Christy, J.R., B. Herman, R. Pielke, Sr., P. Klotzbach, R.T. McNider, J.J. Hnilo, R.W. Spencer, T. Chase and D. Douglass, 2010: What do observational datasets say about modeled tropospheric temperature trends since 1979? *Remote Sens.* 2, 2138–2169. Doi:10.3390/rs2092148.

Christy, J.R., W.B. Norris and R.T. McNider, 2009: Surface temperature variations in East Africa and possible causes. *J. Clim.* 22, DOI: 10.1175/2008JCLI2726.1.

Christy, J.R., W.B. Norris, R.W. Spencer, and J.J. Hnilo, 2007: Tropospheric temperature change since 1979 from tropical radiosonde and satellite measurements, *J. Geophys. Res.*, 112, D06102, doi:10.1029/2005JD006881.

Curry, J. 2011: Reasoning about climate uncertainty. *Climatic Change*, submitted. (see draft: http://judithcurry.com/2011/03/24/reasoning-about-climate-uncertainty-draft/#more-2743).

Dahl-Jensen, D., K. Mosegaard, N. Gundestrup, G.D. Clow, S.J. Johnsen, A.W. Hansen and N. Balling, 1998: Past temperatures directly from the Greenland ice sheet. *Science*, 282, 268–271.

De Laat, A.T.J. and A.N. Maurellis, 2004: Industrial CO2 emissions as a proxy for anthropogenic influence on lower tropospheric temperature trends. *Geophys. Res. Lett.*, 31, L05204, doi:1029/2003GL019024.

De Laat, A.T.J. and A.N. Maurellis, 2006: Evidence for influence of anthropogenic surface processes on lower tropospheric and surface temperature trends. Int. J. Climatol., 26, 897–913.

Douglass, D.H., J.R. Christy, B.D. Pearson and S.F. Singer, 2007: A comparison of tropical temperature trends with model predictions. *International J. Climatology*, DOI: 10.1002/joc.1651.

IAC 2010: Interacademy Council Review of the IPCC. http://reviewipcc.interacademycouncil.net/report.html.

Klotzbach, P.J., R.A. Pielke Sr., R.A. Pielke Jr., J.R. Christy, and R.T. McNider (2009), An alternative explanation for differential temperature trends at the surface and in the lower troposphere, *J. Geophys. Res.*, 114, D21102, doi:10.1029/2009JD011841.

McKitrick, R., 2011: Atmospheric oscillations do not explain the temperature-industrialization correlation. *Statistics, Politics and Policy*, Vol 1, No. 1, July 2010.

McKitrick, R.R., S. McIntyre and C. Herman, 2010: Panel and multivariate methods for tests of trend equivalence in climate data sets. *Atmos. Sci. Lett.*, doi:10.1002/asl.290.

McKitrick, R.R. and P.J. Michaels, 2004: A test of corrections for extraneous signals in gridded surface temperature data. *Clim. Res.*, 26(2), 15–173, Erratum, Clim. Res. 27(3), 265–268.

NRC 2006: Surface temperature reconstructions for the last 2,000 years. National Academies Press, Washington DC, www.nap.edu. 155pp.

Sakamoto, M. and J.R. Christy, 2009: The influences of TOVS radiance assimilation on temperature and moisture tendencies in JRA–25 and ERA–40. *J. Atmos. Oc. Tech.*, doi:10.1175/2009JTECHA1193.1.

Santer, B.D., P.W. Thorne, L. Haimberger, et al. Consistency of modeled and observed temperature trends in the tropical troposphere. *Int. J. Climatol.* 2008. DOI:1002/joc.1756.

Wegman, E.J., D.W. Scott and Y.H. Said, 2006: Ad hoc committee report on the 'Hockey Stick' global climate reconstruction. www.uoguelph.ca/rmckitri/research/WegmanReport.pdf.

ChristyJR Appendix A

IAC 15 June 2010

Montreal

John R. Christy

Distinguished Professor of Atmospheric Science
Director, Earth System Science Center
Alabama State Climatologist
University of Alabama in Huntsville

IPCC Lead Author: 2001 TAR
Contributor: 1992 Supplement
Contributor: 1994 Radiative Forcing of Climate Change
Key Contributor: 1995 SAR
Contributing Author: 2007 AR4, WG I and II

NASA Medal for Exceptional Scientific Achievement
American Meteorological Society Special Award for satellite observations
Fellow, American Meteorological Society

Mr. Chairman and members of the IAC panel, thank you for inviting me to offer my views on the IPCC process. Five years ago the *New York Times* quoted me saying that an IPCC-like process, "... is the worst way to generate scientific information, except for all the others." (23 Aug 2005) I now think I was a bit too generous.

A fundamental problem with the entire issue here is that climate science is not a classic, experimental science. As an emerging science of a complex, chaotic climate system, it is plagued by uncertainty and ambiguity in both observations and theory. Lacking classic, laboratory results, it easily becomes hostage to opinion, groupthink, arguments-from-authority, overstatement of confidence, and even Hollywood movies. When climate scientists are placed in the limelight because this issue can generate

compelling disaster scenarios, we simply don't want to say, "We just don't know."

I have been a contributor to the IPCC Assessments since 1992 and a Lead Author in the Third Assessment of 2001. Though I had some good things to say about the IPCC, I did respond in 2001 to the US National Academy of Sciences when they solicited information about certain problems (see Appendix A).

At the time, I was more concerned about the product rather than the process. The first objection I raised regarding the Third Assessment was that the fabled Hockey Stick was oversold as an indicator of past climate change. This was well before the critical work of the Wegman Report, National Academy of Sciences, McIntyre's papers and the East Anglia emails. *Indeed, I urge you in the strongest terms to engage Stephen McIntyre in your deliberations at a high level as he has accurately documented specific failures in the IPCC process, some of which I can attest to, as I was there.*

My second objection to the TAR was its overstatement of confidence in model projections.

My role in the Fourth Assessment of 2007 was limited to that of a Contributing Author. This means I submitted recommendations that were dealt with by the Lead Authors who tended to disagree with my published findings. Thus, their views carried the day in the report. In this process, the final result really boils down the opinions of those selected as Lead Authors, a point I will address below.

ChristyJR Appendix A

In March of last year, 8 months before the email fiasco, about 140 former IPCC Lead Authors gathered in Hawaii for a preview of what the Fifth Assessment might tackle. I was the only one there well-known to be essentially outside the IPCC "consensus." I had come to the conclusion that the IPCC establishment demonstrated a disturbing homogeneity-of-thought regarding the hypothesized but unproven role that greenhouse gases might impose on the climate system. My short talk (Appendix B) and poster (Appendix C) at that meeting last year dealt with three science issues and offered a recommendation. The three issues were (1) the surface temperature record is flawed in many ways, but is flawed in particular as a metric to detect greenhouse-imposed warming, (2) direct tests of the so-called fingerprint of climate model temperature changes versus observations indicated significant differences, failing simple hypothesis tests, and (3) the critical value of climate sensitivity to greenhouse gases was overstated because it had not been properly calculated. All of these were supported by peer-reviewed publications which even now continue to appear.

In my view, the IPCC process had drifted away from allowing authors to serve as Brokers of climate science, in which various views are given attention, to becoming Gatekeepers of climate science in which one view is elevated and promoted. The IPCC Assessment had become a "consensus of those who agreed with the consensus." Since "consensus" is a political notion, not a scientific notion, a goal of "consensus" in any forum is at its heart a political goal.

My recommendation last year was to include a chapter written by credentialed climate scientists who would provide evidence concerning these heretofore minimized issues, in particular the low sensitivity of the climate system. My assumption at that time was that the IPCC writing process would be the same, i.e. that the Lead Authors of this chapter, as the others, would be given the sacred right of being their own final reviewers to let a new voice be heard. No one at the meeting thought this was a useful suggestion, I believe, because it would allow the expression of reasonable alternatives to claims too entrenched in the message of looming climate disasters promoted with IPCC indulgence.

Since last March, much has happened to expose some of the scientists who dominated the IPCC, whom I call the establishment, as less than transparent, subject to bias, and who suppress alternative views while using the IPCC's perception as a near-sacred document to promote their own opinions. This establishment dominates not only the IPCC but also the review process of the peer-reviewed literature, making it extremely difficult for alternative evidence to even be published now. This happens when your type of science is rather murky to begin with.

In my view, the three fundamental flaws in the current IPCC process are (1) the two-step political filter by which Lead Authors are selected, (2) the review-authority granted the Lead Authors who write the chapters and synthesis reports, and, (3) the very limited word-count available for each topic, which encourages short and overconfident statements about questions that in truth are plainly nasty to deal with.

ChristyJR Appendix A

In February of this year, *Nature* magazine asked me for a brief discussion about the IPCC and a way forward (Appendix D, last page). My main concern there was to define a process that would let the world know that our ignorance of much of the climate system is simply enormous and we have much to do. Mother Nature has a tremendous number of degrees of freedom up her sleeves, many of which we don't even know about or account for.

So, I suggested a living, carefully-managed, wikipedia-style process. Important questions, most of which are already laid out in the IPCC manifest, would be addressed by teams of Lead Authors who would be far less constrained by the word-count rules, and so would allow fuller expression of uncertainty and disagreement – expressions contributed by the specific people who perform whatever research is being discussed. The Lead Authors main task would be to organize and summarize the information on each question, acting strictly as Brokers, not Gatekeepers. With web-based links to actual text (and data) the Lead Authors would be far less tempted to be biased. Lead Authors need to know they do not have to agree with the findings they report. I believe such transparency would spur the Lead Authors to be fairer and more humble in their summary comments.

Peer-reviewed research of course would dominate the source material, but other documents – whose source is clearly identified – could contribute to the discussion. I know there would be significant issues of managing such a process, but I believe it would be far better than producing big books every six years that are limited, biased and out-of-date when they are printed. We *are* in the 21st Century, and, to the despair of those who find comfort in

absolute answers, there are only continuously evolving levels of understanding (and ignorance) to most of the climate questions being asked. This situation begs for a dynamic assessment process.

The selection of Lead Authors through a two-step political process is a problem too. Presently, national governments nominate to the IPCC those who over the years, they can generally count on to be consistent with national policy. From this pool, the IPCC itself selects those it wants to be Lead Authors. To combat the political influence of governments and the U.N., to a small extent, I would recommend that Lead Authors be nominated by appropriate learned societies, such as yours, and selected for overlapping, rotating terms. I'm not completely comfortable with this as I'm aware that councils of science are deeply involved in political maneuvering which is why I state that to a "small extent" the political influence of governments and the U.N. might be mitigated.

Some Lead Authors could and should be scholars from other disciplines but who have a keen awareness of the hard rules of hypothesis testing, admissible evidence, and the power of language ... physicists, chemists, engineers and yes, even lawyers. As I told a colleague the other day, it is clear to me now that climate science needs some adult supervision.

I realize such a recommendation creates consternation among those who have controlled the process up to now and who believe deeply that the "science is settled" because they find comfort in easy and unimaginative answers to difficult questions. For example, why doesn't the IPCC report on (and funding agencies invest in) major research about the internal

dynamical properties of the climate system? At present these properties are incapably represented in climate models to date, and yet have been shown to be a major source of the variability we've seen. Why must we be so unimaginative that we just give up and claim that nothing else but enhanced greenhouse forcing explains most of the temperature rise in the past 50 years?

Others will complain that such an open process I describe will not generate the definitive statements necessary to drive policy. To those I say, "Welcome to climate science." If a specific policy is desired, climate science is a weak leg on which to stand which means a policy should have multiple, defensible reasons for adoption.

You will hear from those within the IPCC establishment that the IPCC does a terrific job of getting down to the truth about climate science and that the consensus reports are the best documents for policymakers. But as one mostly outside the "consensus", I can not agree, and I am far, far from being alone in that disagreement. I say this as a working-stiff climate scientist who builds datasets from scratch to create understanding and test assertions about the climate system. The process followed in the Fourth Assessment, in my view, simply did not provide to the world the true ambiguities, uncertainties and contentions of our fledgling science.

In summary, to me, the impediments to providing a more honest expression of our science to the world in the current IPCC process are (1) Lead Authors essentially having final review authority, (2) the Lead Author selection process which encourages government-approved, homogeneity-of-thought,

and (3) the limited size, the dead-line character, and the past-expiration-date of printed documents. Thank you.

ChristyJR Appendix A

Appendix A

Response to National Research Council for IPCC TAR Comments
John R. Christy

21 May 2001

Vaughan:
I suspect I will have a slightly different view on the SPM, TS and TAR Text of the IPCC than most other participants on the list.

I believe the IPCC effort was a good effort, but not a perfect effort. ~~Attached is the text of an op-ed piece I was asked to write by the Atlanta Journal-Constitution who stated to me they (the paper) felt manipulated by the aggressive media push of certain of the IPCC leaders. The op-ed appeared on 11 March 2001. Note that in general I thought the IPCC body of work (main text) was fine, but that the media reports were not.~~

Here are three issues that specifically concern me regarding your message.

1. 1000-year temperature record

This first concern arises from our chapter (2) for which I must accept as much blame as anyone. We (chapter 2 authors) are guilty of omitting information that indicated the temperature history of the past 1000 years is not as well known as is implied by the prominent figure in the SPM (Fig. 1) and TS (Fig.5). At each of the Lead Authors meetings I pointed out that we should include mention of publications which strongly suggest the medieval warm period was warmer than the current century. In particular I mentioned the Dahl-Jensen et al. 1998 Science paper which I believe presents the most direct measurement of temperature and thus should be highlighted. Broeker (2001, SCIENCE) echoed the very concerns I had put forward in our meetings. In the final version of the text the Dahl-Jensen paper was not even cited in Section 2.3 - a fact I did not realize until last week when I read the report in detail (2.3 is the section on the temperature record of the past 1000 years.) Thus, its information was not carried forward in the TS or SPM. (The paper is only mentioned in passing regarding the warming 8 kybp in the TAR.) I should point out that the final wording concerning the warmth of the 1990's and 1998 as "likely" the warmest of the past millennium (i.e. only 2/3 chance of being correct) tried to account for the lack of certainty in our knowledge of past temperatures. However, the very prominent placement of the time series of the last 1000 years in the TS and SPM overrules what tentativeness some of us actually intended. This is my personal view.

2. Model confidence

Secondly, I view the whole modeling effort with more skepticism than most, perhaps because I do not receive funding to produce model results. Each global modeling group has had 20 years to look at the global surface temperature record and devise clever ways to reproduce what is in the record. This is "a posteriori" science in my view. No one has from first principles actually reproduced the record. The sulfate hypothesis is highly uncertain (as indicated by the IPCC itself) yet has become a critical component of modeling efforts in order to hold down the unrealistic temperature rise most models produce for the past century. Too, models have not reproduced the observed surface-tropospheric differential temperature trends (especially in the tropics), yet now are trying to do so. I'm somewhat confident that a model result will appear soon that announces a reproduction of the differential trend observations - but will it be based on correct physics? Modelers are

working to reproduce observations, and when a match is finally constructed, the insinuation is that the models are successful. In my view, this procedure is not a scientific success as much as an exercise in curve-fitting. Do we know whether the "match" is correct for the right reasons? I generally am comforted by the many references to uncertainty that the TAR contains. The magnitudes of those uncertainties do not convince me that the "science is settled" as several IPCC authors have stated (please define what "science" is settled!) or that we know what policy road to take.

3. SPM representation of surface/troposphere issue

Though I was the Lead Author of the discussion of the upper air temperature data, I was not able to influence a few phrases and statements in the SPM which appeared in the final version. For example, the following is a bullet from the SPM:

The lowest 8 kilometres of the atmosphere and the surface are influenced differently by factors such as stratospheric ozone depletion, atmospheric aerosols, and the El Nino phenomenon. ... In addition, spatial sampling techniques can also explain some of the differences in trends, but these differences are not fully resolved.

I do not believe these explanations have been objectively demonstrated in terms of explaining the trend differences between the surface and troposphere. Nearly all of the discrepancy in trends is found in the tropics. However, in the tropics there is the least amount of ozone depletion (some tropical regions actually show no decrease or a slight increase). And, the stratosphere (16 km and above) is separated by an 8 km layer from the lower troposphere (0 - 8 km), thus little influence would be expected. Too, examination of individual tropical sondes (which have maintained consistent instrumentation) shows the lower troposphere (850-500 hPa) has cooled relative to the upper troposphere. Thus, ozone depletion does not rise to more than speculation as a cause for the trend differences.

The aerosol effect is as yet an unproven hypothesis, and it is unclear that it has much influence at all in the tropics - again speculation. Michaels and Knappenberger (2000) have shown that the El Nino phenomenon has actually influenced the lower troposphere to warm relative to the surface, thanks to the 1997-98 event, not cool as suggested by the SPM above.

The statement that "spatial sampling techniques can also explain some of the differences" is less than fully accurate. The tropospheric data are fully global, thus spatial sampling errors apply to surface temperatures only. However, left as it is in this section the insinuation could be that the tropospheric data are suspect. The most substantive statement in this bullet is the last phrase, "... but these differences are not fully resolved."

In summary, my personal view is that there is a "spin" placed on some of the statements that "leads the witness" toward a conclusion that is not entirely justified. I found this also in many of my discussions with authors from the other chapters. I had a feeling of discomfort in trying to express a view that would diminish the human-related climate paradigm.

Overall, the interactions among the Lead Authors in Chapter 2 were quite open and congenial, and we produced a good document (now outdated a bit) but not a perfect document.

John C.

Vaughan Turekian wrote:

ChristyJR Appendix A

As you may know, the National Academies is conducting a fast-track study to examine a number of key questions about the science of climate change. As part of this study the committee requires information regarding the IPCC WG I report and summary preparation process. Owing your involvement in the IPCC WG I process, you may be able to provide some needed insight. Specifically, do you feel that the WG I SPM and the TS accurately reflected the information in the main body of the WG I report? Were there any instances where the WG I SPM (or the TS) did not accurately convey the information in the WG I report, or do you know of any situation where the body of the WG I report was altered to justify statements in the SPM or the TS?

Please note that any written response to these questions will be included in the study's public access file. If you would prefer to discuss this by phone, please provide contact information.

I thank you in advance for your help on this and look forward to your input. If you have any questions please do not hesitate to contact me.

Vaughan

Vaughan C. Turekian, Ph.D. Program Officer Board on Atmospheric Sciences and Climate The National Academies 202-334-3512 vturekia@nas.edu

--

****
John R. Christy
Director, Earth System Science Center voice: 256-961-7763
Professor, Atmospheric Science fax: 256-961-7751
Alabama State Climatologist
University of Alabama in Huntsville
http://www.atmos.uah.edu/atmos/christy.html
Mail: University of Alabama in Huntsville, Huntsville AL 35899 Express: NSSTC/ESSC 320 Sparkman Dr., Huntsville AL 35805

ChristyJR Appendix A

Appendix B

Presentation at IPCC Lead Author's Meeting
Honolulu Hawaii

Can the IPCC Allow a Section of Alternative Views Authored by Equally Credentialed Climate Scientists?

John R. Christy
University of Alabama in Huntsville

I want you all to understand this: No one is holding a gun to my head and no one is paying me money either above or under the table to arrive at the conclusions I (and others) have come to. I propose that the IPCC allow for well-credentialed climate scientists to craft a chapter on an alternative view presenting evidence for low climate sensitivity to greenhouse gases than has been the IPCC's recent message – all based on published information.

In other words, I am proposing that the AR5 be a true Scientific Assessment, not a document designed for uniformity and consensus. In a scientific area as uncertain as climate, the opinions of all are required.

Three quick examples are on the poster.

First, the iconic mean surface temperature is a poor proxy for detecting greenhouse gas influences for reasons shown. And, this metric is not well-observed in any case.

Secondly, many of the so-called metrics of human-induced climate change are not changing at rates policymakers have assumed and the media promotes with the indulgence of the IPCC Leadership. And,

other variables showing change are still within the magnitudes of long-term natural variations.

Thirdly, confidence that the climate system is highly sensitive to greenhouse gases can been shown to be overstated due to assumptions about how the sensitivity is calculated. Latest measurements clearly suggest a strong negative feedback in the short wave – in other words, in warming episodes, clouds respond to cool the climate. Another problem with popular sensitivity estimates is the dependence on essentially one century of an oblique greenhouse-proxy (mean surface temperature) combined with the notion that all of the natural, multi-decadal variability can be defined so accurately that the left-over warming is assumed to be human-induced. The investigation rather should examine all levels of natural variability that have been observed and seek to defensibly eliminate those as possible causes.

An alternative view is necessary, one that is not censured for the so-called purpose of consensus. This will present to our policymakers an honest picture of scientific discourse and process. I submit this proposal because our level of ignorance of the climate system is still enormous and our policymakers need to know that. We have much work to do.

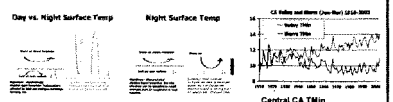
An *Alternative View* Proposal for IPCC AR5

John R. Christy, University of Alabama in Huntsville

ChristyJR Appendix A

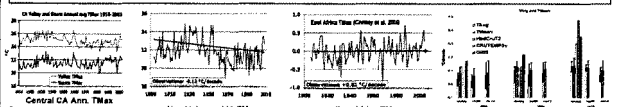
Mean Surface Temperature: a Poor Metric for measuring response of climate to enhanced GHGs

TMean = (TMax + TMin)/2. TMin is heavily influenced by surface development and changing atmospheric constituents over time. The thermal radiation budget and boundary-layer mixing altered by these changes, introduce higher temperatures. TMax, though not perfect, is better since its spatial mixing scale is much larger.



Central CA TMin
Developed (Valley) vs. Non-developed (Sierra)

"Super-sampled" regions generate TMax temperature trends near zero while under-sampled methods using TMean (e.g. GISS, HadCRUT, NCDC) do not. Thus TMean overstates the warming rate by (1) using TMin and (2) using too few stations.



Central CA Ann. TMax (Compare with TMin above right)

No. Alabama JJA TMax

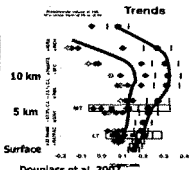
East Africa TMax

East Africa TMean (more stations give less warming)

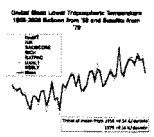
Christy, 2002, Christy et al. 2006, Christy et al. 2007, Walters et al. 2007, Pielke Sr. et al. 2007, Christy et al. 2009

Modeled climate change temperatures inconsistent with observed changes

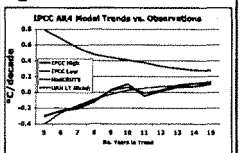
When climate models generate the same tropical surface trend value as the observed tropical sfc temperature trend (below left), their upper air trends are significantly different from observations where GHG signal is largest. Global tropospheric temperature trends of the IPCC mid-range estimate (below right) are significantly higher than the mean of observations from seven sources.



Douglass et al. 2007
Red: IPCC Best Estimate
Blue: Observations Estimate



IPCC Best Estimate 0.22-0.27 °C/decade for troposphere vs. Observations of +0.14.

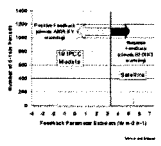


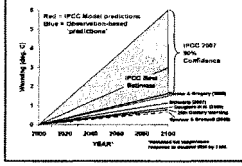
Projections of 21 A1B IPCC Climate models' global trends for segment lengths shown (ending in model year 2020 and observation year 2008, HadCRUT3 and UAH LT - sfcAdj). Models' 95% range bounded by red (high) and orange (low). Results show observations are well below the "best estimate" (+0.20°C/decade) and along the edge of the "significantly different" region. Adapted from P. Michaels.

Climate sensitivity to CO2 Forcing too high in Climate Models

(Left) Hansen projected 3 scenarios in 1988, 2 of which (red, orange) had slightly lower GHG emissions than actually observed over the next 20 years, and one with drastically lower emissions ( ). The climate sensitivity of the model was so high that all three scenarios, even the one with sharp cuts in emissions, significantly overshot the observations (lower tropospheric temperatures adjusted for surface comparisons, CCSP 1.1 2006)

(Right) Longwave (LW) and shortwave (SW) feedback parameters (W/m²/K) were calculated for all 5-year periods from 18 IPCC AR4 transient simulations, and also from 5 years of Aqua CERES data. The satellite diagnosis indicated positive LW feedback, right in the middle of the model distribution of similarly computed feedbacks. But the observed reflected solar SW feedback was strongly negative, well outside the range of all 5-year SW feedbacks computed from the models. The total feedback parameter (seen here) is then the sum of both (LW+SW) individual parameters, which is also outside the range of all total feedbacks computed from the models.





(Left) The range of solutions from the IPCC AR4 climate model simulations (pink). Empirically calculated model projections and current observed trend (blue) which by implication factor in the negative feedbacks of cloud responses. The rate of warming in these empirical models is much lower than the full blown coupled models.

Summary: An *Alternative View Section* written by well-credentialed climate scientists is needed in the IPCC AR5

If not, why not? What is there to fear?

nature Vol 463|11 February 2010

OPINION

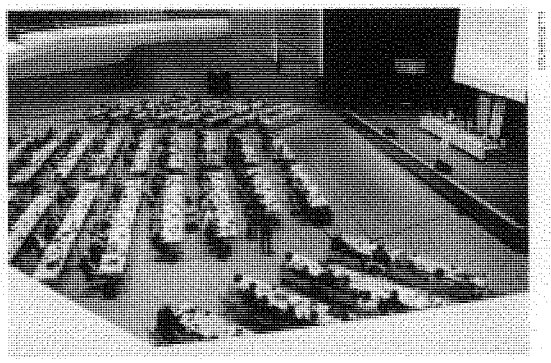
ChristyJR Appendix A

IPCC: cherish it, tweak it or scrap it?

As calls for reform intensify following recent furores about e-mails, conflicts of interest, glaciers and extreme weather, five climatologists propose ways forward for the Intergovernmental Panel on Climate Change. Their suggestions range from reaffirming the panel's governing principles to increasing the number and speed of its publications to replacing the volunteer organization with a permanently staffed structure.

Split into three panels

Mike Hulme
Coordinating lead author, lead author, review editor (AR3), University of East Anglia, Norwich, UK



An IPCC meeting: the panel will publish its Fifth Assessment Report (AR5), in 2014.

Much has changed since the late 1980s when the Intergovernmental Panel on Climate Change (IPCC) was designed, notably the nature of scientific practice and its relationship with society. How the world's knowledge communities are mobilized to enlighten policy deliberations also needs to be different. The assessments published by the IPCC have firmly elevated anthropogenic climate change to one of the major international political issues of our time. But they have made this impact by drawing in an ever-widening subset of the social, technological, environmental and ethical dimensions of climate change — well beyond the physical sciences.

The IPCC is no longer fit for purpose. It is not feasible for one panel under sole ownership — that of the world's governments, but operating under the delegated management of the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) — to deliver an exhaustive 'integrated' assessment of all relevant climate-change knowledge. As I remarked three years ago in these pages, "The IPCC needs a complete overhaul. The structure and process are past their sell-by dates."

"A new class of short, rapidly prepared, peer-reviewed reports is needed."

My suggestion for radical reform is to dissolve the IPCC after the Fifth Assessment Report (AR5) in 2014. The work would be split into three types of assessment and evaluation, each rather different to the three existing IPCC working groups.

The first would be a Global Science Panel (GSP). An IPCC-like assessment process should continue to operate for the physical sciences that observe and predict the Earth system. Rather than comprehensive reports every six years, this panel would commission, on a rolling basis, a larger number of smaller, sharply focused syntheses of knowledge on fast-moving topics that have great scientific or policy salience. Perhaps two or three would be in production at any one time and each would be no more than 50 pages in length. These would need to be globally coordinated and could be governed either through an intergovernmental process as now, or devolved to a governing council of representative national academies of science.

The second group would be made up of Regional Evaluation Panels (REPs). The cultural, social, economic and development dimensions of climate change are essentially regional in nature. Each region — five to ten continental or subcontinental regions in all — should conduct its own evaluation of relevant knowledge. This should use the work of the GSP, but also draw in a much more diverse set of expertise, knowledge and scholarship. As well as being structured according to the concerns of each region, the ownership and governance patterns of these REPs would vary regionally, but should ideally involve a consortium of national governments, civil-society organizations and businesses.

The third group would be the Policy Analysis Panel (PAP) — a standing panel of expertise, global in reach, with interdisciplinary skills and a diverse analytical capacity. Perhaps 50–100 strong, this panel would undertake focused and rapid (6–12 months) analyses of specific proposed policy options and measures that have global significance. These could be subjects such as environmental effectiveness of controlling black carbon, economic implications of carbon border tariffs or new financing options for reducing emissions from deforestation. The policy options to be analysed can be brought forward by UN bodies, non-governmental organizations (NGOs), businesses and groupings of national governments. The PAP could be governed by a council of women and men of international stature and strong cultural significance to represent the breadth of civil society around the world. Such high quality and transparent policy evaluation would broaden the options available

for national and international deliberations.

This restructuring would allow clearer distinctions to be made in areas that have been troublesome for the IPCC: assessments of published knowledge versus policy analysis and evaluation; the globalized physical sciences versus more geographically and culturally nuanced knowledge; a one-size, top-down model of ownership and governance versus more inclusive, representative and regionally varying forms of governance. It would better serve the world, and its peoples, in understanding and responding to anthropogenic climate change.

Independent agency needed

Eduardo Zorita
Contributing author (AR4), GKSS Research Center in Geesthacht, Germany

Like the financial sector last year, the IPCC is currently experiencing a failure of trust that reveals flaws in its structure. This presents the climate-change community with the opportunity to address these faults. The IPCC currently performs as a diffuse community of government-nominated academic volunteers occupying a blurred space between science and politics, issuing self-reviewed reports under great stresses and unmanageable deadlines. Its undefined structure puts it at the mercy of pressure from advocates.

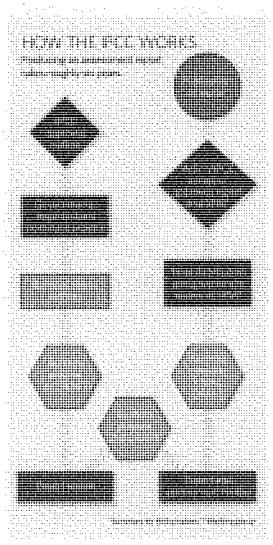
The IPCC should be made stronger and independent. We do not need to reinvent the wheel; there are excellent examples of agencies that society has set up when credibility is of the utmost importance. The European Central Bank, the International Atomic Energy Agency (IAEA), the International Energy Agency and the US Congressional Budget Office all independently navigate their way through strong political pressures, delivering valuable assessments, advice, reports and forecasts, tapping academic research when necessary. These agencies are accountable and respected.

An international climate agency (ICA) along such lines would have a staff of around 200 full-time scientists who would be independent of government, industry and academia. Such an agency should be resourced and empowered to do the following: issue streamlined biennial state-of-the-climate reports; be a repository and quality-controller of observational climate data; advise governments on regional assessments of climate impacts; and coordinate the suite of future-climate simulations by research institutes.

An ICA could be built, for instance, on the IAEA template, encompassing many more countries than the IAEA but with a smaller staff. ICA reports should be independently reviewed in a transparent process, draw only on established, peer-reviewed literature, and highlight research gaps. External reviews would then be incorporated into the reports to form white papers to include possible opposing views in a transparent way.

The process of moving towards such an ICA could start now, alongside the preparation of the next IPCC assessment report, and culminate after its completion. Those climate researchers in the IPCC Bureau who have widely recognized credibility could initiate this transformation, supported by lead authors and review editors more numerous and with a bigger say than presently. These review editors should be elected not by governments but directly by scientific unions, for instance the American Geophysical Union, the European Geosciences Union and similar associations from Asia.

As with finance, climate assessment is too important to be left in the hands of advocates.



SOURCE: IPCC

Apply best practice rules

Thomas F. Stocker
Co-chair IPCC Working Group I (AR5), coordinating lead author (AR3, AR4), University of Bern, Switzerland

The basis of the IPCC is the voluntary contributions of thousands of dedicated scientists from all over the world. The *Principles Governing IPCC Work* (IPCC, 1998) provide a clear framework for an open, transparent and robust process. This bottom-up endeavour is a unique model of providing scientific information, mainly from the peer-reviewed scientific literature, for decision-making on a challenging problem. It has worked extremely successfully for the past 21 years.

Recent controversies have demonstrated both the value and the limitations of these procedures. The team structure of the chapter authors, the multiple reviews by peers and governments, and the full and public documentation of this process largely eliminate personal views or biases in the science assessment. But procedures are only as strong as their enforcement at all levels of the assessment process. When I served as a coordinating lead author of Working Group I in the Third and Fourth Assessment Reports (AR3 and AR4), I was deeply impressed by the strict adherence to these principles by the co-chairs who ensured that these standards were applied at all levels. The combination of the best scientists and clear procedures constitute the authority of the IPCC.

Calls for reform of the IPCC have been made before. Changes were discussed after the completion of the Fourth Assessment Report in 2007. One possibility mooted was the production of more frequent assessments, more limited in scope. Fast-track assessments in support of the United Nations Framework Convention on Climate Change process were also considered. However, the panel concluded that the production of comprehensive reports roughly every six years is preferable because it ensures the robustness required for a thorough and rigorous assessment. Faster turnover would jeopardize the multi-stage review and thus compromise authority and comprehensiveness. In asking scientists to produce reports and assessments every year, say, we could lose their support rather quickly.

The IPCC has served as an honest broker in the past and will do so, hopefully, in the future. Now that the problem of climate change is on the

radar screen of the world, there are many NGOs and other groups, even groups of scientists and institutions, that provide climate-change information in various forms and quality, often lacking comprehensiveness and proper recognition of uncertainties. There is a strong pressure to provide 'just-in-time' scientific updates for policy-makers and stakeholders, as was the case in the preparations for the 2009 climate-change conference in Copenhagen. The IPCC must not yield to this pressure.

In this field of different and divergent forces, confusion may arise. An honest broker therefore is an asset. From my perspective, the IPCC has fulfilled this role with remarkable rigour and integrity. This role is now at risk, as the stakes are higher than ever before. The requirement that assessments are policy relevant but never policy prescriptive, as formulated in the *Principles Governing IPCC Work*, is of paramount importance. Our task is to inform the policy-makers and the public strictly in a 'what if' mode. Any other approach must be left to NGOs, negotiators or individuals. Only with strict adherence to procedures and to scientific rigour at all stages will the IPCC continue to provide the best and most robust information that is needed so much.

Produce more reports faster

Jeff Price
Lead author (AR3, AR4), director, climate-change adaptation, WWF United States

The IPCC is accepting nominations (until 12 March 2010) from governments and participating organizations for authors for its Fifth Assessment Report. One recommendation for the IPCC that could be implemented immediately is in how its coordinating lead authors and review editors are selected.

Currently, authors are selected to represent "a range of views, expertise, gender and geographical representation". However, given the importance placed on these assessments, the most senior positions should be filled by the nominees most expert in their field, regardless of balance. These authors should be the most knowledgeable nominee about the range of topics in their chapter, best able to cooperatively work with a team of international scholars. Preferably, they should have previously been involved in an IPCC assessment and be familiar with IPCC standards and methodologies. Geographic and gender balance should then be used in selection of lead authors. The level of work required in preparing an assessment is large. Increasing the number of lead authors would provide better balance and give more scientists the ability to participate in the process.

A new class of short, rapidly prepared, peer-reviewed reports is also needed. At present, publication options include supplemental material (no peer review required), technical papers (based on existing assessments) or assessments and special reports that undergo two reviews (expert and government/expert, usually taking more than two years to complete). For topics of emerging importance or uncertainty, we need reports based on expert meetings and literature synthesis that undergo only a single round of extensive peer review with review-editor oversight before publication. The IPCC should also expand the number of specialist task forces, task groups and hold more expert meetings to provide additional scientific review and oversight for the broadening array of models (including model comparisons and validation) and methodologies used in emissions reporting, estimating and monitoring impacts, and in developing assessments and adaptation plans.

Finally, the current period between assessments is too long. One option would be for the IPCC, or another body, to produce an annual review, assessment and synthesis of the literature for policy-makers (for example, three annual review volumes with a synthesis chapter in each volume) prepared by experts in the field. Although the editors of the volumes should ideally be drawn from past IPCC authors and editors, the review articles could be submitted by any author, as they would for a journal, with appropriate peer review and assessment for publication.

Open debate: Wikipedia-style

John R. Christy
Lead author (AR3), University of Alabama in Huntsville, USA

Since 1992 I have served as an IPCC contributor and in 2001, as a lead author. My experience has left me of the firm conviction that the IPCC should be removed from UN oversight.

The IPCC selects lead authors from the pool of those nominated by individual governments. Over time, many governments nominated only authors who were aligned with stated policy. Indeed, the selections for the IPCC Fourth Assessment Report represented a disturbing homogeneity of thought regarding humans and climate.

Selected lead authors have the last word in the review cycle and so control the message, often ignoring or marginalizing dissenting comments. 'Consensus' and manufactured-confidence ensued. The recent leaking of e-mails from the Climatic Research Unit at the University of East Anglia in Norwich, UK, put on display the unsavoury cycle of marginalizing different viewpoints. Now several errors of overstatement, such as that of the melting rate of the Himalayan glaciers, have been exposed.

Unfortunately, prestigious media, including *Nature*, became cheerleaders for these official reports, followed then by governments trying to enact policies that drastically reduced emissions to 'stop global warming' while increasing energy costs.

I recommended last year that the next IPCC report invites published authors to write about the evidence for low climate sensitivity and other issues. The IPCC then would be a true reflection of the heterogeneity of scientific views, an 'honest broker', rather than an echo chamber. My recommendation assumed a business-as-usual IPCC process.

However, voluminous printed reports, issued every six years by government-nominated authors, cannot accommodate the rapid and chaotic development of scientific information today. An idea we pitched a few years ago that is now worth reviving was to establish a living, 'Wikipedia-IPCC'. Groups of four to eight lead authors, chosen by learned societies, would serve in rotating, overlapping three-year terms to manage sections organized by science and policy questions (similar to the Fourth Assessment Report). The authors would strike a balance between the free-for-all of true science and the need for summary statements.

Controversies would be refereed by the lead authors, but with input from all sides in the text, with links to original documents and data. The result would be more useful than occasional big books and would be a more honest representation of what our fledgling science can offer. Defining and following rules for this idea would be agonizing, but would provide greater openness.

The truth, and this is frustrating for policy-makers, is that scientists' ignorance of the climate system is enormous. There is still much messy, contentious, snail-paced and now, hopefully, transparent work to do. ■

See also Perspectives, page 747.
Have your say on the future of the IPCC at go.nature.com/orzWau.

ChristyJR Appendix B

UNIVERSITY of GUELPH

DEPARTMENT OF ECONOMICS
College of Management and Economics
University of Guelph
Guelph Ontario, Canada N1G 2M5
(519) 824-4120 Ext. 52532
http://www.uoguelph.ca/~rmckitri/ross.html
rmckitri@uoguelph.ca

Ross McKitrick, Ph.D.
Professor

March 9, 2011

To: Rep. Ed Whitfield, Chair Energy and Power Subcommittee
cc: Rep. John Sullivan, Vice Chair Energy and Power Subcommittee
Rep. Fred Upton, Chair Energy and Commerce Committee
Rep. Joe Barton, Chairman Emeritus Energy and Commerce Committee
Rep. Steve Scalise
Rep. Morgan Griffith

Re. Technical Problems with the EPA Endangerment Finding

Dear Mr. Whitfield

I understand your committee is considering legislation to limit the EPA's ability to regulate greenhouse gases. I believe that the review process leading to the EPA Endangerment Finding was flawed, and I am writing to provide information that may be pertinent to your deliberations.

In its Proposed Endangerment Finding of April 2009 (74 FR 18886) regarding greenhouse gases, the Environmental Protection Agency stated that it relied primarily on the work of the Intergovernmental Panel on Climate Change, and the US Climate Change Science Program:

> The [EPA] therefore relies most heavily on the major assessment reports of both the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Climate Change Science Program (CCSP). EPA took this approach rather than conducting a new assessment of the scientific literature. The IPCC and CCSP assessments base their findings on the large body of many individual, peer reviewed studies in the literature, and then the IPCC and CCSP assessments themselves go through a transparent peer review process.
> (EPA p. 46)

Likewise in the December 2010 version of the Endangerment Finding the EPA reiterates its reliance on IPCC Reports:[1]

[1] http://www.epa.gov/climatechange/endangerment/downloads/Federal_Register-EPA-HQ-OAR-2009-0171-Dec.15-09.pdf

> However, the Administrator is relying on the major assessments of the USGCRP, IPCC, and NRC as the primary scientific and technical basis of her endangerment decision for a number of reasons. (FR 74 page 66510)

The EPA Administrator claims the material therein is subject to a review process even more rigorous than that for academic journals.

> Fourth, these assessment reports undergo a rigorous and exacting standard of peer review by the expert community, as well as rigorous levels of U.S. government review and acceptance. Individual studies that appear in scientific journals, even if peer reviewed, do not go through as many review stages, nor are they reviewed and commented on by as many scientists. The review processes of the IPCC, USGCRP, and NRC (explained in fuller detail in the TSD and the Response to Comments document, Volume 1) provide EPA with strong assurance that this material has been well vetted by both the climate change research community and by the U.S. government.
> (FR 74 page 66511).

I was an expert reviewer for the IPCC Fourth Assessment Report. I explain herein two incidents that show the EPA's views of the IPCC process to be, at best, naïve. One concerns insertion of apparently fabricated evidence within the IPCC report regarding the quality of the surface temperature data, and another concerns deletion of peer-reviewed evidence about the uncertainty of global warming trends. In both cases the IPCC review process was subverted by making the text changes outside the expert review process. I submitted information on both items[2] to the EPA in response to the Advanced Notice of Proposed Rulemaking (a-and-rDocket@epa.gov, November 24, 2008) but, as I will show, the EPA failed to respond adequately to either matter.

To preface, the EPA reliance on the IPCC has already been put into question by the findings in the Inter-Academy Council's (IAC) August 2010 Report.[3] Human health and welfare impacts of climate change are discussed in the Working Group II volume of the IPCC Report, which has been widely discredited due to its extensive reliance on non peer-reviewed literature and its unsubstantiated conclusions. The IAC noted:

> The Working Group II Summary for Policy Makers in the Fourth Assessment Report contains many vague statements of "high confidence" that are not supported sufficiently in the literature, not put into perspective, or are difficult to refute.
> (IAC p. 37)

And

> Many of the 71 conclusions in the "Current Knowledge about Future Impacts" section of the Working Group II Summary for Policy Makers are imprecise statements made without reference to the time period under consideration or to a climate scenario under which the conclusions would be true....In the Committee's view, assigning probabilities to imprecise statements is not an appropriate way to characterize uncertainty. If the confidence scale is used in this way, conclusions will likely be stated so vaguely as to make them impossible to refute, and therefore statements of "very high confidence" will have little substantive value.
> (IAC pp. 33-34).

---

[2] My submission is online at http://rossmckitrick.weebly.com/uploads/4/8/0/8/4808045/epa-anprsubmission.pdf.
[3] http://reviewipcc.interacademycouncil.net/report.html

ChristyJR Appendix B

My comments pertain to Working Group I, for which I served as an expert reviewer.

1. Reliance on Apparently Fabricated Evidence Concerning Problems in Surface Temperature Data Contamination

The EPA relied on conclusions from IPCC modeling work as the basis of its scientific findings. They stated (April 2009 document, p. 59):

> Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Global observed temperatures over the last century can be reproduced only when model simulations include both natural and anthropogenic forcings, that is, simulations that remove anthropogenic forcings are unable to reproduce observed temperature changes.

This statement pre-supposes that there are no biases or contamination problems in the surface temperature record. In the April 2009 Technical Support Document (TSD) accompanying the Endangerment Finding, the EPA dismissed evidence of problems in the surface temperature record as follows (p. 22):

> Biases may exist in surface temperatures due to changes in station exposure and instrumentation over land, or changes in measurement techniques by ships and buoys in the ocean. It is likely that these biases are largely random and therefore cancel out over large regions such as the globe or tropics (Wigley et al., 2006). Likewise, urban heat island effects are real but local, and have not biased the large-scale trends (Trenberth et al., 2007).

Wigley et al. (2006) is a reference to the 2006 Climate Change Science Program Report "Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences" which did not address evidence of problems in surface temperature records in detail. Trenberth et al. (2007) is a reference to Chapter 3 of the 2007 IPCC Report. At the time of the report's preparation, evidence had been published by two independent teams (of which I was a coauthor on one) in high-quality peer-reviewed journals[4] showing statistically significant evidence that contamination in the surface temperature record due to industrialization and related land-use effects had not been adequately removed from climatic data sets and it added a clear warming bias.

One of the Climategate emails is from IPCC Author Phil Jones to his colleague Michael Mann on July 8 2004, in which Jones confides that he and IPCC coauthor (Kevin) Trenberth were determined to keep this evidence out of the IPCC Report:

> "The other paper by MM is just garbage. [...] I can't see either of these papers being in the next IPCC report. Kevin [Trenberth] and I will keep them out somehow — even if we have to redefine what the peer-review literature is!"

[4] De Laat, A.T.J., and A.N. Maurellis (2004), Industrial CO_2 emissions as a proxy for anthropogenic influence on lower tropospheric temperature trends, *Geophys. Res. Lett.* Vol. 31, L05204, doi:10.1029/2003GL019024. McKitrick, R.R. and P. J. Michaels (2004), A test of corrections for extraneous signals in gridded surface temperature data, *Climate Research* 26(2) pp. 159-173, Erratum, *Clim. Res.* 27(3) 265—268. De Laat, A.T.J., and A.N. Maurellis (2006), Evidence for influence of anthropogenic surface processes on lower tropospheric and surface temperature trends, *Int. J. Climatol.* 26:897—913.

ChristyJR Appendix B

Consistent with that plan, all mention of the studies in question were kept out of drafts shown to reviewers. Then after the close of expert review a paragraph was inserted into the IPCC chapter that misrepresented the findings in the publications and made empirical claims with no supporting evidence:

> McKitrick and Michaels (2004) and De Laat and Maurellis (2006) attempted to demonstrate that geographical patterns of warming trends over land are strongly correlated with geographical patterns of industrial and socioeconomic development, implying that urbanisation and related land surface changes have caused much of the observed warming. **However, the locations of greatest socioeconomic development are also those that have been most warmed by atmospheric circulation changes (Sections 3.2.2.7 and 3.6.4), which exhibit large-scale coherence. Hence, the correlation of warming with industrial and socioeconomic development ceases to be statistically significant.** In addition, observed warming has been, and transient greenhouse-induced warming is expected to be, greater over land than over the oceans (Chapter 10), owing to the smaller thermal capacity of the land.
>
> (IPCC 2007 Chapter 3 page 244, cited by the EPA as Trenberth et al. 2007, emphasis added).

The first highlighted sentence is false: neither of the cited report sections address the topic or show any information on the spatial pattern of industrialization or its overlap with the warming record. The second highlighted sentence is a fabrication. Both papers reported statistically *significant* correlations between warming patterns and the spatial distribution of industrialization; neither one offered any evidence that these results could be attributed to natural atmospheric circulation changes, nor does the IPCC present any such evidence, nor does any such evidence exist. In a 2010 paper, published in a peer-reviewed statistics journal, I specifically tested the IPCC's conjecture and showed it to be untrue:

- McKitrick, Ross R. (2010) "Atmospheric Oscillations do not Explain the Temperature-Industrialization Correlation." *Statistics, Politics and Policy*, Vol 1 No. 1, July 2010

I cited a preliminary copy of this paper to the EPA in my comment on the ANPR. Consequently, in this regard, the EPA's conclusions regarding the integrity of the surface temperature record can be shown to depend entirely on IPCC material that was fabricated and which was kept out of drafts shown to peer-reviewers—something which the Climategate emails showed not to have been inadvertent.

The EPA relied verbatim on the IPCC fabrication quoted above in its dismissal of comments on the Endangerment finding:

> Commenters also point to recent papers (e.g., McKitrick and Michaels, 2007; de Laat and Maurellis, 2006) that attempt to demonstrate that geographical patterns of warming trends over land are strongly correlated with geographical patterns of industrial and socioeconomic development, implying that urbanization and related land surface changes have biased the temperature trends (and are, therefore, the cause of much of the observed warming). In the case of de Laat and Maurellis (2006) and an earlier paper by McKitrick and Michaels (2004), IPCC (Trenberth et al., 2007) assessed these papers and noted that the locations of greatest socioeconomic development coincided with those most warmed by atmospheric circulation changes, which are not limited to urban areas but rather have large-scale coherence. When this is taken into account, IPCC concludes that the correlation of warming with industrial and socioeconomic development ceases to be statistically significant.
> http://www.epa.gov/climatechange/endangerment/comments/volume2.html#2

The last two sentences repeat uncritically the unsupported claims in the IPCC Report, which the EPA attributes to Trenberth et al. (2007). I should note that the IPCC claim was obviously an invention since it is presented with no supporting evidence and misrepresents the actual findings in the studies they cite. The EPA's failure to recognize this obvious fact is, in my view, prima facie evidence that their review of evidence was biased, cursory and inadequate.

In the years since publishing the second of my studies on this topic (McKitrick and Michaels 2007, cited by the EPA quotation above), a number of statistical criticisms have been advanced, chiefly in a 2009 paper by Gavin Schmidt of NASA, who made a series of claims about the reliability of our results without subjecting them to formal statistical modeling and testing. The EPA relied upon Schmidt's paper in another section of its rejection of comments on the Endangerment finding:

> Neither IPCC nor CCSP assess McKitrick and Michaels (2007) which conclude that "that non-climatic factors, such as those related to land use change and variations in data quality, likely add up to a net warming bias in climate data, suggesting an overstatement of the rate of global warming over land." However we note a recent study by Schmidt (2009) that finds "The reported correlations [in McKitrick and Michaels, 2007]...are probably spurious (i.e. are likely to have arisen from chance alone). Thus, though this study cannot prove that the global temperature record is unbiased, there is no compelling evidence from these correlations of any large-scale contamination."

It is noteworthy that the TSD cites Gavin Schmidt as an expert reviewer (p. ii) but not anyone from the other side of the debate, indicating a lack of diligence on their part in obtaining balanced information on this issue.

Schmidt's paper makes the quoted assertions without subjecting them to formal statistical testing. In a recent peer-reviewed paper I have tested Schmidt's conjectures and showed them to be unfounded. Specifically I show that the evidence of data contamination is consistent across multiple combinations of surface and satellite data, that it is not an artefact of statistical modeling, and that it cannot be replicated by climate models:

- McKitrick, Ross R. and Nicolas Nierenberg (2010) "Socioeconomic Patterns in Climate Data." *Journal of Economic and Social Measurement,* Vol 35 No. 3-4 pp. 149-175.

Consequently I submit that the EPA's consideration of this issue is at best inadequate and at worst based on fabricated evidence. The reality of problems in the surface temperature record fundamentally impair the conclusions about the magnitude of warming and its attribution to greenhouse gases, since the studies that support EPA findings on this either directly or indirectly presuppose the absence of any contamination problems in the surface temperature record.

In addition to submitting the above information to the EPA in response to its Advance Notice of Proposed Rulemaking, I made submissions on the above information to both the UK House of Commons Science and Technology Committee investigation and to the Muir Russell Review of the Climate Change Emails,[5] neither of which disputed or rebutted any of the information, but neither of which addressed the implications either.

[5] My submissions are online at http://rossmckitrick.weebly.com/climategate.html.

ChristyJR Appendix B

2. Deletion of Evidence on the Uncertainty of Warming Trends
One of the IPCC's most important topics is the measurement of modern warming trends. In the Second Order Draft of the Working Group I section of the Fourth Assessment Report, in the discussion of Table 3.2, which presents data on observed temperature trends at the global and hemispheric level, the following cautionary text was included on page 3-9 (emphasis added)

> Table 3.2 provides trend estimates from a number of hemispheric and global temperature databases. Determining the statistical significance of a trend line in geophysical data is difficult, and many oversimplified techniques will tend to overstate the significance. Zheng and Basher (1999), Cohn and Lins (2005) and others have used time series methods to show that **failure to properly treat the pervasive forms of long-term persistence and autocorrelation in trend residuals can make erroneous detection of trends a typical outcome in climatic data analysis.**

This paragraph was not in the First Order Draft and appears to have been inserted on the basis of technical comments received during expert review. There do not appear to have been any reviewer objections to this paragraph. A statement was also included in the Appendix of the Second Order Draft (p. 3-116) cautioning that the method used by the chapter authors to compute trends, called REML AR1, yields statistical significance levels that are "likely to be overestimated" (emphasis added):

> As some components of the climate system respond slowly to change, the climate system naturally contains persistence, so that **the REML AR1-based linear trend statistical significances are likely to be overestimated** (Zheng and Basher, 1999; Cohn and Lins, 2005). Nevertheless, the results depend on the statistical model used, and more complex models are not as transparent and often lack physical realism.

The draft of the IPCC Report that was circulated on July 3 2006 (immediately after the close of expert review) still included the statements about erroneous trend detection:

17
18 Table 3.2 provides trend estimates from a number of hemispheric and global temperature databases. Brohan
19 et al. (2006) and Rayner et al. (2006) provide uncertainties on annual estimates, incorporating the effects of
20 measurement and sampling error, and uncertainties regarding biases due to urbanization and earlier methods
21 of measuring SST. We take these into account, although ignoring their serial correlation. Determining the
22 statistical significance of a trend line in geophysical data is difficult, and many oversimplified techniques
23 will tend to overstate the significance. Zheng and Basher (1999), Cohn and Lins (2005) and others have used
24 time series methods to show that failure to properly treat the pervasive forms of long-term persistence and
25 autocorrelation in trend residuals can make erroneous detection of trends a typical outcome in climatic data
26 analysis (see more extensive discussion in Appendix 3.A).
27

This version of the text was an attachment to an email released to David Holland in the UK in response to his 2010 Environmental Information Regulation request to the University of Reading for the records of IPCC Review Editor Brian Hoskins.

In the version of the IPCC report that was released to the public ten months later, in May 2007, the statement warning of erroneous trend detection had been deleted, and replaced with the following (p. 242) (emphasis added):

ChristyJR Appendix B

> In Table 3.2, the **effects of persistence on error bars are accommodated** using a red noise approximation, which **effectively captures the main influences.** For more extensive discussion see Appendix 3.A

The text in the Appendix 3.A had been changed to the following (p. 336) (emphasis added):

> As some components of the climate system respond slowly to change, the climate system naturally contains persistence. Hence, the statistical significances of REML AR1-based linear trends **could be** overestimated (Zheng and Basher, 1999; Cohn and Lins, 2005). Nevertheless, the results depend on the statistical model used, and more complex models are not as transparent and often lack physical realism. Indeed, long-term persistence models (Cohn and Lins, 2005) have not been shown to provide a better fit to the data than simpler models.

Hence the changes made to the IPCC report after the close of peer review were as follows.

- A caution about the likelihood of erroneous detection of trends, that had been inserted based on information received during expert review, was deleted.
- An unsupported claim was inserted into the chapter (p. 242) claiming that the chapter authors' method (REML AR1) "effectively captures the main influences," despite the warming in the Appendix to the Second Order Draft that this method likely overestimated the significance of trends.
- A caution in the Appendix that "linear trend statistical significances are likely to be overestimated" was changed to say merely that they "could be" overestimated.
- A sentence was added to the Appendix disputing the validity of persistence models, with no supporting citations.

In sum, the IPCC deleted evidence pointing to uncertainties in their claims, and also falsified the review record insofar as they added text in response to expert review, then led reviewers to believe that it had been inserted, then deleted it after the reviewers had no further access to the text.

I described these alterations to the IPCC text in my submission to the EPA, but to the best of my knowledge they are not addressed in the responses to comments as posted online at http://www.epa.gov/climatechange/endangerment.html#comments.

3. New Evidence Concerning Model-Data Mismatch in the Troposphere over the Tropics

I also wish to draw your attention to a new paper, of which I am coauthor, regarding the tropical troposphere, that has direct bearing on a key claim relied upon by the EPA in its dismissal of some critical comments. The region in question is the vast section of atmosphere up to an altitude of 16 km, spanning 20 degrees North and South of the equator. The importance of this region is based on the fact that, ever since the first climate models were produced, and in all the modeling work done since, including for the IPCC in its 2007 Report, the theory of amplified greenhouse gas-induced warming implies that warming trends should reach a maximum there, specifically in the mid-troposphere over the tropics. A recent survey article by Thorne et al. (2011) summarizes the point as follows:

> "Since the earliest attempts to mathematically model the climate system's response to human-induced increases in greenhouse gases, a consistent picture of resulting atmospheric trends has emerged. The surface and troposphere (the lowest 8—12 km) warm with a local maximum trend in the upper levels in the tropics, while the stratosphere above cools."

The IPCC also emphasizes that,[6] according to climate model predictions, warming due to greenhouse gases reaches a maximum in the upper troposphere over the tropics, and that all model runs suggest this pattern ought to be observable in current data.

But there is considerable empirical evidence that no such warming "hotspot" has been observed since the advent of satellite monitoring in 1979. Many commenters on the EPA Endangerment Finding pointed to the empirical evidence that the combined records from weather balloons and satellites does not support the model predictions of amplified warming in the tropical troposphere.[7] A significant discrepancy between models and observations on this point would imply a major failure on the part of climate models, directly undermining the soundness of, among other things, the EPA's position. Indeed the 2006 CCSP Report on surface and satellite records, mentioned above, pointed to this problem, as follows:

> A potentially serious inconsistency, however, has been identified in the tropics. Figure 4G shows that the lower troposphere warms more rapidly than the surface in almost all model simulations, while, in the majority of observed data sets, the surface has warmed more rapidly than the lower troposphere. In fact, the nature of this discrepancy is not fully captured in Fig. 4G as the models that show best agreement with the observations are those that have the lowest (and probably unrealistic) amounts of warming.
> (Wigley et al. 2006, p. 11)

In 2007, papers by two teams of authors (Christy, Norris, Spencer and Hnilo, and Douglass, Christy, Pearson and Singer) showed that observed data sets contained much less warming than even the lowest model-based predictions. The Douglass et al. paper specifically asserted that the model-data discrepancy is statistically significant. The EPA Response to comments on the Endangerment Finding (3-7) reveals some hesitation on their part concerning this matter:

> EPA is aware of the emerging literature on this issue and the challenges in identifying the anthropogenic fingerprint in the tropics. The TSD's characterization of this issue is consistent with the assessment literature as well as the most recent studies, which find that when uncertainties in models and observations are properly accounted for, newer observational data sets are in agreement with climate model results.

The new study, of which I was coauthor, specifically rebuts the latter statement.

The EPA responds to the evidence in the Douglass et al. paper by citing three sources. First, they refer to a paper by Haimberger et al. (2008) which uses a weather balloon series called RAOBCORE version 1.4, which apparently agrees with some model projections. However, Haimberger has since revised the RAOBCORE version 1.4 data to remove a spurious warming influence from an input data source.[8] The trend in the lower tropical troposphere in RAOBCORE 1.4 set is now 0.117 degrees C per decade whereas the average predicted trend in climate models for the same region is 0.272 degrees C per decade,

[6] IPCC WGI pp. 763-764; also Figure 9.1.
[7] http://www.epa.gov/climatechange/endangerment/comments/volume3.html
[8] The problem apparently was in the ERA-40 reanalysis data.

more than twice as high. Clearly this data set cannot be the basis for setting aside the commenters' concerns about models overstating warming.

The second paper cited by the EPA is Allen and Sherwood (2008), who use *windspeed* data collected by weather balloons to infer temperature trends. They find higher trends than studies using thermometers to measure temperature trends. The EPA does not provide a discussion of the problems associated with using wind data to infer temperatures. A 2010 paper by John Christy and 8 coauthors in the journal *Remote Sensing* points out that until the advent of modern GPS systems, weather balloons tended to drift out of radio range at high altitudes on the windiest days, leading to an artificial depression of the highest windspeeds in the earlier years of the record, introducing a known source of bias in the trend over time. Also, windspeed data is very limited in the tropics compared to temperature data, and as Christy et al. point out, the temperature trend calculations by Thorne et al. imply windspeeds in the interpolated regions would have to be much higher than those observed in regions that do have data. Consequently, it was inappropriate for the EPA to place greater reliance on this study than on the many studies using direct temperature observations, especially since its method is new and rather speculative.

The third study cited by the EPA, and arguably the one that is key to their position, is a 2008 paper by Ben Santer et al., asserting that uncertainties in climate models and observations are sufficiently large with regards to trends in the tropical troposphere as to rule out a finding of inconsistency. They reach this conclusion by arguing that Douglass et al. used an incorrect statistical methodology to compare modeled and observed trends, and in the Santer et al. analysis they propose a slight improvement in methods, which they apply to data ending in 1999. They report the uncertainties in the model trends to be sufficiently large as to partially overlap with the uncertainties in the observed trends, leading Santer et al. to conclude that the models-data differences are not statistically significant.

In a paper published in fall of 2010, I and two coauthors showed that the Santer et al. conclusions fail on two grounds. First, neither Douglass et al. nor Santer et al. used modern statistical modeling techniques for comparing trends in data sets of the kind under dispute. We applied two different state of the art statistical methods for trend comparisons, both of which are well-established in the econometrics literature. Second, we extended the data up to the end of 2009 (the maximum extent available when we did the analysis). Ending the data at 1999 is a problem because there was a large El Nino event in 1998, temporarily boosting the observed trend so it appears to match models.

We found that on the full sample up to 2009, the satellite and weather balloon data sets were not significantly different from each other, but were significantly different from models. In particular, the models predicted two to four times more warming, on average, than is observed in the data, and the differences are statistically very significant.

Our paper is

- McKitrick, Ross R., Stephen McIntyre and Chad Herman (2010) "Panel and Multivariate Methods for Tests of Trend Equivalence in Climate Data Sets." *Atmospheric Science Letters*, DOI: 10.1002/asl.290.

In light of these updated findings, the EPA's reliance on Santer et al. (2008) is unsound, as is their claim that

> "when uncertainties in models and observations are properly accounted for, newer observational data sets are in agreement with climate model results."

Chairman HALL. I thank you very much, and let us assume the testimony that has been withheld until the liberal press hadn't reported it. I am going to be watching how they report your testimony. I thank you very much, sir.

At this time, I recognize Dr. Peter Glaser, a partner at Troutman Sanders for five minutes to present his testimony, and I thank you, Dr. Christy, for staying within the five minutes.

STATEMENT OF MR. PETER GLASER, PARTNER, TROUTMAN SANDERS, LLP

Dr. GLASER. Thank you, Chairman Hall, Ranking Member Johnson, for the opportunity to appear today. My name is Peter Glaser. I am not a doctor. I am a partner with the law firm of Troutman Sanders.

Let me emphasize at the outset that I am not appearing before this Subcommittee on behalf of any of my clients. The views I present here are my own and do not necessarily represent those of my clients, and I am not being compensated by them for this testimony.

I have been asked to comment on the process EPA used to prepare its greenhouse gas endangerment finding, and that process suffered from a number of flaws in my opinion that undermine confidence in the substantive conclusions reached in that finding. These flaws are identified at more length in my written testimony, and I will provide a brief summary here.

In the first place, EPA did not consider the societal health and welfare benefits created by the energy sources that produce greenhouse gas emissions. The EPA's decision to limit its analysis in this fashion caused it to miss an obvious fact and that is that over the last century as anthropogenic greenhouse gas emissions have increased and in EPA's view, the public health and welfare danger from these emissions has accelerated, every relevant indicator of public health and welfare has improved dramatically around the world, rather than deteriorated.

Moreover, EPA pre-judged the principal issue on which the public was asked to comment when EPA proposed the endangerment finding which was whether anthropogenic greenhouse gas emitted from new light-duty motor vehicles may reasonably be anticipated to endanger public health or welfare. Even before the comment period began, EPA had already made up its mind that it would issue the proposed finding, and indeed the President had already agreed to the motor vehicle greenhouse gas regulations for which the endangerment finding was the necessary predicate.

Other process flaws include the Administrator's failure to exercise independent judgment in determining the endangerment question. Instead, as the Administrator conceded, she relied almost exclusively on what she referred to as third-party assessment literature. In particular, on the critical question of whether anthropogenic greenhouse gas emissions are causing deleterious climate change, the Administrator relied most heavily on the work of the Intergovernmental Panel on Climate Change, or the IPCC.

The failure by her to exercise her own judgment is a violation in my view of the statutory provision under which the endangerment finding was made.

The endangerment finding also violated various provisions of the Information Quality Act, or the IQA and EPA's own IQA guidelines. For instance, EPA's IQA guidelines require to ensure the quality, integrity and transparency of information on which EPA relies for scientific reports. Despite relying so heavily on the IPCC, however, EPA never examined the quality, integrity and transparency of the data and studies on which the IPCC itself relied. EPA decided instead that it could satisfy its IQA obligations as to the IPCC material by examining the IPCC's own information quality standards and procedures. EPA's rationale, however, does not pass muster on the IQA, but in any event, that rationale was undermined by the so-called Climategate revelations.

Climategate showed that either EPA's investigation of the IPCC's procedures was wanting or the IPCC had departed from those procedures. Either way, given the Climategate material, EPA should have at least afforded the public an opportunity to comment on whether EPA's reliance on the IPCC was justified in light of this new information, but EPA refused to do so. And the Climategate issue is discussed in more detail in a petition that is attached to my written testimony and is in the public record in the EPA docket.

My testimony addresses a number of other process flaws and contrasts the abbreviated and expedited endangerment finding proceeding with the measured and methodical process that EPA uses to develop national ambient air quality standards, a process that unlike the GHG endangerment finding process involves numerous opportunities for public comment on successive draft scientific and policy assessments.

I appreciate the opportunity to provide my testimony to you today, and I look forward to questions. Thank you.

[The prepared statement of Mr. Glaser follows:]

PREPARED STATEMENT OF MR. PETER GLASER, PARTNER, TROUTMAN SANDERS, LLP

Analytical and Process Flaws in EPA's Greenhouse Gas Endangerment Finding

INTRODUCTION

My testimony [1] addresses analytical and process flaws in the finding of the U.S. Environmental Protection Agency (EPA or the Agency) that anthropogenic emissions of greenhouse gases (GHGs) "may reasonably be anticipated to endanger the public health and welfare" within the meaning of Section 202(a) of the Clean Air Act (CAA). [2] This finding is commonly referred to as the Endangerment Finding.

In my view, EPA failed to observe basic requirements set forth in applicable law as to how a regulatory determination such as the Endangerment Finding should be made. These flaws are not technical. They go to the fundamental fairness and transparency of the way EPA arrived at its Endangerment Finding and the quality of the information on which EPA relied. The procedures EPA failed to observe are designed to ensure the integrity both of the decision-making process and the ultimate result an agency reaches. EPA's failure to observe these basic requirements therefore undermines confidence in the substantive scientific conclusions in the Endangerment Finding.

---

[1] Although I represent clients in the case now pending before the United States Court of Appeals for the D.C. Circuit in which the Endangerment Finding is on appeal, Coalition for Responsible Regulation v. EPA, No. 09–1322, I am not appearing before this subcommittee on behalf of those or any other clients. The views I present here are my own and do not necessarily represent those of my clients, and I am not being compensated by them for this testimony.

[2] Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act published at 74 Fed. Reg. 66,496 (Dec. 15, 2009).

One particular analytical flaw in the Endangerment Finding stands out, which is that EPA only examined the danger to public health and welfare from GHGs emissions as they accumulate in the atmosphere and did not examine the danger to public health and welfare that would occur if society did not emit GHGs. As I discuss, EPA's one-sided analytical approach caused the Agency to miss an obvious fact—that over the last century, as anthropogenic greenhouse emissions have increased, every relevant indicator of public health and welfare has improved dramatically rather than deteriorated. A new report by the Centers for Disease Control (CDC) finds that the U.S. death rate (number of deaths per 100,000 population) fell for the tenth straight year and is now at an all-time low, continuing a decade-over-decade pattern of improved mortality rates over the 20th century. [3]

This relationship between increasing GHG emissions and improved public health and welfare is not an accident. As I will discuss, the direct cause of both the increased emissions and the improvements in health and welfare is society's use of energy, particularly electricity, which has inevitably produced GHGs. A complete analysis of whether society's emissions of GHGs endanger public health and welfare, as EPA should have conducted, would include not only whether the accumulation of anthropogenic GHGs in the atmosphere may be causing deleterious climate change but also whether the processes that produce those GHGs produce countervailing public health and welfare benefits.

My testimony is divided into two sections. I first discuss EPA's one-sided analytical approach in more depth. I then describe the process EPA used to formulate the Endangerment Finding and discuss how that process violated fundamental obligations EPA has under the Administrative Procedure Act, the rulemaking provisions of the CAA, the Information Quality Act, and other applicable authority. I further contrast the highly expedited and abbreviated Endangerment Finding process with the much more deliberative and open process that EPA uses when it formulates a National Ambient Air Quality Standard (NAAQS).

DISCUSSION

I. One-Sided Analytical Approach

The question that the Endangerment Finding attempts to answer is whether society's emission of GHGs endangers the public health or welfare. But EPA's answer only addresses one side of that question—the effect of the emissions on health and welfare once they enter the atmosphere. There is another side of the question, however—the effect on public health and welfare of the activity that produces those emissions.

Obviously, the emission of GHGs does not occur in a vacuum. GHGs are emitted across the economy for many reasons, the principal of which is that various residential, commercial and industrial processes utilize fossil fuels for energy and because $C0_2$, the most ubiquitous GHG, is the inevitable byproduct of combusting such fuels. These processes produce fundamental health and welfare benefits without which modern life would be impossible. As stated above, a new report by the Centers for Disease Control (CDC) finds that the U.S. death rate (number of deaths per 100,000 population) fell for the "10th straight year" and is now at "a record low." [4] The chief reason is a decline in mortality rates related to heart disease, stroke, malignant tumors, Alzheimer's disease, diabetes, pneumonia/influenza, and other illnesses. As the CDC report and related publications clearly show, U.S. death rates have declined, decade by decade, since 1900, even as GHG emissions have increased.

This relationship between increasing GHG emissions and improved public health and welfare is not an accident. The direct cause of both the increased emissions and the improvements in health and welfare is society's use of energy, particularly electricity, as has been shown by a variety of publications. As the National Academy of Engineers noted in 2000 in naming electrification as the number one engineering achievement of the 20th century:

> One hundred years ago, life was a constant struggle against disease, pollution, deforestation, treacherous working conditions, and enormous cultural divides unbreachable with current communications technologies. By the end of the 20th century, the world had become a healthier, safer, and more productive place, primarily because of engineering achievements. [5]

EPA's decision to limit its analysis to the perceived detrimental impact of emissions after they enter the atmosphere—as opposed to the positive impacts of the

---

[3] CDC, Deaths: Preliminary Data for 2009 (March 16, 2011).
[4] CDC, *Deaths: Preliminary Data for 2009* at 5.
[5] http://www .nationalacademies.org/greatachievements/Feb22Release.PDF.

processes that create the emissions—is based on EPA's overly narrow interpretation of its mandate under Section 202(a) (and in other endangerment finding provisions in other parts of the CAA) and the intent of these provisions. Logically, when EPA assesses whether the emission of GHGs endanger public health and welfare, EPA must assess the dangers and benefits on both sides of the point where the emissions occur: in the atmosphere where the emissions lodge and, on the other side of the emitting stack or structure, in the processes that create the emissions. Otherwise, EPA will not be able to accurately assess whether the fact that society emits GHGs is a benefit or a detriment.

Without belaboring EPA's legal interpretation of its responsibilities here, I would simply note that a full analysis of the dangers to the public health and welfare posed both by emitting GHGs and not emitting GHGs makes sense from a policy perspective. And EPA admitted that policy played a role in its Endangerment Finding. As EPA stated:

> [t]hroughout this Notice the judgments on endangerment and cause or contribute are described as a finding or findings. This is for ease of reference and is not intended to imply that the Administrator's exercise of judgment in applying the scientific information to the statutory criteria is solely a factual finding; while grounded squarely in the science of climate change, *these judgments also embody policy considerations.* [6]

The necessity for exercising policy judgment in acting in a precautionary fashion reflects the fact that determining the proper quantum of precaution in a particular case requires a balancing of risks and benefits in a broad sense. Obviously, overcaution creates its own health and welfare risks. As Justice Breyer stated in his concurring opinion in *Whitman v. Am. Trucking Ass'ns,* 531 U.S. 457, 495–496 (2001) (Breyer, concurring), "a world that is free of all risk—[would be] an impossible and undesirable objective." And as the Endangerment Finding Proposal preamble states, the purpose of such a finding is to review "the totality of the circumstances" to determine "whether the emissions *'justify regulation'* under the CAA." [7]

If, as EPA says, the basic purpose of the Endangerment Finding is to assess all risks and benefits of emissions in order to arrive at a policy judgment of the proper amount of precaution that justifies regulation in a particular case, that purpose cannot be fulfilled if EPA only looks at the atmospheric impacts of emissions, and ignores the health and welfare reasons why the emissions occur in the first place. Without a full view of the balance of health and welfare factors that relate to emissions, EPA could find that society would be better off without GHG emissions, when a balanced analysis might yield the opposite conclusion.

The GHG regulation that EPA has already undertaken and further GHG regulation that EPA is likely to undertake in the future provides a particularly compelling illustration of the need for a balanced approach in assessing possible endangerment. As the regulatory preamble to the Endangerment Finding proposal stated, in somewhat of an understatement, "[t]he Administrator recognizes that the context for this action is unique." [8] As the IPCC has noted, "[e]missions of GHGs are associated with an extraordinary array of human activities." [9] Eighty-five percent of energy in the United States is derived from the combustion of fossil fuel. As a result, according to EPA, "[v]irtually every sector of the U.S. economy is either directly or indirectly a source of GHG emissions." [10]

Because GHG emissions, particularly CO_2 emissions, are so closely tied with all facets of modern life, a finding that GHG emissions endanger public health and welfare is akin to saying that modern life endangers public health or welfare. That may be true in some sense, but the necessary rejoinder is: compared to what? Certainly not as compared with pre-industrial society with pre-industrial levels ofatmospheric GHG concentrations. To again quote Justice Breyer's concurring opinion in *Am. Trucking Ass'ns,* "[p]reindustrial society was not a very healthy society; hence a standard demanding the return of the Stone Age would not prove 'requisite to protect the public health.'" [11] Thus, although EPA would presumably conclude that preindustrial society would not pose a health and welfare danger in terms of GHG

---

[6] Endangerment Finding, 74 Fed. Reg. at 18,892, n.10 (emphasis supplied).
[7] Id. at 18,892/3 (emphasis supplied).
[8] Id. at 18,890/3.
[9] IPCC, *Climate Change 2001: Mitigation* ("IPCC 2001"), at 608, available at http://www.ipcc.ch/.
[10] *Proposed Consent Decree, Clean Air Act Citizens Suit,* 68 Fed. Reg. 52,922, 52,928 (Sep. 8,2003).
[11] 531 U.S. at 496.

emissions, the lack of industrial activity that causes GHG emissions would pose other, almost certainly more serious health and welfare consequences.

Finally, the broader assessment of health and welfare impacts that I discuss here does not mean that EPA is without power to conduct a full assessment of the health and welfare impacts caused by potential climate change. To the contrary, such an assessment is a fundamental part of endangerment analysis. Nor do I maintain that, on balance, EPA could not find that GHG emissions endanger the public health or welfare. EPA, for instance, might find that the risks of what EPA might see as potentially catastrophic climate change outweigh the benefits accruing from energy production and other processes that result in the emission of GHGs. Or EPA might find that the risks to society of unabated GHG emissions outweigh the risks to society of some level of abated GHG emissions.

But what EPA cannot do is to ignore the public health and welfare benefits that cause society to emit GHGs—to, in effect, pretend that a possible scenario exists where GHGs are not emitted at all and modern life continues. Such a scenario does not exist, and to assume that it does is to ignore the purpose for which EPA is called on to assess endangerment, which is to duly protect society against real-world risk.

II. Process Flaws

A. Process that Led to Endangerment Finding

Proposed Endangerment Finding

When the current Administration took office in January 2009, it brought with it a firm conviction that a scientific consensus existed that anthropogenic GHG emissions were the cause of significant deleterious global climate change and that continued emissions would make the situation far worse. A central plank of President Obama's campaign position on energy and environmental issues was the need to reduce GHG emissions by 80 percent by 2050.[12] And considerable frustration was felt over what was believed to be the Bush Administration's failure to pursue GHG regulation under the CAA following the Supreme Court's decision in *Massachusetts v. EPA,* 549 U.S. 497 (2007). Indeed, Carol A. Browner, who would become director of the White House Office of Energy and Climate Change Policy, testified in hearings immediately following the Court decision that EPA should begin regulating GHG emissions from motor vehicles and powerplants at once and that "climate change is real, it is caused by human activities, it is rapidly getting worse, and it will transform both our planet and humanity if action is not taken now."[13]

The new Administration did not wait long before taking action. In one of her first acts, EPA Administrator Lisa P. Jackson issued a January 23, 2009 "Opening Memo to EPA employees" discussing her overall views on environmental regulation that set forth "five priorities that will receive my personal attention." Her first priority was "[r]educing greenhouse gas emissions," including through regulation under the CAA:

> The President has pledged to make responding to the threat of climate change a high priority of his administration. He is confident that we can transition to a low-carbon economy while creating jobs and making the investment we need to emerge from the current recession and create a strong foundation for future growth. I share this vision. EPA will stand ready to help Congress craft strong, science-based climate legislation that fulfills the vision of the President. As Congress does its work, we will move ahead to comply with the Supreme Court's decision recognizing EPA's obligation to address climate change under the Clean Air Act.[14]

Consistent with this view, EPA proposed the Endangerment Finding on April 17, 2009, less than three months after the Administration took office. Although the proposed Endangerment Finding was ostensibly issued as a formal rulemaking document on which public comment was sought on all issues, including whether the Administration should make the Endangerment Finding at all, there was little doubt that the Administrator had already pre-judged that issue. Apart from her previous public statements on climate science and those of others senior to her in the Administration, the President announced in May 2009, just one month after the proposed Endangerment Finding was published in the Federal Register and before the comment period even closed, that he had committed EPA to issuing motor vehicle GHG

---

[12] http://my.barackobama.com/page/content/newenergy__more.

[13] Testimony of Carol A. Browner in hearings before the Senate Environment and Public Works Committee (Apr. 27, 2007).

[14] (Emphasis supplied.) The memorandum can be found at http://blog.epa.gov/administrator/2009/01/26/opening-memo-to-epa-employees/.

regulations that were premised on EPA making the Endangerment Finding. [15] The President's announcement was based on an agreement that resulted from private negotiations among the Administration, automakers, environmental parties, and representatives of the State of California, and these negotiations had commenced before EPA had even proposed the Endangerment Finding.

Despite the Administration's commitment to unparalleled transparency in Agency decision-making—the Administrator had issued an April 23, 2009 memorandum on "Transparency in EPA's Operations" that promised that EPA would operate "in a fishbowl" and declared that "[i]t is crucial that we apply the principles of transparency and openness to the rulemaking process"—no public record of these negotiations exist. Press reports, including in The New York Times, quoted the senior California representative in the negotiations as saying that she and Carol Browner, who coordinated the negotiations, specifically required that no written records of the negotiations be kept by any party. [16]

The agreement provided for imposition of GHG standards for model year 2012 automobiles and light duty trucks. In order to provide the automakers sufficient lead time to comply with the new standards, EPA needed to propose and then finalize the standards by the Spring of 2010. (It was also decided to coordinate the EPA GHG standards with Corporate Average Fuel Economy (CAFE) standards to be issued by the National Highway Traffic Safety Administration (NHTSA), and NHTSA is statutorily obligated to provide certain defined advance notice of new CAFE standards.) Given the agreement to put these new standards in place by model year 2012, there was now no doubt that the Endangerment Finding. without which the EPA standards could not be promulgated, would need to be issued soon.

Final Endangerment Finding and the Administrator's Failure to Exercise Her Own Judgment

The final Endangerment Finding was issued on December 7, 2009 and published in the Federal Register shortly thereafter. Despite the requirement of Section 202(a) that the Administrator exercise her own judgment as to whether GHGs endanger public health and welfare, the Endangerment Finding was not the product of the Administrator's or her Agency's independent review of climate science. Instead, as the Administrator readily conceded, the Endangerment Finding was based almost exclusively on reports produced by third parties summarizing their views of global climate change science, reports that the Endangerment Finding referred to as "assessment literature." [17] As the Endangerment Finding stated, " . . . the Administrator is relying on the major assessments of the USGCRP, the IPCC, and the NRC as the primary scientific and technical basis of her endangerment decision." [18] The Administrator's statement of her primary reliance on these reports is repeated throughout the Endangerment Finding, the Technical Support Document (TSD) (which was the detailed document prepared by EPA in connection with the Endangerment Finding that discussed climate science), and the document EPA prepared to respond to rulemaking comments (the Response to Public Comments). For instance, the TSD stated that it "relies most heavily" on this "assessment literature." [19] The Response to Comments stated:

> The endangerment analysis for greenhouse gases under the CAA requires that EPA examine the extent to which the GHGs constitute the air pollution that may be reasonably anticipated to endanger public health or welfare . . . The Findings discuss in detail the information that is relevant to the determination and how the Administrator has interpreted it in deciding whether the air pollution is reasonably anticipated to endanger public health or welfare. The scientific literature as synthesized in the TSD provides exactly the kind of infor-

---

[15] *President Obama Announces New Fuel Efficiency Policy,* http://www.whitehouse.gov/the_press—office/President-Obama-Announces-National-Fuel-Efficiency-Policy/.

[16] Colin Sullivan, *Vow of Silence Key to White Hause-Calif. Fuel Economy Talks,* THE NEW YORK TIMES, May 20, 2009.

[17] See, e.g, Endangennent Finding, 74 Fed. Reg. at 66,498/2.

[18] Endangerment Finding, 74 Fed. Reg. at 66,510. The USGCRP refers to the United States Global Change Research Program. USGCRP subsumed the work of the U.S. Climate Change Science Program ("CCSP "), which had previously coordinated such research. As ofJanuary 16, 2009, the CCSP had produced 21 synthesis and assessment reports ("SAPs "), and these reports, along with the IPCC reports, became the principal basis for the June USGCRP report GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES. The IPCC is a body that was established by the United Nations Environment Programme and the World Meteorological Organization to "provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences." Among other things, the IPCC releases Assessment Reports. The NRC is National Research Council.

[19] TSD at 4.

> mation that can help inform these issues. For example, *the TSD summarizes the conclusions of the assessment reports* with respect to: 1) current emissions of GHG emissions; 2) how these emissions are changing the composition of the atmosphere; 3) how such changes in the atmosphere are affecting the global and regional climate; and 4) the potential impacts of such changes in climate on human health and welfare, for current and future generations. *In its scope and quality, the assessment literature is relevant and appropriate for addressing the scientific issues under the CAA.* [20]

Similarly, EPA stated that:

> EPA disagrees that review of the scientific and technical information contained in the TSD was inadequate. *EPA did not develop new science as part of this action and instead summarized the existing peer-reviewed assessment literature.* [21]

Importantly, although EPA says it relied on reports of the USGCRP, the IPCC, and the NRC, EPA relied almost exclusively on the work of the IPCC on the critical "attribution" issue: whether changes to the climate system that EPA says are occurring and will accelerate in the future can be attributed to anthropogenic GHG emissions and not natural forces. Most of the TSD examines observed and projected climate and the effect on public health and welfare. Only eight pages of the TSD are devoted to the attribution issue. [22] I count 67 citations in this section, with 47 to the IPCC. All the graphics in this section are taken from the IPCC, as is the introduction. Plainly, the principal authority for EPA's central conclusion that anthropogenic GHG emissions are causing deleterious climate change is the IPCC.

Limited Comment Period

EPA allowed only a sixty-day comment period on the Endangerment Finding, a period that was not sufficient to address the vast volume of material cited in the "assessment literature" on which EPA was relying—as well as the voluminous material that such literature ignored or which had been published after the "assessment literature" itself was published. Nevertheless, given the time pressure to make the Endangerment Finding that resulted from the Administration's agreement to promulgate GHG standards for model year 2012, requests to EPA to extend the sixty-day comment deadline were denied.

EPA's publicly-stated rationale for denying requests for more time to comment on the proposed Endangerment Finding is interesting because it amounts to a further admission that the Administrator did not exercise her own judgment in making that finding and instead relied on the "assessment literature." She said that:

> the major scientific assessments that the EPA relied upon in the TSD released with the ANPR had previously each gone through their own public review processes and have been publicly available for some time. In other words, EPA has provided ample time for review, particularly with regard to the technical support for the Findings. [23]

Thus, according to EPA, the ability of the public to comment on the "assessment literature" during the processes in which that literature was developed guided EPA's decision in determining how much time the public should be given to comment on the proposed Endangerment Finding. [24] EPA's logic makes sense only if one accepts that the Administrator has authority to essentially delegate her obligation to exercise her own judgment to third party institutions and that comments to these third party institutions as they exercise their judgment are tantamount to comments to EPA. But Section 202(a) does not permit the Administrator to delegate her

---

[20] Endangerment Finding Response to Public Comments, VoL 1 at 5 (emphasis supplied.)
[21] Id. at 7 (emphasis supplied).
[22] TSD at 47–54.
[23] Endangerment Finding, 74 Fed. Reg. at 66,503.
[24] In denying the extension requests, EPA also said that it had provided a 120-day comment period in the Advance Notice of Proposed Rulemaking ("ANPR ") regarding potential GHG regulation (*Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act,* 73 Fed. Reg. 44,353 (JuL 30, 2008) (ANPR). The ANPR, however, did not contain any proposed Endangerment Finding or indeed any meaningful discussion of conclusions that might be drawn from the draft TSD that was included with the ANPR. Moreover, although the TSD in the ANPR was similar to the TSD in the proposed Endangerment Finding, there were important differences between the two. Additionally, a number of the CCSP assessment reports on which the ANPR TSD relied had not been through the public comment period for those reports and were not final at the time of the ANPR comment period. Thus, the 120-day conunent period on the ANPR did not provide an opportunity for the public to comment on these reports *to EPA.*

obligation to exercise judgment to third parties, and the public has a right to comment on her exercise of judgment *to EPA.*

Lack of Independent and Objective Peer Review

The Administrator's near-total reliance on the third-party assessments is also shown in EPA's failure to provide for objective peer review of the Endangerment Finding. EPA's Information Quality Act (IQA) guidelines,[25] which are discussed in more detail below, incorporate a "Peer Review Policy" that "provides that major scientifically and technically based work products (including scientific, engineering, economic, or statistical documents) related to Agency decisions should be peer-reviewed." During the Endangerment Finding comment period, a number of commenters questioned the independence and objectivity of the personnel EPA selected to peer review the Endangerment Finding, which is plainly a major scientifically based work product requiring peer review under EPA's IQA guidelines. As these comments pointed out, all of the peer reviewers were government scientists and many had worked directly on the "assessment literature" on which EPA relied. 1A[26]

In responding to this comment, the Administrator recognized that she was obligated to provide for independent peer review. She nevertheless maintained that her near complete reliance on the "assessment literature" meant that she was justified in selecting peer reviewers not on the basis of their independence from EPA or the "assessment literature" but on the basis of their familiarity with that literature. As she stated, "[g]iven our approach to the scientific literature . . . the purpose of the federal expert review was to ensure that the TSD accurately summarized the conclusions and associated uncertainties from the assessment reports."[27] In other words, it was not important to the Administrator that she receive an independent critique of her own Endangerment Finding; her concern was merely to ensure that she had accurately summarized the conclusions of the "assessment literature" on which she was relying.

Failure to Docket Information Relied On

Another example of the Administrator's near total reliance on the "assessment literature" in lieu of making her own judgment is EPA's failure to include in the official Endangerment Finding record the publications and scientific information relied on by the "assessment literature." Docketing all of the information on which the Administrator relies is not a procedural formality. It is the key way in which the public is informed of the basis of the Agency's decision and therefore is a critical part of the public's ability to comment on the action the Agency is taking. As explained in the Administrator's April 23, 2009 "Memo to EPA Employees" cited above, EPA can only ensure that the principles of transparency and openness are observed in the rulemaking process "if EPA clearly explains the basis for its decisions and *the information considered by the Agency appears in the rulemaking record."* (Emphasis supplied.)

Recognizing that she was required to include in the Endangerment Finding record the information on which she relied,[28] the Administrator nevertheless maintained that since she is "reasonably relying on the major assessments of the USGCRP, IPCC, and NRC as the primary scientific and technical basis of her endangerment decision," she is not required to docket material that these reports themselves relied on.[29] She took the position that "[i]nformation regarding the underlying data, models, and studies used by the IPCC, USGCRP, CCSP, and NRC in developing their assessment reports can be accessed by consulting these reports."[30] Similarly, the Administrator stated that she "did not conduct new research or modeling in developing the TSD, and instead relied upon the findings of the assessment literature, including data and modeling studies presented in those reports. The information mentioned by the Commenter can be accessed by consulting these assessment reports and the underlying studies."[31] She went on to say that "[o]ur comprehensive

---

[25] The IQA was enacted as Section 515 of the Consolidated Appropriations Act, 2001 (pub.L. 106–554). EPA's IQA Guidelines are *Guidelines for Ensuring and Minimizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency (Oct. 2002). http://epa.gov/quality/informationguidelines/documents/EPA*_InfoQualityGuidelines.pdf.

[26] See comments responded to at Endangerment Finding Response to Public Co1D.Irients, Vol. 1 at 7.

[27] 27 Id. at 7.

[28] Endangerment Finding Response to Comments, Vol. 1 at 54.

[29] Id.

[30] Id.

[31] Id.

referencing of the assessment literature ensures transparency regarding the source of the data used . . .” [32]

The Administrator's rationale, however, is wrong in at least two respects. In the first place, if (as she admitted) she relied on the “assessment literature,” then presumably Agency personnel read the studies and data cited in that literature and were persuaded that the conclusions reached by that literature are correct. If that is the case, then those underlying studies and data must be included in EPA's record, since ultimately it is that information that forms the basis of the Administrator's conclusion that anthropogenic GHGs endanger public health and welfare. Additionally, as the so-called “climategate,” revelations showed (see below), the data underlying the IPCC conclusions, in fact, were not made publicly available by the IPPC or by the authors of the IPCC reports and indeed were withheld even when asked for under freedom of information law. Thus, the Administrator was incorrect in saying that the information cited in the “assessment literature” can be “accessed by consulting these assessment reports and the underlying studies.”

Refusal to Allow the Public to Comment on Climategate

Just weeks before EPA issued its Endangerment Finding, a considerable body of email and other information from the University of East Anglia (UEA) Climatic Research Unit (CRU) became available on the Internet. The emails are primarily those of American and British scientists who had critical roles in writing the IPCC reports.

The CRU information undermines a number of the central pillars on which the Endangerment Finding rests, particularly the work of the IPCC. The CRU information reveals that many of the principal scientists who authored key chapters of the IPCC scientific assessments were driven by a policy agenda that caused them to cross the line from neutral science to advocacy. They went far beyond even what is acceptable as advocacy, as they actively suppressed information that was contrary to, in their words, the “nice, tidy story” that they wished to present, they refused to disclose underlying data concerning the studies in which they were involved to third parties who might use the information to critique those studies—even when asked for that information in freedom of information requests and even to the extent of deleting emails—, they engaged in a wide variety of improper and indeed unethical tactics to manipulate the type of scientific information that appeared both in the IPCC reports and in the peer-reviewed scientific journals upon which the IPCC largely relied, and they relied on inaccurate and unverified information from secondary source material that was produced by advocacy groups, information that the authors apparently knew was unverified but included anyway to advance the authors' advocacy agenda. A comprehensive discussion of the climategate material can be found in the attached Petition for Reconsideration. [33]

The climategate revelations (at least) created significant doubt as to the heavy reliance the Administrator had placed in the IPCC reports. As discussed below, the IQA obligates EPA to ensure the reliability and transparency of the information on which it relies for important decisions. In responding to comments on the proposed Endangerment Finding, however, the Administrator stated that she had not made her own expert determination as to the quality and transparency of the information used in the “assessment literature” despite her relying so much on that literature. Instead, she said that she had satisfied her obligations to ensure the reliability and transparency of the information underlying the “assessment literature” by reviewing the procedures used by the entities that prepared the that literature to confirm that those entities, in her view, had adequately taken steps to ensure information quality and transparency. She stated that “[o]ur approach is consistent with these [EPA's IQA] guidelines because we thoroughly reviewed and evaluated the author selection, report preparation, expert review, public review, information quality, and approval procedures of IPCC, USGCRP/CCSP, and NRC to ensure the information adhered “to a basic standard of quality, including objectivity, utility and integrity.” [34]

There are at least two problems with the Administrator's rationale in this regard. In the first place, it is by no means certain that the Administrator can satisfy her IQA obligations as to information quality and transparency without examining the transparency and quality of the information cited in the “assessment literature” given her heavy reliance on that literature to fulfill her statutory obligations. But

---

[32] Id.

[33] Petition for Reconsideration of Peabody Energy Company (Feb. 11, 2010). I am submitting both the Petition and the Executive Summary of the Petition for the record. If the Petition is considered too long to be included in the record, I ask that the Executive Summary be included instead.

[34] Response to Comments, Vol. 1 at 57.

even if she could satisfy her IQA obligations solely by examining the procedures used by the authors of the "assessment literature" to ensure reliability and quality, climategate undermined her conclusion that the IPCC's procedures, in fact, had conformed with U.S. norms for scientific objectivity, integrity, and transparency.

A number of parties asked EPA to reconsider the Endangerment Finding in light of the climategate material and, in particular, to take public comment on this new information since it had not been available at the time comments were submitted on the proposed Endangennent Finding. These reconsideration petitions maintained that the climategate information and its implication for EPA's reliance on the IPCC was at least important enough that EPA should allow the public an opportunity to comment on the impact of this information on the Endangerment Finding.

EPA, however, refused to even take public comment on climategate, dismissing the new infonnation as essentially irrelevant to whether EPA had properly relied on the IPCC. Oddly, however, the Agency's decisional documents needed more than five hundred pages to reach the conclusion that the climategate material was not important enough to warrant input from the public. [35]

B. The Process EPA Conducted to Formulate the Endangerment Finding Failed to Meet Basic Requirements for Fairness and Transparency

The above discussion reveals basic process flaws in the manner in which the Endangerment Finding was developed. American law sets forth a number of procedural requirements that administrative agencies like EPA must observe in rulemaking proceedings and in making scientific determinations like the Endangennent Finding that become the basis for regulatory policy. These include rulemaking requirements set forth in the CAA and the Administrative Procedure Act (APA), information quality and transparency requirements set forth in the IQA, and a number of analytical requirements set forth in various statutes and executive orders, such as the Unfunded Mandates Reform Act and Executive Order 12866 and President Obama's new Executive Order 13563 on "Improving Regulation and Regulatory Review."

As stated above, these process flaws are not mere technicalities that have no relevance to the substance of the Endangerment Finding. The reason that the law sets forth required procedures for administrative decision-making and scientific determinations is to ensure the integrity of the ultimate decision made.

Some of the most important flaws are as follows: [36]

First, the most basic flaw is the Administrator having prejudged the Endangerment Finding, which is an obvious violation of the Administrative Procedure Act and the rulemaking provisions of the CAA. As discussed, even before the Endangerment Finding was proposed, the President had already undertaken negotiations to commit EPA to regulations that the Agency could not issue unless it made the Endangerment Finding, and these negotiations resulted in an agreement even before the comment period on the proposed Endangerment Finding expired. As to the basic issue of whether or not anthropogenic GHG emissions endanger the public health or welfare, the comment period and indeed the rulemaking process was largely a formality.

Second, in contravention of Section 202(a), the Administrator failed to exercise her own judgment and instead adopted the findings of the "assessment literature." I can think of no instance where, on a matter of such overriding national importance, EPA relied so heavily and deferred so much to the judgment of third parties.

Third, apart from the pre-judgment issue, and whether or not limiting the comment period to sixty days is strictly a violation of law, sixty days was wholly insufficient for public input into the Endangerment Finding. This limited comment period contrasts dramatically with the numerous and often lengthy comment periods that inform EPA promulgation of the National Ambient Air Quality Standards (NAAQS), as will be further discussed below. Moreover, the Agency's rationale that the public had an opportunity to submit comments during preparation of the "assessment literature" lacks merit. Public comments were not taken in preparation of the IPCC science reports, and the public could not have been expected to know that comments on the USGCRP reports were necessary on the theory that EPA would later decide to use those reports as the basis for the Endangerment Finding and for the ensuing regulation (and, indeed, in contrast to the numerous public comments on the Endangerment Finding, relatively few public comments were submitted on those reports). More fundamentally, the right to comment on the Endangerment Finding is

---

[35] See the Response to Petitions at http://www.epa.gov/climatechange/ endangerment/petitions.html.

[36] This discussion is not intended to be a complete discussion of the process and other flaws of the Endangerment Finding but instead is intended to illustrate some of the flaws.

a right to comment to EPA, in order to influence EPA action, not a right to comment to third parties.

Fourth, climategate destroyed EPA's basis for concluding that it could rely on the IPCC's procedures for ensuring the quality, integrity and transparency of the information on which the IPCC relied. Climategate showed that either EPA's investigations of the IPCC procedures were wanting or the IPCC had departed from those procedures. Either way, given the climategate revelations, EPA should have (at a minimum) afforded the public an opportunity to comment on whether EPA's reliance on the IPCC was justified.

Moreover, in attempting to show that climategate did not affect the conclusions reached in the Endangerment Finding, EPA relied on studies prepared after the Endangerment Finding was finalized and then placed those studies in the Endangerment Finding docket. EPA thus attempted to shore up the rationale for the Endangerment Finding based on new information, but did not allow the public an opportunity to comment on such information or the conclusions EPA reached from it.

Fifth, EPA held separate rulemaking proceedings for making the Endangerment Finding and for promulgating the motor vehicle regulations triggered by that finding. EPA did not identify any other precedent involving an endangerment finding in which it had bifurcated the endangerment finding proceeding from the proceeding to issue substantive regulations.[37] As a result, in considering whether to make the Endangerment Finding, EPA never considered whether the cost of regulating outweighed the benefit. Thus, although EPA took the view that the Endangerment Finding automatically triggered an obligation by EPA to regulate motor vehicle GHG emissions, and that EPA regulation of motor vehicle GHG emissions automatically triggered regulation of GHG emissions from stationary facilities under the Prevention of Significant Deterioration (PSD) and Title V permit programs, EPA failed to undertake an assessment of the costs and benefits of GHG regulation of stationary sources.

Instead, EPA took the position during the Endangerment Finding proceeding that it was not required to assess the costs and benefits of the regulation that its Endangerment Finding triggered because the Endangerment Finding itself was nonregulatory.[38] But EPA also refused to study the costs and benefits of regulation of stationary source GHG emissions during the motor vehicle regulatory proceedings on the ground that such issue was more properly addressed in further proceedings EPA would have on GHG regulation under the PSD and Title V programs.[39] Yet EPA again refused to study the impacts of such regulation even during those proceedings.[40] To this day, EPA still has not conducted any study of the costs and benefits of the stationary source GHG regulation that the Endangerment Finding triggered.

Sixth, in developing the Endangerment Finding, the Administrator did not conform to several provisions of the Agency's own IQA guidelines and those of the Office of Management and Budget (OMB)[41] for the "Utility" and "Quality" of information. The OMB Guidelines define "Utility" as "the usefulness of the information to its intended users, including the public. In assessing the usefulness of information that the agency disseminates to the public, the agency *needs to consider the uses of the information* not only from the perspective of the agency but also from the perspective of the public."[42] EPA's IQA Guidelines amplify this requirement by providing that the Agency will subject "influential" scientific information to a "rigorous standard of quality."[43] "Influential" information is defined to include the following:

> Information disseminated in support of top Agency actions (i.e., rules, substantive notices, policy documents, studies, guidance) that demand the ongoing involvement of the Administrator's Office and extensive cross-Agency involve-

---

[37] According to EPA, "[t]ypically, the endangerment and cause or contribute findings have been proposed concurrently with proposed standards under various sections of the CAA." *Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act,* 74 Fed. Reg. 18,886, 18,888/3 (Apr. 24, 2009).

[38] Proposed Endangerment Finding, 74 Fed. Reg. at 18,90911–2.

[39] *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards EPA Response to Comments Documentfor Joint Rulemaking* (Apr. 2010) at 7–66—7–77.

[40] *See Prevention of Significant Deterioration and Title V GHG Tailoring Rule: EPA's Response to Public Comments* (May 2010) at 163–65. .

[41] OMB's guidelines are set forth in Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies; Notice; Republication, 67 Fed. Reg. 8,452 (Feb. 22, 2002).

[42] Id. at 8,459/1–2 (emphasis supplied).

[43] EPA Information Quality Guidelines at 20.

ment; issues that have the potential to result in major cross-Agency or cross-media policies, are highly controversial, or provide a significant opportunity to advance the Administrator's priorities. Top Agency actions usually have potentially great or widespread impacts on the private sector, the public or state, local or tribal governments. This category may also include precedent-setting or controversial scientific or economic issues. [44]

Plainly, the Endangerment Finding qualifies as "influential" scientific information within the meaning of EPA's guidelines, since it triggered GHG regulation of automobiles, regulation of all major stationary sources of GHG emissions under the PSD and Title V programs, and likely other far-reaching regulation. As a result, EPA should have, but failed in several respects to, apply a "rigorous standard of quality" in making the Endangerment Finding:

- As discussed in a number of comments in the rulemaking process, EPA failed to discuss a large number of peer-reviewed studies that contradict the Administrator's conclusions. According to EPA's Guidelines, EPA must "ensure and maximize the quality of 'Influential' scientific risk assessment information" by, among other things, discussing "peer-reviewed studies known to the Administrator that support, are directly relevant to, or fail to support any estimate of risk and the methodology used to reconcile inconsistencies in the scientific data." [45]
- As also discussed in comments, EPA's discussion did not include a proper context of other peer-reviewed studies that conflict with EPA's conclusions. OMB's IQA Guidelines for Objectivity, however, require information to be "presented in an accurate, clear, complete, and unbiased manner," including presenting the material within its proper context, with dissemination of other information "in order to ensure an accurate, clear, complete, and unbiased presentation." [46]
- As discussed above, EPA failed to provide for independent and objective peer review of the Endangerment Finding.
- Climategate revealed that the information underlying the IPCC reports on which EPA relied did not conform to IQA standards for transparency. Yet, for the reasons discussed above and in the attached Petition for Reconsideration, the climategate material revealed that the information used in the IPCC reports did not meet these standards regarding transparency as to data sources, assumptions used, analytic methods applied and statistical procedures employed. [47]

In sum, the process used by EPA to develop the Endangerment Finding was flawed, and these flaws undermine confidence in the Agency's substantive finding that GRGs may reasonably be anticipated to endanger public health or welfare.

C. EPA's Process for Establishing a NAAQS

The expedited and abbreviated process EPA used to make its Endangerment Finding may be contrasted with the methodical process EPA uses to develop NAAQS, a process that involves numerous opportunities for public comment on successive draft scientific and policy assessments. The example I will use is EPA's promulgation of the NAAQS for particulate matter (PM) in September 2006. [48]

The key scientific documents prepared in connection with a NAAQS review are the Criteria Document (CD) and Staff Paper. The CD is prepared by EPA's Office of Research and Development and is a compilation and evaluation by EPA scientific staff and other expert authors of the latest scientific knowledge relevant to assessing the health and welfare effects of the air pollutant. The Staff Paper is prepared by EPA's Office of Air Quality Planning and Standards. Its purpose is to evaluate

---

[44] Id.

[45] Id. at 22–23 (emphasis supplied).

[46] OMB IQA Guidelines, 67 Fed. Reg. at 8,459/3.

[47] According to EPA's IQA Guidelines, "EPA recognizes that influential scientific, financial, or statistical information should be subject to a higher degree of quality (for example, transparency about data and methods) than information that may not have a clear and substantial impact on important public policies or private sector decisions. A higher degree of transparency about data and methods will facilitate the reproducibility of such information by qualified third parties, to an acceptable degree of imprecision . . . It is important that analytic results for influential information have a higher degree of transparency regarding (1) the source of the data used, (2) the various assumptions employed, (3) the analytic methods applied, and (4) the statistical procedures employed." EPA IQA Guidelines at 20–21.

[48] The information below is taken from EPA's PM NAAQS website.

the policy implications of the key studies and scientific information contained in the CD and to identify the critical elements that EPA staff believes should be considered in establishing a NAAQS. It is intended to help "bridge the gap" between the scientific review contained in the CD and the judgments required of the EPA Administrator in determining whether it is appropriate to revise the NAAQS. CDs and Staff Reports each run to many hundreds of pages, much longer than the Endangerment Finding TSD.

In October 1997, EPA published its plans for the current periodic review of the PM NAAQS. As part of the process of preparing the PM CD, EPA's National Center for Environmental Assessment (NCEA) hosted a peer review workshop in April 1999 on drafts of key chapters pf the CD. The first external review draft CD was reviewed by the Clean Air Science Advisory Committee (CASAC) and the public at a meeting held in December 1999. Based on CASAC and public comment, NCEA revised the draft CD and released a second external review draft in March 2001 for review by CASAC and the public at a meeting held in July 2001. A preliminary Draft Staff Paper was released in June 2001 for public comment and for consultation with CASAC at the same public meeting. Taking into account CASAC and public comments, a third external review draft CD was released in May 2002 for review at a meeting held in July 2002. EPA released a fourth external review draft CD in June 2003, which was reviewed by CASAC and the public at a meeting held in August 2003.

The first draft Staff Paper, based on the fourth external review draft CD, was released at the end of August 2003, and was reviewed by CASAC and the public at a meeting held in November 2003. EPA held additional consultations with CASAC at public meetings held in February, July, and September 2004, leading to publication of the final CD in October 2004. This second draft Staff Paper, released for comment in January 2005, was based on the final CD. The Staff Paper was released in June 2005 and then another and final version was released in December 2005 following further consultation with CASAC.

The proposed standard was published in the Federal Register on January 17, 2006.[49] A ninety-day comment period was provided for. The final PM NAAQS was published in the Federal Register on October 27, 2006.[50]

The 2006 PM NAAQS is now under review for possible revision, and the process is equally as extensive. Without going into detail, just since the new Administration took office, EPA has published 15 notices in the Federal Register of meetings, comment periods and review drafts in connection with this review process. These include: Notice of CASAC Teleconference–August 25, 2010, Notice of Extension of Public Comment Period for Chapter 4–Second Draft Policy Assessment, Notice of Availability–Quantitative Health Risk Assessment (Final Report) and Urban-Focused Visibility Assessment (Final Report), Notice of Availability and Request for Public Comment–Second Draft Policy Assessment, Notice of CASAC Meeting–July 26–27, 2010, Notice of CASAC Teleconference–May 7, 2010, Notice of Extension of Public Comment Period–First Draft Policy Assessment, Notice of CASAC Meeting March 10–11, 2010 and Upcoming Public Teleconference(s), Notice of CASAC Ambient Air Methods and Monitoring Subcommittee (AAMMS) Meeting–February 24–25, 2010; Public Teleconference–March 26, 2010, Notice of Availability and Public Comment Period for Draft Documents Related to the Review of the PM NAAQS, Notice of Availability–Integrated Science Assessment for PM (Final Report), Notice of Extension of Public Comment Period–Second Draft lntegrated Science Assessment, Notice of Extension of Public Comment Period–Draft Assessment Documents, Notice of CASAC Meeting October 5–6, 2009 and Upcoming Public Teleconference(s), Notice of Availability and Public Comment Period for Draft Assessment Documents, Notice of Extension of Public Comment Period–Second Draft Integrated Science Assessment, Notice of Availability and Public Comment Period for PM ISA–Second External Review Draft, Notice of Planning Documents for Public Review and Comment, Notice of CASAC Meeting–April 1–2, 2009.[51]

In sum, the process that EPA used to develop the Endangerment Finding was considerably shorter and involved much less intensive review and a far more limited comment period than typifies the process for establishing a NAAQS. Yet GHG regulation is just as important, if not more so, that PM regulation, and climate science is considerably more complex than the science behind PM effects on health and welfare.

---

[49] National Ambient Air Quality Standards for Particulate Matter; Proposed Rule, 71 Fed. Reg. 2,620 (Jan. 17, 2006).

[50] National Ambient Air Quality Standards for Particulate Matter, 71 Fed. Reg. 61,144 (Oct. 27, 2006).

[50] *See* http://www.epa.gov/ttn/naaqs/standards/pm/s__m__2007__fr.html.

CONCLUSION

EPA's process for developing the Endangerment Finding was characterized by a number of flaws that undermine confidence in the substantive conclusions reached in that finding.

I appreciate the opportunity to provide this testimony.

Chairman HALL. Mr. Glaser, thank you very much. I recognize now Dr. Kerry A. Emanuel, Professor of Atmospheric Science, Massachusetts Institute of Technology, for his testimony.

STATEMENT OF DR. KERRY EMANUEL, PROFESSOR OF ATMOSPHERIC SCIENCE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. EMANUEL. Thank you, Chairman Hall and Ranking Member Johnson, for this opportunity to speak to the integrity of the field of climate research.

The basic physics of climate were established more than 100 years ago by distinguished scientists such as Jean Baptiste Fourier, John Tyndall, and in particular they established that our planet is habitable thanks to gases that comprise less than three percent of our atmosphere.

Already in 1897, the Swedish chemist Svante Arrhenius projected that fossil fuel combustion would increase carbon dioxide levels in the atmosphere, and estimated, by hand, that doubling CO_2 would increase surface temperatures by between 5 and 6 degrees Centigrade.

Analysis of paleoclimate records suggest that natural climate change is caused by variations in solar output, the Earth's orbit around the sun, aerosols, and in greenhouse gases. In particular, elevated greenhouse gases are the primary suspect in explaining the very warm climates of some of the Earth's past.

The scientific basis for the existence of significant risks from anthropogenic climate change is solid and rests on the principles of physics established more than a century ago as well as on records of the Earth's climate as recorded by instruments and in the geological record.

The conclusions of the scientific community that warming of the climate system is unequivocal and that most of the observed increase in global temperatures since the mid-20th century is very likely due to the observed increase in greenhouse gas, rests on sound scientific research. I need not review for you the fact that virtually every major scientific organization that deals with climate around the world has issued strong statements warning of the risks of climate change.

Many government agencies and private enterprises are taking the risks of climate change quite seriously. For example, our own Defense Department has recently issued a report expressing concern about political instability arising from water and food shortages in several locations around the globe.

Historically, science, including climate science, have tended to be conservative and to underestimate risk. I could give you many examples, but a recent and tragic example is the earthquake and tsunami in Japan caused by a magnitude 9 earthquake. The best projections before the earthquake of the largest earthquake that that

region should experience was 8.3, many, many times lower than what was observed.

Notwithstanding anything I have just told you, there is universal agreement among scientists that current assessments of the risk of climate change are highly uncertain. In my view, it is unlikely that these uncertainties will decline appreciably over the next decade. Because of this uncertainty, there is no scientific basis for the confidence expressed by some that the effects of climate change will be benign. In respect to the stolen emails, and I know something about that, Mr. Chairman, because I served on the scientific advisory panel put together by the Royal Society in England to investigate such allegations. While there is general agreement that the preparation of a particular graph by a few scientists shows poor judgment in omitting a part of the record that was demonstrably false, there is no evidence for an intent to deceive. Efforts by some to leverage this into a sweeping condemnation of a whole scholar endeavor should be seen for what they are.

Now, all scientific endeavors entail some diversity of views, including mavericks who challenge accepted science. There are biomedical researchers who do not think that HIV causes AIDS, although surprisingly, recently, there were geologists who thought that the theory of plate tectonics is incorrect. While usually wrong, such mavericks are indispensible to the progress of science, forcing others to constantly test their assumptions, evidence and results. But politicians who make mascots out of mavericks are invariably engaging in advocacy. They are fond of saying that science is not done by consensus. This is true, but if policy is not formulated on the basis of a sound scientific consensus, then it is almost certainly based on political considerations.

Dealing with risks entailed in climate change will be extraordinarily difficult, and reasonable people will differ on questions of strategy. But citizens expect their representatives to confront this issue in an open and honest way. Making mascots of scientific mavericks or shooting the messengers are not rational options. Nations that are first off the mark in developing new technologies and policies that address the risks, selling those technologies to rapidly developing countries will prosper.

Now, let me finish by speaking to you more as a citizen than as a scientist. We properly revere our forefathers for making material and mortal sacrifices for our benefit. One only hopes that our descendants will hold us in similar regard. Thank you.

[The prepared statement of Mr. Emanuel follows:]

PREPARED STATEMENT OF DR. KERRY EMANUEL, PROFESSOR OF ATMOSPHERIC SCIENCE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

I am Kerry Emanuel, the Breene M. Kerr Professor of Atmospheric Science at the Massachusetts Institute of Technology, where I have been on the faculty for almost 30 years. I have taught atmospheric science and climate physics for nearly 33 years and am a member of the National Academy of Sciences. I am here today to affirm my profession's conclusion that human beings are influencing climate and that this entails certain risks. If we have any regard for the welfare of our descendents, it is incumbent on us to take seriously the risks that climate change poses to their future and to confront them openly and honestly.

By the closing decades of the 19th Century, science had firmly established that the main constituents of our atmosphere, molecular nitrogen and oxygen—which together comprise about 97% of the mass of the atmosphere—are almost completely transparent to solar and terrestrial radiation. Without the handful of trace gases

that do interact with radiation, notably water vapor, carbon dioxide, and methane, our planet would be a snowball. Of these so-called greenhouse gases, water vapor is the most important, but cycles through the atmosphere on a time scale of roughly two weeks. Its concentration is highly variable and is controlled mostly by temperature; warming the atmosphere increases its concentration. The other important greenhouse gases include carbon dioxide, methane, and nitrous oxide. These gases have atmospheric lifetimes of decades to thousands of years and have concentrations that are approximately constant over the globe. It is a remarkable fact that these long-lived gases, though they constitute a tiny fraction of our atmosphere, make life as we know it possible. I reiterate that these basic facts of physics and chemistry were established more than a century ago and are not remotely controversial among scientists.

Already in 1897 the Swedish chemist Svante Arrhenius predicted that industrial activity would increase carbon dioxide concentrations and calculated (by hand) that doubling the concentration would cause global surface temperatures to rise by 5–6 degrees centigrade. Modern science projects somewhat lower temperature increases, but Arrhenius's estimate is remarkably close to modern estimates considering the information and techniques at his disposal. Today, students at MIT and elsewhere can do hand calculations or use simple models of radiative and convective heat transfer to explore climate physics, and they find climate sensitivities in the same range as those reported in the first National Academy of Sciences report on anthropogenic climate change in 1979. Global climate models were first developed in the 1960s and have advanced rapidly over the past few decades; they are used as tools to help us understand and predict climate, but it is not the case that they are the single or even most important tool for these purposes. Even before the advent of global models, there was enough science to warrant concern, and already in 1965 President Lyndon Johnson warned Congress that we were changing the composition of our atmosphere at our peril.

Understanding of climate physics was such that, by 1950 or so, we could state with confidence that doubling carbon dioxide concentration would increase global surface temperatures by just over 1 degree centigrade if there were no feedbacks in the system. The most important feedback—increasing water vapor with temperature—serves to amplify the warming. Other feedbacks involving clouds, aerosols, ocean currents, and many other attributes of the complex system remain somewhat uncertain, and when codified in the form of climate models are the principal sources of the still considerable uncertainty in climate projections.

Highly accurate measurements of carbon dioxide began in 1958 and show beyond doubt that concentrations have been increasing from their pre-industrial value of around 280 parts per million to over 390 parts per million today. Analysis of gas bubbles trapped in ice cores show that current levels have not been experienced on our planet for at least a million years.

It is hardly surprising the doubling the concentration of the most important long-lived greenhouse gas will lead to noticeable climate change. Paleoclimate studies inform us that climate change over the history of our planet has been caused primarily by changing sunlight, owing to changes in the sun itself and to the earth's orbit around it, to aerosol particles injected into the atmosphere by volcanoes, and by changing concentrations of greenhouse gases. For example, increased levels of greenhouses gases remain the only plausible mechanism for explaining very warm climates such as that of the Eocene around 50 million years ago, when tropical plants and animals lived near the North Pole.

Over the past few decades, when solar output, as measured by satellites, has been decreasing slightly, there is little doubt that increasing global temperature is attributable to ever more rapidly increasing concentrations of greenhouse gases. We are undertaking an enormous experiment, and so far the response of the planet has been pretty much along the lines predicted more than a century ago.

And yet our understanding of the climate system is far from perfect. We do not fully understand such issues as the feedback effects of clouds and the cooling effect that manmade aerosols have on climate. These uncertainties are reflected in climate projections, which at present range from benign to catastrophic.

It is in such a scientific environment that our generation confronts the various risks associated with climate change. These risks have been well catalogued and endlessly discussed, but let me here focus on just one: the changing distribution of the supply of water. One of the more robust consequences of a warming climate is the progressive concentration of rainfall into less frequent but more intense events. Dry areas of the world, such as the Middle East, are expected to become drier, while flash floods should become more frequent. We are already seeing evidence of these changes in rainfall data. Reductions in rainfall in semi-arid regions lead to decreasing agricultural production, which in turn leads to food shortages. The potential for

political destabilization of these regions is large and is matter of great concern to our Department of Defense, as outlined in their 2007 report *National Security and the Threat of Climate Change*.[1] To quote directly from that report: *Unlike most conventional security threats that involve a single entity acting in specific ways and points in time, climate change has the potential to result in multiple chronic conditions, occurring globally within the same time frame. Economic and environmental conditions in already fragile areas will further erode as food production declines, diseases increase, clean water becomes increasingly scarce, and large populations move in search of resources. Weakened and failing governments, with an already thin margin for survival, foster the conditions for internal conflicts, extremism, and movement toward increased authoritarianism and radical ideologies. The U.S. may be drawn more frequently into these situations, either alone or with allies, to help provide stability before conditions worsen and are exploited by extremists. The U.S. may also be called upon to undertake stability and reconstruction efforts once a conflict has begun, to avert further disaster and reconstitute a stable environment. And, The U.S. and Europe may experience mounting pressure to accept large numbers of immigrant and refugee populations as drought increases and food production declines in Latin America and Africa.*

Among the recommendations of this report is one that states that *The U.S. should commit to a stronger national and international role to help stabilize climate change at levels that will avoid significant disruption to global security and stability.*

In assessing risk, scientists have historically been notably conservative. It is part of the culture of science to avoid going out on limbs, preferring to underestimate risk to provoking the charge of alarmism from our colleagues. A good example is the recent tragic earthquake and tsunami in Japan. Examination of seismic risk maps prepared before that earthquake show that the seismologists had estimated that the magnitude of the largest earthquake that one could reasonably expect to encounter in the region was about 8.2, substantially weaker than what actually occurred. For this reason, the Fukushima-Daiichi nuclear power plant was not designed to withstand the magnitude of earthquake and tsunami that disabled it. In our own country, the levees that protect New Orleans were designed for storm surge events somewhat less severe than we now believe are likely there. And, in the climate arena, summertime arctic sea ice has been declining somewhat more rapidly than had been projected.

Far from being alarmist, scientists have historically erred on the side of underestimating risk.

In recognition of the potential importance of manmade climate change, scientists organized one of the largest efforts ever made to communicate science to the public and to policy makers. I speak of the Intergovernmental Panel on Climate Change, developed under the auspices of the World Meteorological Organization in 1988. It is strictly a communications enterprise (it neither performs nor supports research) and involves large numbers of climate scientists. In my view, the four assessment reports it has issued so far continue the conservative tradition in science. For example, in its second report, issued in 1995, fully seven years after climate scientist James Hansen told Congress he was 99% certain that increasing greenhouse gas concentrations were causing the earth to warm up, the IPCC said rather more cautiously that *"The balance of evidence suggests a discernible human influence on global climate."* But by the time it issued its most recent report, in 2007, the large amount of evidence that had accumulated in the interim forced it to conclude that *warming of the climate system is unequivocal,* and that *most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.* The report, which includes the input of more than 1,200 authors and 2,500 scientific expert reviewers, goes on to review the evidence in great detail, including projections for the next century, likely risks, and the uncertainties involved. A great many scientists whom I know personally took time off from their research and devoted enormous effort to this enterprise whose sole aim is to provide information to people and their representatives.

In addition to the work of the IPCC, essentially all of the professional societies around the world that deal in any way with climate have issued strong statements drawing attention to the risks associated with anthropogenic climate change.

Now I want to speak to you not only as a scientist but as a citizen. I am appalled at the energetic campaign of disinformation being waged in the climate arena. I have watched good, decent, hard-working scientists savaged and whole fields of scholarship attacked without merit. Consider as an example the issues surrounding

[1] Available from the CNA Corporation, 4825 Mark Center Drive, Alexandria, Virginia, 22311, or http://securityandclimate.cna.org/report/

the email messages stolen from some climate scientists. I know something about this as I served on a panel appointed by the Royal Society of Great Britain, under the direction of Lord Oxburgh, to investigate allegations of scientific misconduct by the scientists working at the Climate Research Unit of the University of East Anglia. Neither we nor several other investigative panels found any evidence of misconduct. To be sure, we confirmed what was by then well known, that a handful of scientists had exercised poor judgment in constructing a figure for a non peer-reviewed publication. Rather than omitting the entire record of a particularly dubious tree-ring-based proxy, the authors of the figure only omitted that part of it that was provably false. If this was a conspiracy to deceive, though, it was exceedingly poorly conceived as anyone with the slightest interest in the subject could (and did) immediately find the whole proxy record in the peer-reviewed literature.

The true scandal here is the enormously successful attempt to elevate this single lapse of judgment on the part of a small number of scientists into a sweeping condemnation of a whole scholarly endeavor. When the history of this event is written, the efforts of those seeking to discredit climate science will be seen for what they are; why many cannot see it now is a mystery to me.

It falls to our generation to confront a global problem of potentially enormous implications. There are three aspects of this problem that make it particularly difficult to deal with:

1. It is global. All countries emit greenhouse gases to varying degrees, and it is therefore politically very difficult to regulate such emissions.
2. The risks, while potentially large, are still very uncertain, and in my view, the level of uncertainty is not likely to drop anytime soon.
3. While the costs of confronting these risks will fall largely to our generation, the primary beneficiaries of our actions will be our children and grandchildren, not us.

In facing this highly difficult problem, reasonable people will differ in what approaches to take. But citizens have a right to insist that their representatives confront this complex problem in an open and honest way. In soliciting advice, we should be highly skeptical of any expert who claims to be certain of the outcome. I include especially those scientists who express great confidence that the outcome will be benign; the evidence before us simply does not warrant such confidence. Likewise, beware those who deride predictive science in its entirety, for they are also making a prediction: that we have nothing to worry about. And above all, do not shoot the messenger, for this is the coward's way out of openly and honestly confronting the problem.

Finally, let me emphasize what many others have pointed out before: Those nations that are first to develop sensible technology and policies to deal with climate change and pollution will likely attain great economic advantages. The market for clean energy in China alone is of staggering proportions. Nations that invest in energy research and in novel ideas in such fields as carbon sequestration and that foster enterprises that are in a position to sell such technologies to rapidly developing countries will prosper.

In her past, the U.S. helped the world confront such global problems as fascism and communism. As a citizen, I hope that my country will once again rise to the challenge and assume leadership in this arena too.

SUMMARY OF WRITTEN STATEMENT OF DR. KERRY EMANUEL, PROFESSOR OF ATMOSPHERIC SCIENCE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

1. The scientific basis for the existence of significant risks from anthropogenic climate change is solid and rests on principles established more than a century ago, as well as on records of the earth's climate as recorded by instruments and in the geologic record.

2. The conclusions of the scientific community that warming of the climate system is unequivocal, and that most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas rests on sound scientific research.

3. Historically, scientists have tended to underestimate risk.

4. Notwithstanding any of the above, there is universal agreement among scientists that current assessments of climate change risk are highly uncertain.

5. There is no scientific basis for the confidence expressed by some that the effects of climate change will be benign.

6. In respect to the stolen emails, while there is general agreement that the preparation of a particular graph by a few scientists shows poor judgment, there is no evidence for intent to deceive. Efforts by some to leverage this into a sweeping condemnation of a whole scholarly endeavor should be seen for what they are.

7. Dealing with the risks entailed in climate change will be extraordinarily difficult, and reasonable people will differ on questions of strategy. Citizens will expect their representatives to confront this issue in an open and honest way; making mascots of scientific mavericks or shooting the messengers are not rational options.

8. Nations that are first off the mark in developing new technologies and policies that address the climate issue, and selling these technologies to rapidly developing countries, will prosper.

9. We revere our forefathers for making material and mortal sacrifices for our benefit. One hopes that our descendents will hold us in similar regard.

Chairman HALL. Thank you. I now recognize Dr. David Montgomery, an economist, Ph.D., from Harvard, for his testimony.

STATEMENT OF DR. DAVID MONTGOMERY, ECONOMIST

Dr. MONTGOMERY. Thank you, Chairman Hall, and Ranking Member Johnson to testify before the Committee. I am not here to question climate science. I am an economist, and instead what I intend to discuss are failures in economic analysis that I believe have led scientists and others to reach entirely unjustifiable conclusions about public policy.

The economics of climate policy are in fact shaped by several generally accepted propositions from mainstream climate science. It is a global phenomenon, driven by global emissions, so it does not matter where the emissions came from. Concentrations of greenhouse gases in the atmosphere are what matter, not emissions in a single year, and these concentrations change very slowly. And stabilizing global temperatures at any level ultimately requires reducing net greenhouse gas emissions to zero.

These propositions lead to some important economic principles. To avoid unnecessary economic harm, policy must involve comparable efforts by all countries. Mandates for emission reductions must not get out ahead of technology readiness, and effective R&D policy is essential.

Now, reducing greenhouse gas emissions will have a cost. All of the comprehensive economic models used to study past proposals before this Congress have agreed on this point. Model results differ about the size of these costs, but the differences stem from the model's varied assumptions, particularly those about future tech-

nology and about the nature of the policies that are assumed to be employed. All models find that the deeper the emission cuts are, the higher is the cost of making them. Moreover, these costs are not just waiting a few months for GDP to catch up as EPA officials are fond of saying. Their loss is every year relative to the standard of living that would otherwise be achieved, and those costs grow over time.

We keep hearing that we need emission regulations to create jobs and new industries. Green jobs claims are simply wrong and come from studies that only tell half the story. They add up jobs in producing green energy and ignore what happens to all the rest of the economy that would face higher energy costs and an eroded competitive position. This is so obvious to economists that few have even bothered to comment. Nor will climate regulations enable a U.S. clean energy industry to compete more effectively in global markets. Regulations may create a demand for low-carbon energy, but the evidence is clear that industries producing that equipment are increasingly being located in countries that do not bear the cost of reducing their own emissions.

There are a number of additional ways in which the cost of policy is intended to reduce greenhouse emissions have been underestimated in recent studies and their benefits exaggerated. Two points are very important. Studies that use current policy baselines ignore the cost of greenhouse gas policies that were put in place by past legislation, like the Energy Security Act and the stimulus package when they look at the cost of, say, a proposal for cap-and-trade regulations. It is like celebrating how much cheaper a home improvement project has become because you paid half the bill in advance. You have to look at the whole thing, unfortunately.

Many of these studies do not model the actual policies being proposed and instead estimate the much lower cost of idealized optimal policies, and you are going to face a very large problem when you hear about estimates of the cost of EPA regulations because there is no economic model that can really capture all the distortions that they are going to create in the economy, and they will probably assume something much more efficient in coming to you with cost estimates.

Now, there are other practices that underestimate costs such as widespread use of what many of my colleagues and I call free lunch assumptions that I cover in my written testimony.

If fears about climate change are correct, curbs on greenhouse gas emissions will have some benefit, but the harm to the United States that can be avoided directly by our action is often greatly exaggerated. I discuss the topic of avoided damages from climate regulations and how they have been distorted in my written testimony. Right now I would like to just make one point, that efforts to reduce our own emissions would make almost no direct difference to global temperature, especially if industrial production and associated emissions are simply exported to other countries.

The Environmental Protection Agency's own modeling of climate impacts of the Lieberman-Warner bill, using a model developed at Pacific Northwest Laboratories in the University of Maryland called Minicamp shows that the Lieberman-Warner bill which would have had massively expensive economy-wide effort to reduce

greenhouse gas emissions would only reduce global concentrations of greenhouse gases by 12 parts per million and that is against a target of 550 parts per million. By itself, the U.S. can't make a difference, and therefore there will be no benefits to the U.S. of unilateral action, and there is no sign that China, India and other rapidly industrializing countries would take actions that would undermine their economic interests.

Unless we find a more effective approach to international action that brings them along, U.S. emission reductions are likely to have costs far greater than their benefits. Thank you, Mr. Chairman, and Ranking Member Johnson.

[The prepared statement of Mr. Montgomery follows:]

PREPARED STATEMENT OF DR. W. DAVID MONTGOMERY, ECONOMIST

Mr. Chairman and Members of the Committee:

I am honored by your invitation to testify today. I am an economist by profession and training and am at this moment an independent consultant. I will start with a brief word about my qualifications. My work for the past 20 years has concentrated on economic issues in climate policy. I have published many papers in peer-reviewed journals dealing with design and economic impacts of climate policies, and I was honored by the Association of Environmental and Resource Economists with their 2004 award for a "publication of enduring quality" for my pioneering work on emission trading. I taught environmental economics at the California Institute of Technology and economic theory at Caltech and Stanford University. I was a Principal Lead Author of the IPCC Second Assessment Reports chapter that dealt with the costs of climate change policy and until recently I led the group at Charles River Associates that developed a pioneering set of economic models and used them in studies of virtually every major proposal for national and global climate policy. My testimony today will address the Committees concerns about the economic analysis of climate policy. Needless to say, these are my own opinions.

I. Summary

Climate change is a global phenomenon driven by global emissions. Concentrations of greenhouse gases in the atmosphere are what matter, not emissions in a single year, and these concentrations change very slowly. Stabilizing global temperatures at any level requires ultimately reducing carbon dioxide emissions from energy use to near zero. To avoid unnecessary economic harm, policies must involve comparable efforts by all countries, mandates for emission reductions must not get out ahead of technology readiness, and effective R&D policy is essential.

Reducing greenhouse gas (GHG) emissions will have a cost. All the comprehensive economic models used to study past proposals have agreed on this point. Model results do differ about the size of these costs, but the differences stem from the models' varied assumptions about future technology and the effectiveness of a global emission trading system. All models also find that the deeper are the emission cuts, the higher is the cost of making them. Some recent studies that make claims to the contrary have recently garnered undue public attention, but the fact remains that regulatory or cap and trade policies will not lead to a net increase in U.S. jobs, nor will they create conditions for a U.S. clean energy industry able to compete more effectively in global markets.

Studies that purport to show that GHG controls will produce these outcomes make a number of common errors. To be sure, if fears about climate change are correct, curbs on GHG emissions will have some benefit. But the harm to the U.S. that can be avoided directly by U.S. action is often greatly exaggerated. Most of the damage from climate change will occur in countries without adequate public health systems and with poor, undernourished and unempowered populations. Four points are crucial to keep in mind. First, if the U.S. were to act without solid assurance of comparable efforts by China, India, and other industrialized countries, its efforts would make almost no difference to global temperature, especially if industrial production and associated emissions are simply exported to other countries. Second, even global action is unlikely to yield U.S. benefits commensurate with the costs it would incur in making steep GHG emission cuts. Third, globally, even with moderate emission reductions, benefits would not be much greater than costs, and, fourth, conflicting economic interests will make international agreements on mandatory limits unstable.

II. Climate economics is driven by three features of climate change

First, climate change is a global phenomenon driven by global emissions. A ton of carbon dioxide put in the air by China causes the same effects on Washington DC as a ton from a power plant in Alexandria. And China has already surpassed the U.S. as the largest emitter of carbon dioxide, and together with other rapidly developing countries will be responsible for the vast majority of emissions over the next century. Their growth is so rapid that even if the U.S. and all other industrial countries ceased all greenhouse gas emissions tomorrow, climate models would still predict global warming to continue unchecked, after a brief pause.

Second, concentrations of greenhouse gases in the atmosphere are what matter, not emissions in a single year, and these concentrations change very slowly. Emissions today are harmless to those in the vicinity of their sources, and matter only because of the consequences of their slow buildup that are predicted by climate models. Most of the carbon dioxide released today will still be in the atmosphere 50 years from now, so that the time scales on which climate policy must operate are very long.

Third, stabilizing global temperatures at any level requires reducing carbon dioxide emissions from energy use to near zero. The smaller the temperature increase society feels is tolerable, the more rapidly this must happen and the lower emissions must go. Achieving near-zero emissions is not possible with today's technology; it requires R&D for and deployment of technologies not known today in every aspect of energy production and use. [1]

These three points have very important implications for the costs and benefits of U.S. climate policy:

1. Reductions in U.S. greenhouse gas emissions, taken by themselves, will not noticeablely lessen the impacts of climate change on the United States. The Energy Information Administration projects that the U.S. will contribute about 20% of cumulative global emissions by 2035. [2] But even if the U.S. were to succeed in reducing its emissions to 75% of 2007 levels by 2035, that would make only a 3% difference in cumulative global emissions between now and 2035 and have virtually no effect on temperature increases. The Kerry-Boxer bill that was rejected in the last Congress set the ambitious goals of lowering U.S. emissions to 20% below 2007 levels by 2020 and 50% below by 2035. [3] Even these ambitious targets would lead to only about a 7% reduction in cumulative global emissions over that time period. It is no surprise then that the EPA Administrator herself has admitted that EPA's proposed GHG rule will make virtually no difference to global emissions or impacts on the U.S. Action by the United States cannot possibly be in U.S. national interest unless it is part of a larger bargain in which all other major emitters make similar efforts.

2. Achieving reductions in emissions at minimum cost requires Where, When and How flexibility. **Where** flexibility means that on a global and regional scale, emission reductions must occur where they cost least. A system in which the United States adopts costly reductions and China does nothing, in addition to being insufficient to prevent the projected rise in temperature, is an excessively costly way of achieving whatever reductions do occur. **When** flexibility means that targets for reducing emissions must not get ahead of the availability of cost-effective technologies for achieving them. **How** flexibility means that all sources of emissions must be included so that all the lower cost opportunities to reduce emissions are used before more costly ones.

3. Achieving near-zero emissions will require a much more effective program of incentives for R&D into low carbon energy sources and energy efficiency technologies than has ever been seen in U.S. energy R&D. I convened a group of the most distinguished scholars who have studied the economics of R&D at Stanford two years ago. They produced a set of recommendations for R&D policy that would focus government funding on a much more risky program of basic and applied research and leave most development and all demonstration and deployment to the private sector: it would use stable and credible incentives to stimulate private investment in development, demonstration and deployment.

---

[1] Martin I. Offer, Ken Caldeira, Gregory Benford, David R. Criswell, Christopher Green, Howard Herzog, Atul K. Jain, Haroon S. Kheshgi, Klaus S. Lackner, John S. Lewis, H. Douglas Lightfoot, Wallace Manheimer, John C. Mankins, Michael E. Mauel, L. John Perkins, Michael E. Schlesinger, Tyler Volk, and Tom M. L. Wigley (2002). "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet," Science, 298(5595): 981–987.

[2] EIA, International Energy Outlook 2010, May 2010, Table A10.

[3] http://www.nicholas.duke.edu/thegreengrok/waxmanmarkey-vs-kerryboxer.

It would also avoid any direct funding of the white elephant demonstration projects that led to failure of many past energy R&D activities.[4] This would require the Department of Energy to concentrate its funding on high-risk early-stage R&D and require Congress to eschew the earmarking and micromanagement that has produced so little result for so much wasted money on energy technology development and deployment of costly and immature technologies.

III. Common errors that lead to job benefits and deny the existence of costs

I would like now to discuss a number of areas where I believe that there are serious problems with studies of the economic costs and benefits of climate policy. I start with the most questionable studies. These conclude that, by mandating the premature retirement of electric generators and increasing the cost of automobiles and most other goods and services climate policy would create massive numbers of new jobs and stimulate economic growth. I take as an example a series of studies by the Political Economy Research Institute on job benefits of climate policy and other environmental regulations. The most recent of these was based on studies funded by Exelon Corporation and released last month by the Center for American Progress and Ceres.

Telling only half the story about jobs

The PERI study and its like only reach their happy conclusions about economic benefits because they leave out of their calculations all the jobs lost in the rest of the economy because of environmental regulations and the costs they impose. In its calculations of the net jobs created by Clean Air Act regulations that would force retirement of a large number of coal-fired powerplants, PERI did not even include the loss in coal mining jobs that would be caused by lower coal demand. And it completely ignored all the jobs affected in the rest of the economy by higher energy costs and loss in competitive advantage of U.S. industries.

Green jobs studies can make these errors because they do not use a model of the U.S. economy—they simply uses numbers called multipliers that add to the direct jobs involved in producing pollution control and generating equipment an estimate of jobs supplying materials used in that production. If PERI used any comprehensive model of the U.S. economy, it would be forced to account for where the mandatory spending on compliance with carbon limits and other environmental regulations came from.

In previous testimony I described how I used CRAs model of the electric power sector (that supplied the estimates of investment in generation used by PERI), but linked it to CRA's broad model of the entire economy, I found exactly the opposite results from PERI. PERI calculated an increase of 1.5 million jobs from EPA's utility regulations but it ignored what happened to investment outside power generation. EPA's regulations would reduce, not increase, total macroeconomic investment, by increasing the cost burden on new investment. The reduction in investment would be about $150 billion from 2010–2015. If these numbers were used with PERI's multipliers the result would be net destruction of over 1 million jobs. I am not espousing either +1.5 million or -1 million jobs as a useful number, my point is that people would have had jobs doing something else if these regulations were not put in place, and it would be doing something that creates more wealth.

Even PERI's calculations of jobs directly associated with compliance are exaggerated because they assume that 100% of the required new equipment will be manufactured in the United States. As I discuss later, there is clear evidence that this is not happening.

The Luddite approach to industrial policy

Studies like PERI explicitly recommend climate and other environmental regulations because they would favor industries that employ more employees per dollar of output and would direct investment away from industries that employ less workers per unit of output. This is nothing more than the Luddite program to save jobs by breaking up productivity-enhancing machines.

More output per worker is the major indicator of technical progress and increasing productivity in the economy. Increasing labor productivity through capital investment and technology improvement is what drives economic growth and undergirds our standard of living. The overall effect of restructuring the economy toward labor intensive industries and processes can only be to lower output per worker and to lower average wages.

---

[4] Arrow, Kenneth J., Linda R. Cohen, Paul A. David, Robert W. Hahn, Charles D. Kolstad, Lee L. Lane, W. David Montgomery, Richard R. Nelson, Roger G. Noll, Anne E. Smith (2008). "A Statement on the Appropriate Role for Research and Development in Climate Policy," *The Economists' Voice,* 6(1): Article 6.

Indeed, the logic of the PERI report implies that the greater the unproductive investment caused by a regulation, the greater its beneficial impact on jobs. If that logic were really valid, rather than seeking cost effective regulation we should seek out the highest cost way to achieve environmental goals. The result is absurd because the 'logic' upon which it is based is nonsense.

Believing there is a free lunch in energy efficiency and green energy

There is a long tradition of "bottom-up" studies that do not examine macroeconomic effects or market responses, but conclude based on simple engineering models that greater investment in energy efficiency would produce direct monetary savings in excess of their costs. My experience with these studies goes back to the early 90s when a series of studies by the ACEEE, UCS and OTA produced analysis and conclusions virtually identical to the "McKinsey Curve" that has become so popular in recent years. Despite a series of detailed criticisms by economists, these conclusions are repeated over and over again. [5]

All the studies contradict the basic principle that 'there is no free lunch' unless specific market failures or government interventions distort the incentives that are conveyed by market prices. Unless these market or government failures exist, the free lunch conclusions imply that households and businesses are consistently mistaken in a major way in making choices about energy use that it is in their own economic interest to get right. And the policy conclusion that energy efficiency standards, technology mandates, or subsidies are the remedy implies that government agencies could do a better job of making those decisions for them.

This has come to be known as the "conservation paradox:" simple engineering studies find that certain energy conservation practices and technologies should on balance save money while observations of actual behavior show that those practices and technologies are not adopted. The technologists' answer is that people are in general wrong or some hidden and unspecified market failure must exist. The economists' answer has been that the engineering studies are missing hidden costs, barriers, or other consequences of adopting more energy efficient vehicles, appliances, structures, and equipment that matter to people.

Considerable research remains to be done on the conservation paradox. Stanford's Energy Modeling Forum is conducting a workshop in which leading bottom up and top down models, including that which I developed at CRA, are participating. An institute at Stanford University headed by Professor James Sweeney is conducting behavioral research. Perhaps the most comprehensive work has been done by my co-author in the IPCC Mark Jaccard at Simon Fraser University in Canada, who finds that upon closer examination the claims of net cost energy savings are almost universally false.

Any claim that a regulation or standard will on balance save money should be regarded with a high degree of skepticism unless accompanied by a well researched and peer reviewed demonstration that the specific action will cure a market failure, and do so without administrative costs great enough to wipe out the gains. As EPA and Congress move more and more into regulating greenhouse gas emissions through traditional command and control regulations and technology mandates and subsidies, this becomes a critical element of sensible policymaking. And the gutting of the agencies that provided critical review of regulatory analysis, such as the OIRA at OMB and OPA at EPA, has just about eliminated that review in the Executive Branch. [6]

Claiming that climate policy will promote a new clean energy industry in the U.S.

Costly greenhouse gas regulations are not likely to create industries producing clean energy equipment for export or domestic use. The experience of the past decade has proven that environmental standards or clean energy mandates will not create industries in the United States that will export clean technology to the rest of the world. To the contrary, the cost of such mandates is borne where they are imposed, but the equipment may well be produced by workers in other countries. For instance, in 2008 U.S. wind turbine imports were $2.5 billion and exports were $22 million; less than half the wind turbines installed in the U.S. in 2007 were manufactured by U.S. companies. [7] China is becoming the world's largest manufacturer of

---

[5] Adam B. Jaffe and R. N. Stavins. "Energy-Efficiency Investments and Public-Policy." The Energy Journal 15. 2 (1994): 43–65. Mark Jaccard and W. David Montgomery "Costs of Reducing Greenhouse Gas Emissions in the USA and Canada." In Energy Policy, Vol. 24, No. 10. pp. 889–898. October/November 1996.

[6] Randall Lutter and Richard Belzer, EPA Pats Itself on the Back, Regulation Vol 23, No. 3.

[7] USITC, Wind Turbines: Industry and Trade Summary, Office of Industries, Publication ITS–02.

wind equipment,[8] and exporting that technology to the U.S. solar manufacturers, including some of the technologically advanced, are moving to China to manufacture the solar arrays.[9] German experience has been similar; its huge subsidies for wind energy largely drew electric power from Denmark where the generation capacity had already been installed. And now Vestas (Denmark's largest wind producer) recently closed all or most of its Danish manufacturing, despite the large EU demand for such technologies.

Economic theory and the experience in Europe and the United States with renewable energy policies show the effect is the opposite of stimulus to clean technology industries. Clean energy equipment will be produced where it is least costly to do so, and domestic policies that raise energy costs can shift that comparative advantage against the U.S. Regulations create a demand in the U.S. for that equipment, but leave it open to all to supply that equipment. At the same time, environmental regulations increase the cost of doing business in the U.S. relative to other countries. Thus domestic manufacturers of mandated equipment and its components are put at a cost disadvantage relative to competitors located in countries that do not incur the cost of regulation. The result is to shift the supply chain for pollution control and electric generation equipment offshore toward less regulated regions where companies are better able to compete in producing components for powerplants and pollution controls. The result is that regulation increases demand for pollution control equipment but reduces domestic supply.

Even if the goal of industrial policy were accepted, mandatory reductions on greenhouse gas emissions are the wrong way to go about it. A study by economist Michael Spence that was discussed in the *Washington Post*[10] confirms this point. Spence points out that what he calls the tradable sector—which includes manufacturing—has grown in output but not jobs, while the nontradable sector—principally government and health care—has provided the job growth. He then addresses the challenge of how to create U.S. job growth in the tradable sector—which means policies that improve the productivity of U.S. workers so that growth in output is not accompanied by increased outsourcing. Modeling of greenhouse gas regulations that I will discuss later shows that they increase costs and lower worker productivity, thus leaving U.S. workers even more vulnerable to competition from cheaper foreign suppliers. This is not to say that climate policy should be abandoned, but it does imply that it must be designed carefully and sparingly because it does make the task of spurring job growth and income equality more difficult.

IV. Common errors in discussing climate benefits or avoided damages

The most fundamental error is failing to admit how little is known about the direct causes of damage to human and economic systems that have been attributed to climate change. Climate models predict various geophysical consequences of increasing greenhouse gas emissions—change in global average temperature is the fundamental outcome of interest. Different models produce increasingly inconsistent results when they attempt to predict the regional distribution of temperatures or of other climatic variables such as rainfall. In order to predict effects on agriculture, the range of disease vectors, or other land related effects an even finer scale on which the models produce nothing of value is required, as are many other assumptions about levels of institutional development, public health systems, and on and on.[11] Some changes may be beneficial, such as increased growing seasons and carbon dioxide fertilization in high latitudes, and some are negative, such as drought or storms in tropical areas. But the range of possibilities and whether it adds up to a positive or a negative in any particular region is impossible to predict with confidence. Therefore, any economic evaluation of damages is equally uncertain.

Another, and more intentional distortion, is describing total effects of climate change rather than damages avoided by actions under consideration. Many times the argument for action starts by describing all the potential damaging consequences of temperature increases above today's level and the costs they would impose, and then uses this image to support a particular action or proposed legislation

---

[8] "With their government-bestowed blessings, Chinese companies have flourished and now control almost half of the $45 billion global market for wind turbines. The biggest of those players are now taking aim at foreign markets, particularly the United States, where General Electric has long been the leader." Keith Bradsher, New York Times, Dec 14, 2010.

[9] Edward L. Glaeser: Why Green Energy Can't Power a Job Engine—NYTimes.com. http://economix.blogs.nytimes.com/2011/01/18/why-green-energy-cant-power-a-job-engine/?ref=business.

[10] Steven Pearlstein, Good for GDP not good for workers, *Washington Post* March 13, 2001, G–1.

[11] See paper by Robert Mendelssohn on impacts of climate change on land-based activities and comment by David Montgomery in forthcoming book published by the Lincoln Land Institute.

that cannot avoid more than a fraction of that damage. In analyzing any particular policy the costs of that policy must be compared to the damage it avoids. It is shocking how rarely this fundamental economic principle is violated.

Benefits are also overstated by exaggerating fears of health effects and other damages to the U.S. based on what is only likely to happen in poor countries without adequate public health infrastructure and with populations vulnerable due to poverty and poor diet. Concern about greater prevalence of tropical disease in the United States is the most egregious example, when the U.S. public health system already eliminates that risk through vaccination and vector eradication. It is not because of temperature that malaria stops at the US–Mexican border.

There are a number of other more technical errors that lead to overestimation of damages. The first is ignoring how individuals and businesses will adapt to climate change in order to avoid harm. This error was labeled the "dumb farmer" approach in pioneering work by Robert Mendelsohn of Yale who showed the large reduction in damages when it is assumed that farmers adapt through changing farming practices rather than continuing with practices that are more vulnerable to changes in climate.

Another error is including avoided damages that occur in all the rest of the world in estimates of the social benefits of greenhouse gas reductions in the United States. This approach was adopted by the U.S. government in its guidance for calculating the social cost of carbon for use in cost-benefit within the U.S. government. It leads to choices that have significantly higher costs than the benefits they provide in the United States.

The final error that exaggerates distant benefits relative to near term costs is the use of low discount rates derived from ethical arguments rather than economically meaningful discount rates that represent economic costs of displacing more productive investments with less productive ones.

V. Common errors that lead to underestimating costs

A review of modeling studies of costs of climate regulations reveals four common errors that lead to underestimating costs.

The first I call hiding policy interventions in the baseline. This is particularly a problem because of the incremental approach we have taken to adopting a climate policy. Fuel economy and renewable fuel standards were adopted in ACES. Subsidies for renewable technologies were expanded in the stimulus package. Fuel economy standards have been tightened again under the Obama administration. Each time this happened, the EIA included the new regulations in its reference case and lowered its emission forecast. This means that each time it analyzed the cost of a cap on greenhouse gas emissions—even when it had exactly the same provisions as a previous year's proposal—its costs came down. The prior regulatory programs hidden in the baseline appeared to be providing emission reductions at no cost. It is only by stripping out all explicit climate measures from the baseline—even those put in place in the past—that it is possible to calculate the full cost of committing to mandatory limits on greenhouse gas emissions.

A second common practice is assuming more efficient policies than are actually under consideration. This occurred in the Clinton Administration when the official estimate of the cost of the Kyoto Protocol assumed that all countries would participate in unrestricted emission trading, when under the actual provisions of the Protocol only industrial countries would do so. I observed the same thing in estimates in the cost of the Lieberman-Warner bill, when some of EPA's estimates assumed levels of availability of offsets that were not possible under the provisions of the law, and when estimates by other groups were based on earlier, less stringent legislative proposals. It is necessary to make sure that cost estimates are actually representing the policies on which a decision is to be made. This is going to be a major problem in evaluating EPA's proposed greenhouse gas regulations, because many models are incapable of incorporating the intricacies of those regulations and will simplify them to be no different from a carbon tax or cap and trade program.

This leads to a gross underestimate of the full cost of command and control regulations. The reason in simple terms why command and control regulations cost more than cap and trade is that they are designed by bureaucrats who know next to nothing about the circumstances of individual businesses. Therefore, their orders cannot possibly lead to the same cost-effective solutions that managers would find for their own businesses when facing a price on greenhouse gas emissions. Likewise, no model can incorporate sufficient detail to capture all the costs imposed by imposing uniform mandates or standards on a highly diverse population of households and businesses.

Costs are also underestimated in models that assume unproven "learning curves" for all green technologies (and no others). EPA's recent "Prospective" cost-benefit of

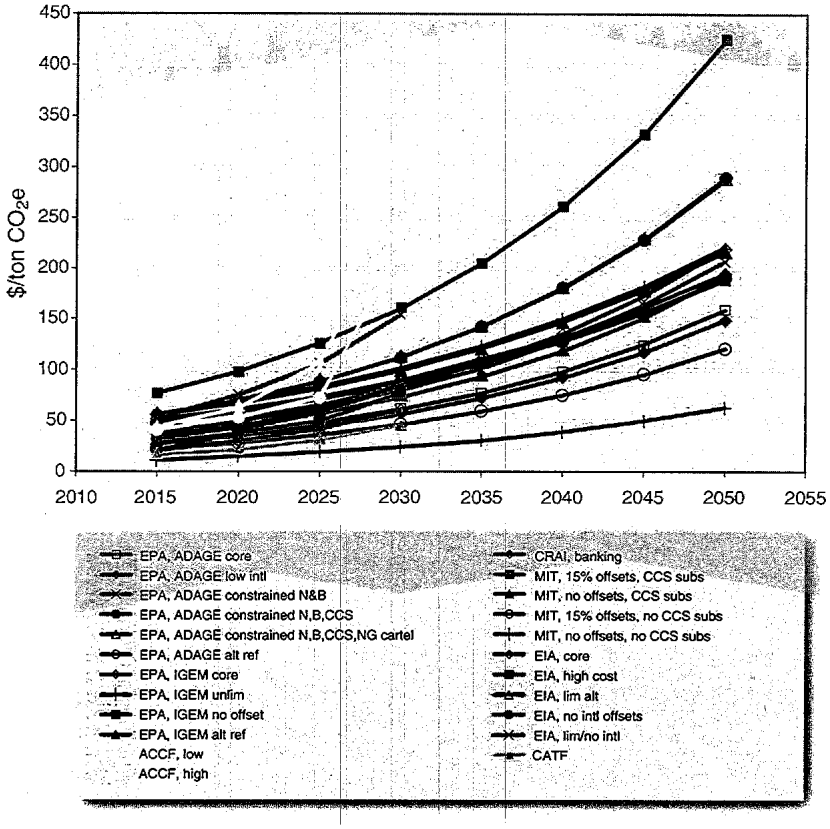
Clean Air Act regulations is a case in point. A substantial economics literature has arisen questioning whether the empirical observation that costs of some complex processes or equipment (semiconductors, airframes, for example) to decline as cumulative output increases indicates a causal connection that could be attributed to "learning." Several alternative explanations are equally compelling and have more support in case studies of actual R&D processes. These include the hypothesis that cost reduction comes from a combination of R&D to create new and less costly processes, followed by a limited period of learning; the likelihood that learning is specific to the worker, company or establishment and not able to be transferred to an entire industry, and the fundamental problem that costs may be falling because of general technology improvement over time that cannot be accelerated by producing the item more quickly.[12] Yet many studies of the cost of climate policies assume aggressive "learning curves."

Finally, some studies that reach only a single optimistic conclusion have failed to recognize adequately the uncertainty of future technologies. For example, the low costs found in some studies by the EIA are based on a highly questionable premise of the growth of nuclear generation.

VI. Findings of studies based on broadly accepted models and economic principles

Before turning to global issues, I would like to present some findings from broadly accepted models that have been used to estimate the costs of climate legislation in the United States. I will base these observations on presentations made at workshop held by the Electric Power Research Institute in May 2007 to which authors of all extant studies of the then-pending Lieberman-Warner bill were invited. This included the Energy Information Administration (EIA), the Environmental Protection Agency (EPA), the Congressional Budget Office (CBO), the Massachusetts Institute of Technology (MIT), Charles River Associates (CRA), the American Council for Capital Formation (ACCF) and the Clean Air Task Force (CATF)

[12] William D. Nordhaus, The Perils of the Learning Model For Modeling Endogenous Technological Change. Yale University December 15, 2008.



Source: Electric Power Research Institute, EPRI Modeling Workshop May 8, 2008

Although the graph that I have reproduced above [13] of costs per ton of emission reduction appears to show great diversity in estimates of impacts, all the models found that there would be costs to adopting emission controls, and the costs would become larger as deeper cuts are made in emissions.

It is striking that the variation within a single model due to different assumptions is far greater than across the economic models. Looking at 2030, CRA and MIT fall in about the same place on the cost per ton of emission reductions, EPA spans all the results of other models save those from ACCF, and EIA's model NEMS which was used by EIA, ACCF, and CATF spans an even wider range than EPA.

Moreover, the Chair pointed out that "While there are important differences in the modeling approaches and models used, much of the variation in the cost estimates appears to be driven by a handful of key assumptions, several of which are highlighted here:

Reference case

> Most modeling efforts rely on the Energy Information Administration's Annual Energy Outlook (AEO) to develop their reference case. In general, models that use an earlier projection of the baseline (AEO2006 or AEO2007) have to find more emission reductions to achieve the Lieberman-Warner targets and have higher costs—everything else equal—than those using the recent AEO2008 projection . . .

[13] Tom Wilson, Understanding Model Estimates of the Economic Costs of Climate Policy EPRI Modeling Workshop, May 8, 2008.

Technology Cost and Deployment

> In general, scenarios that limit the use of advanced, low and non-emitting electricity generation technologies result in higher costs; those that let them enter freely result in lower costs. Model results presented at this workshop show dramatic variations in renewable, coal with CCS and nuclear capacity additions . . .

Emission Offsets

> In general, scenarios that allow for compliance using offsets (emission reductions that are made outside of an emissions cap) show a much lower cost than those scenarios without offsets. Most groups do not model offsets in detail, but rather make relatively crude assumptions about their cost and quantity. Several teams did not include any international offsets in their analyses based upon their interpretation of the bill.

Time Horizon

> The EIA's NEMS model runs (used by several groups) extend through 2030, but most of the other models run through 2050. Different time horizons can affect compliance behavior (e.g. banking of extra credits), choice of technology deployments, and other aspects of model economics.

Discount Rates

> The models use discount rates (which define the time preference for money) ranging from 4 to 7%. This affects the time period in which emissions reductions are viewed to be most attractive from an economic point of view, and leads to differences in total economic cost." [14]

VII. Common errors in dealing with global nature of climate change

I have concentrated on costs of climate policies in the U.S. to the U.S. Let me say a few words about estimates of global costs and benefits of climate policy. Studies that avoid the errors and biases that I have described generally conclude that globally the benefits and the costs of even modest temperature goals would be of roughly of the same magnitude—if they could be achieved with perfect where, when and how flexibility.

But these studies are also overly optimistic, because they ignore two huge obstacles to achieving where, when and how flexibility:

- They ignore the institutional realities that are likely to prevent most countries from adopting the most cost-effective policies to reduce missions within their borders, and
- They ignore clear evidence that no global agreement on mandatory emission reductions is likely to be in the national interest of the countries that must participate for it to be effective.

Excessively costly national policies

Even national governments are complex institutions, and their workings can frustrate the adoption and enforcement of comprehensive emission limits or lead to the use of policies that are needlessly costly. There is good evidence that this will occur in the case of domestic GHG limits. In a recent study, a colleague and I used two examples, the United States and China, to illustrate how the systematic study of institutions and the political economy of choices can expand understanding of current policy choices and likely future progress in countries with very different kinds of political and economic institutions. [15] This analysis suggests several conclusions:

- There is a strong, systematic and comprehensible political logic that leads to choice of policies that differ widely from the economist's ideal of a single price on all greenhouse gas emissions.
- In the United States, the most cost-effective approaches, a carbon tax and cap and trade, were respectively never on the agenda and defeated in Congress. Instead we appear to be embarking on a piecemeal approach of command and control regulation through the Clean Air Act and technology mandates and subsidies through legislation. This outcome was completely predictable given the

[14] http://my.epri.com/portal/server.pt?open=512&objID=342&&PageID=223366&mode=2&in__hi__userid=2&cached=true.

[15] Lee Lane and David Montgomery (2010), "Political Institutions and Greenhouse Gas Controls," AEI Center for Regulatory and Market Studies (Revised August 2010).

history of comprehensive energy legislation and the nature of legislative institutions.

- In China it is likely to be difficult or impossible for the central government to enforce comprehensive and binding limits on greenhouse gas emissions; a related finding is that the outcome of China's adopting a comprehensive cap-and-trade policy is likely to be very different from that predicted by economic models that assume costless enforcement and efficient markets.

Impossibility of a single global commitment to mandatory reductions

Globally, the asymmetric distribution of costs and benefits implies that the national interests of even the most important states that must agree to a global climate regime are inconsistent with any agreement on mandatory emission limits. Most studies of the distribution of damages from climate change conclude that under the most likely scenarios the greatest harm will occur in poor countries located in tropical regions. The United States and Europe will suffer little direct harm in relation to the size of their economies, at least if sensible measures for adaptation are undertaken. Russia is very likely to benefit from warmer temperatures. Yet the distribution of present and future emissions is exactly the opposite. In other word, the countries that would have to undertake the largest emission reductions gain the least benefits. China and India are possible exceptions; they have very large emissions and are also threatened by great potential harm, at least in some regions.

This pattern of costs and benefits is not a formula for a successful agreement in which industrial countries make drastic emission reductions while also covering the cost of emission reductions and adaptation in poor countries. Only a willingness to incur high costs for the benefit of the poor countries of the world could motivate the U.S. to agree to such an outcome, and our current allocation of resources to aid gives no indication of such willingness. China and India might well find an agreement in their national interests, but both are hard bargainers and face their own institutional and political obstacles to carrying out meaningful reductions in emissions. Far from receiving compensation and adaptation assistance, poor countries would have to make payments to the rich in order to make an agreement be in the national interests of the wealthy countries of the world.

VIII. The net result

1. Even on a global scale, costs and avoided damages are quite similar.

The global net benefits of even optimal GHG controls appear to be relatively modest. One recent estimate pegged their present discounted value at slightly more than $3 trillion over the next two hundred and fifty years.[16] Compared to the size of the global economy, this is not a very big number. Also, controls are certain to be far from optimal,[17] and costs could easily exceed benefits.[18] The rewards of an agreement on controls may, then, be offer only a weak incentive.

2. No global agreement to keep temperature increase to 2 deg C or less will be stable.

The most comprehensive formal analysis of the resulting outcomes that I have seen concludes that

> "Only coalitions including all large emitting regions are found to be technically able to meet a concentration stabilization target below 550 ppm CO_2eq by 2100. Once the free-riding incentives of non-participants are taken into account, only a "grand coalition" including virtually all regions can be successful. This grand coalition is profitable as a whole, implying that all countries can gain from participation provided appropriate transfers are made across them. However, neither the grand coalition nor smaller but still environmentally significant coalitions appear to be stable. This is because the collective welfare surplus from cooperation is not found to be large enough for transfers to offset the free-riding incentives of all countries simultaneously."[19]

---

[16] William D. Nordhaus, *A Question of Balance: Weighing the Options on Global Warming Policies,* New Haven: Yale University Press, 2008.

[17] Lee Lane and David Montgomery (2008), "Political Institutions and Greenhouse Gas Controls," AEI Center for Regulatory and Market Studies.

[18] Richard S.J. Tol (2009), "An Analysis of Mitigation as a Response to Climate Change," Copenhagen Consensus on Climate.

[19] Valentina Bossetti, Carlo Carraro, Enrica De Cian, Romain Duval, Emanuele Massetti and Massimo Tavoni, "The Incentives To Participate In And The Stability Of International Climate Coalitions: A Game-Theoretic Approach Using The Witch Model, OECD Economics Department Working Papers No.702.

Chairman HALL.

I thank all of you for your testimony, and I once again remind our Committee and the Members that I would ask you to limit your questioning to five minutes. I will open with some questions, and I thank all of you for your good testimony.

This is a group that I have wanted from the beginning. We have asked for it. We asked for it in letters from the opposite side and been turned down, and the Ranking Member said I think in her closing statement that I hope this is not the beginning and ending of the record on climate science in the 112th Congress with this hearing. It won't be. We are going to have others because we want to finally get to those who did indicate that it was, as you have, that it was bad science and had the right to question that science and find out those that will question. We will have that committee at a later time here.

Let me start mine. I don't want to call you doctor if you are not a doctor. Mr. Glaser, is that right? In your testimony you discussed the timeline of the issuance of the endangerment finding, and I appreciate you bringing that up. With respect to the promulgation of standards for reducing greenhouse gas emissions for motor vehicles worked out with the White House, automakers, California state regulators and environmental groups, you state that the timing of the auto rules suggest that the endangerment finding was predetermined. Do you want to enlarge on that a little bit? How often does the EPA change the direction of its rule-making between the issuance of the proposed rule and the release of the final rule?

Dr. GLASER. Yeah, I can address that. It happens. In fact, it has happened very, very recently. One good example of EPA's substantially changing a regulation in response to public comments is the so-called boiler MACT rule which is a rule to address hazardous air pollutant emissions from commercial and industrial boilers. In that case, EPA made a proposal. They got very, very significant comments in opposition, and in the final rule that was just issued, EPA made very significant changes to the rule, and they say they are going to consider further changes still.

So the integrity of the public comment period is very important. The process flaws that I talk about in my testimony are not technicalities. They are meant to protect the integrity of the ultimate decision that is reached. So when we have a situation as we had here, when the Administration came to office determined to regulate greenhouse gases, through the Clean Air Act if necessary, and therefore pretty early in the Administration committed to the motor vehicle regulations for which the endangerment finding was the necessary predicate, it undermines the integrity of the process. It undermines the ability of the public to affect that process with comments and therefore undermines the integrity of the ultimate decision reached.

Chairman HALL. I thank you, sir. How does that predetermination of the final rule affect the usefulness and the legitimacy of the rule-making process?

Dr. GLASER. Yeah, well, as I said——

Chairman HALL. You touched on that, but I have a couple of minutes left. I hope you will give us an answer on that.

Dr. GLASER. Yeah, sure. The whole purpose that we have notice and comment rule-making which EPA undertook for the endangerment finding is for the public to comment and to be able to present information and studies and affect what the ultimate decision would be. Keep in mind that the fundamental question that EPA was asking when it put the endangerment finding out for public comment was should we be making this endangerment finding? Do we have a basis for making this endangerment finding? There are lots of comments that were submitted saying no, you should not do that, but it did not appear to me anyway and to many others that that was an outcome that was possible. In other words, the EPA would change its mind and not make an endangerment finding. One way we know this is that EPA only allowed a 60-day comment period for the endangerment finding, 60 days to comment on this massive amount of scientific information. It wasn't enough time. But in my view, EPA had determined that it wanted to move very quickly on the underlying regulations which drove the endangerment finding process forward more quickly than it should have been and therefore really made it difficult for companies, members of the public, private institutions, public institutions to make comments and ultimately to affect the process.

Chairman HALL. I thank you, sir. Dr. Montgomery, if the United States were to drastically reduce carbon dioxide emissions, electric utilities would have to rapidly retire traditional and coal-fired power plants which currently make up approximately 45 percent of America's current generation mix, and the EIA anticipates, that is the Energy Information Administration, anticipates that coal will remain an important part of our electricity generation producing 43 percent of our total generation by the year 2035. So considering the EIA projects, that they project electricity demand will increase in the United States by 21 percent by 2035, what would be the repercussion from removing coal, say, from the generation mix?

Dr. MONTGOMERY. Mr. Chairman, removing coal from the generation mix would impose very large costs and potentially disruptive effects on electricity markets. It all depends on how fast it is done and the extent to which technologies such as carbon capture and sequestration become available and make it possible actually to continue to use coal through clean-coal technologies which capture carbon and sequester it. But all of those technologies are unproven, in the future, at best in an experimental stage and are themselves subject to a number of regulatory and environment objections.

We looked just at the retirements—when I was at Charles River Associates, we looked just at the retirements that would be associated with EPA's greenhouse gas regulations and concluded that they would produce very large increases in electricity costs, maybe something like and I am relying on memory now, 40 to 50 percent increase in whole electricity prices over the next ten years or so and quite large impacts on the standard of living. I remember something on the order of $500 to $1,000 say loss in income to the average worker.

Chairman HALL. Okay. I thank you. Recognizing that China, Russia, Mexico, India and on and on are not going to participate with us financially, and that is a fact, is it not? Yes or no. Yes?

Dr. MONTGOMERY. Yes, it is. We see very little evidence that China——

Chairman HALL. And does it surprise you that we spend over $30 billion just on research with no expectation of any money from them? So somebody has got to go by the cash register. Now, you are an economist. There is a cash register in every store in this town, and there will be a cash register involved here. And I think they ought to consider that. I think that is your opinion, isn't it?

Dr. MONTGOMERY. Yes, it is. There will be costs to what we do.

Chairman HALL. Thank you. I yield back my time. At this time I recognize Mrs. Johnson for five minutes.

Ms. JOHNSON. Thank you very much, Mr. Chairman. I would like to pose this question to the three physical scientists on the panel, Dr. Christy, Dr. Muller, and Dr. Emanuel. There seems to be some attitudes that is an elaborate hoax orchestrated by the scientific community on global change, and I don't know that I have heard you argue whether or not there is global change happening and human activity as a factor. Instead, it is more of a disagreement over the magnitude of warming and the degree of which human activity plays a role.

Based on your work, the three of you, do you agree that the global temperature is rising and will continue to rise and that greenhouse gas concentrations are at least partly to blame?

Dr. CHRISTY. The global temperature might continue to rise, it might not, but greenhouse, the extra greenhouse gases we are putting into the atmosphere are indeed a warming influence. The question is what are the other gazillion things that affect global temperature going to do as a result. But greenhouse gases in and of themselves do exert a warming influence on the planet.

Ms. JOHNSON. Thank you.

Dr. MULLER. I agree with Dr. Christy. Greenhouse gases do exert a warming. I believe we are seeing that warming. The issue in my mind is not whether we are seeing but what is the degree. Is it something which, if it is at the high end, we really do need to move very rapidly, although we do have to engage the other countries because as Dr. Montgomery said, most of the warming is not going to come from the United States? Most of the carbon dioxide will come from other countries in the world.

On the other hand, if the warming is a little bit less, the models have the ability to account for less. There are unknowns in the models having to do with cloud cover feedback and water vapor feedback, and so if the warming is a little bit less than we thought previously, then we have time to implement some more long-term solutions that currently some people object to because they wouldn't work within the next short period of time.

Dr. EMANUEL. I think all three of us are in pretty good agreement on this point. The planet is warming up. The bulk of evidence suggests that increasing carbon dioxide and other greenhouse gases have something to do with it, and we are all in agreement that unfortunately when we try to project forward, the risks are poorly quantified at this point. And projections that have been made by modelers range from the benign to the catastrophic. So the problem for all of us is how do we deal with the risk that is so uncertainly quantified?

Ms. JOHNSON. Do you think we have the answers now or do we need to continue, do the research?

Dr. MULLER. I believe that continued research is essential and should be expanded. You asked about a conspiracy earlier. I don't believe there is a conspiracy, but I do believe that many of the scientists who have been involved in this field are so deeply concerned about what they found that they work as advocates. And when they work as advocates, there is a danger that they lose their impartiality. I fear that this is happening. I fear that the scientists are not trusting the public enough. They feel they have to make it clear how scared they are, and they are advocates and no longer scientists. The bad effect of this is that the public then loses some of its trust in science, and that is deeply unfortunate. In Berkeley Earth, our goal is to not have any political views, not to become advocates, simply do the best job we can on the science.

Ms. JOHNSON. Thank you.

Dr. CHRISTY. You are asking a scientist if he wants more research? I will leave that answer there. But I would say this. One of the things I do is I test climate model output that has been talked about here, and what we have found is that the climate model output does not match up to the real world. So I would say we have many questions out there that do need to be addressed. And so that is a foundation for more research, yes.

Dr. EMANUEL. I would just chime in here that there are regions of disagreement between observations and models, and some of those disagreements have shown demonstrably that the model projections have been too conservative. So once again, I emphasize that anyone who pretends to a certainty in a benign outcome is probably kidding himself.

Now, I think of course it is ridiculous that there was ever a notion that thousands of scientists all over the world would be engaged in some kind of hoax. It seems to me a hoax itself that that kind of statement ever got made. I don't understand that.

I want to say one thing about the IPCC because I have a sense of widespread misperception, probably not among the panel but perhaps among the Members. It is not a research organization. It does not conduct research, it doesn't fund research. It was set up I think in response to requests from broad segments of the public as a communications exercise between scientists and the public. One can certainly claim that it hasn't been perfect in this regard, but that is what it is.

And so when people say you shouldn't trust IPCC research, you are not actually speaking about that body correctly.

Ms. JOHNSON. Thank you very much. My time has expired, but I think we can finally say that global warming is happening. The details of it and the various ranges of concern and opinion will rest with continual research.

Chairman HALL. The Chair at this time recognizes Mr. Sensenbrenner, Vice Chairman of this Committee, for five minutes.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman. I want to have a few questions for Dr. Emanuel, but as a predicate, you know, let me say that I think that the scientific community has wrapped itself too tightly around the axel rod of the fatally flawed Kyoto Protocol which let 134 countries off the hook, and we are see-

ing, you know, huge increases in emissions from countries like China and India, and as a result with draconian increases in the cost of energy, this is no longer an environmental debate but it is a debate on jobs and economics and who wins and who loses in jobs and economics.

Now, Dr. Emanuel, on December 10 of 2009 which was a couple of weeks after the release of the emails, you were at a forum at MIT which you kind of had very advocacy comments on that. And about three months afterwards, you were appointed to the Oxborough Panel which was supposed to look into the circumstances around the emails and the release of the emails from the Climate Research Unit at the University of East Anglia. And you know, I question the objectivity of that panel, but since you were a member of it, I want to ask you five questions about seriatim, and if the answer is yes to any of them, please let us know. If the answer is no to all of them, let us know.

The first question is does the panel have any written terms of reference and if so, what were those terms? Did the panel issue a call for reference? Did they hold any public hearings? Did the panel interview any of the critics of the Climate Research Unit's scientific work, and were the panel interviews with CRU staff recorded and released? Now, are any of those questions to be answered yes?

Dr. EMANUEL. I must confess, I couldn't write them down fast enough.

Mr. SENSENBRENNER. Okay. Would you like me to repeat?

Dr. EMANUEL. But let me say, because I was on the panel, we did have clear terms of reference. That much I can tell you. We did write a report whose release was public, and let me say that the scope of that panel was very narrowly defined. As I am sure you are aware, there were several panels——

Mr. SENSENBRENNER. If I may interrupt you, the question that I asked was not whether the report was released but were any of the panel interviews with CRU staff recorded and released?

Dr. EMANUEL. No, I don't believe so.

Mr. SENSENBRENNER. Okay. Go ahead.

Dr. EMANUEL. I was going to simply say that our objective we were told was to determine whether there had been any sort of breach of scientific integrity in this particular unit, CRU. It wasn't a comprehensive review of the quality of the science, anything like that. It was a very narrowly defined objective.

Mr. SENSENBRENNER. Okay. Well, this has called into question the quality of the science and whether the scientific community put the wagons in a rather tight circle, and I have a press release from the British Parliament, and there is a Labor Party MP named Graham Stringer who said Oxborough didn't go as far as I expected. The Oxborough report looks more like a whitewash. And then I go back to the fact that Lord Oxborough is the Vice-Chairman of an environmental group called Globe International, the CEO of carbon capture and storage and Chairman of Falk Renewable Enterprise. All of them are advocacy groups. Two of them have the potential of making a lot of money if all of this is implemented. And isn't that a conflict of interest?

Dr. EMANUEL. All I can say in response to that is that as part of this commission which involved some very gifted scientists who

have no ax to grind at all in this climate debate, the papers we read, the interviews we conducted showed that the entire enterprise was one of great integrity.

Mr. SENSENBRENNER. Well, that is not what the Labor Party MP says, Mr. Stringer, and he is a Member of the Select Committee on Science and Technology and has a Ph.D. in chemistry. He said it was a whitewash, and here the chairman of this group ends up, I think, having a very clear conflict of interest, you know. I can tell you that if the President or the Congress appointed somebody with those types of conflicts to head an investigation over something that has cropped up, I think that that chairman would get drummed out of office because of the conflict of interest. You know, I don't know how we can believe the report of the commission that you were on simply because there was no real sunshine in on the process. There wasn't any public hearings, they didn't interview any critics of their scientific work, and the interviews with the CR staff were neither recorded nor released. Now, you know, we are just saying that you who have been an advocate, witness your comments at MIT, should state that the commission that you were on is objective. And I don't think anybody who wants to be fair-minded of this can buy it.

My time is up and I yield it back.

Chairman HALL. Thank the gentleman. The Chair recognizes Mr. Miller, the gentleman from North Carolina for five minutes.

Mr. MILLER. Thank you, Mr. Chairman. I would like to begin by moving into the record a paper that comes from Professor Armstrong's website on predicting elections from politicians' faces. It concludes that surveys of voters taken a year out before an election are predictive of how elections will come out based upon voters' snap judgments of the competency of the politicians' faces. It appears to forecast that Hillary Clinton will run away with the 2008 presidential nomination and that the Republican nomination will be a dead heat between John McCain and Duncan Hunter.

I would now move this into the record.

Chairman HALL. Let me ask, did my staff have an opportunity to review it? Staff hadn't had an opportunity to review it, so I reserve the right to object to the inclusion.—

Mr. MILLER. I really don't think——

Mr. ROHRABACHER. Quick question at this point about the relevancy——

Mr. MILLER. I don't have time.

Mr. ROHRABACHER. —of what you have just put into the record?

Chairman HALL. It is not in the record.

Mr. ROHRABACHER. It is not? Thank you.

Mr. MILLER. Mr. Glaser, your testimony is the most peculiar testimony I have ever heard before a Congressional Committee. You know, if you went to the Player's Retreat, a bar in Raleigh, tonight you can find a set of lawyers who are sharing a pitcher or two and complaining about the rulings that judges made against him the previous week, and they would say, you know, he didn't even listen, he had his mind made up, and on and on. But I have never really heard testimony by a lawyer before a Congressional Committee to that effect.

Now, you take some pains to say both in your written testimony and in your oral testimony that you are offering your own personal opinions in your testimony here, that you are offering your personal opinions about the very same matters about which you have appeared as an attorney. Now, it is unethical for a lawyer to offer their own personal opinions in any matter in which they represent a client? Isn't that correct? I have heard judges admonish lawyers from the bench when they say Your Honor, I think. The judge will say, counsel, you are not here to tell me what you think. You are here to tell me your clients' position. That is correct, right?

Dr. GLASER. Not in front of this body, sir.

Mr. MILLER. No, it is not in front of this body, but in front of this body you are saying now these are your personal opinions. I don't think many clients would really like their attorney going out and saying here is how I disagree with my client. Is there any point on which you disagree with your client?

Dr. GLASER. In what respect, sir?

Mr. MILLER. Well, I mean, in any respect. I mean, you have offered us as your testimony today what is clearly a lightly edited version of a brief you wrote on behalf of your clients. But while you are saying to a court or to the EPA in a rule-making matter that that is your client's opinion, you are now saying it is also your personal opinions. So is there any way in which your personal opinion that you offer here today differs from the opinions of your clients on facts or on law?

Dr. GLASER. You know——

Mr. MILLER. I take that as no, isn't it?

Dr. GLASER. Wait. You know what? I don't know the answer to that question because I have not reviewed the testimony in detail with all of my clients. I can tell you I hope they don't, sure.

Mr. MILLER. Well, you have submitted to this Committee filings that you have made with EPA and with the court.

Dr. GLASER. Yeah, I did——

Mr. MILLER. As part of your testimony to us.

Dr. GLASER. I did submit an attachment that I thought would be valuable. That of course is a public document that was filed, and so I did submit it. The Committee of course is free to review the record——

Mr. MILLER. Okay.

Dr. GLASER. —and then——

Mr. MILLER. Certainly I will have to look at it.

Chairman HALL. Don't interrupt. Just let him repeat and answer your question, please.

Mr. MILLER. Mr. Chairman, I have never heard that as the rule. The rule has been that it is my time and that I get to control my time. And if a witness is filibustering, I can cut them off so that I can get answers.

Chairman HALL. All I am asking you to do is to be fair with these people who have given a lot of time.

Mr. MILLER. I will try to be fair——

Mr. MILLER. I will try to be polite——

Chairman HALL. Just be fair with them is all I ask of you. That is not asking too much, is it?

Mr. MILLER. No. So——

Mr. ROHRABACHER. Mr. Chairman, I would move that we give our colleague an extra minute.

Chairman HALL. I will give him extra five minutes because he is just getting more and more in trouble all the time.

Mr. MILLER. So Mr. Glaser, you have not convinced the EPA of the correctness of your position? You have not yet convinced the court of the correctness of your client's position but you have convinced yourself of the correctness of your position?

Dr. GLASER. Yes, we will be bringing this to the court. I had been asked to come here and testify about the process under which the endangerment finding——

Mr. MILLER. Okay.

Dr. GLASER. —was prepared. I have done so, sir.

Mr. MILLER. All right. And how much then have you or your law firm been paid by your clients for appearing on their behalf before the EPA and in litigation?

Dr. GLASER. Sir, I cannot disclose confidential communications between myself and my client.

Mr. MILLER. Including how much they paid you?

Dr. GLASER. Absolutely. I hope that you can appreciate that, that I cannot breach attorney/client privilege.

Mr. MILLER. You have said, you have told this Committee, that obviously we should think poorly of the EPA. They really didn't listen to your arguments. They didn't follow the law. They violated the law, on and on. If the court doesn't hold for you, if the court also disagrees with you, what should we think of the court?

Dr. GLASER. I think that you should first of all wait and see what the court says, number one, but number two, I am offering my opinions here both on law and on proper administrative policy. You could say for instance is it a violation of law for EPA to have only allowed a 60-day comment period. You could differ on that. The court might say, okay, 60 days. That is enough. Is that good policy? Is that good administrative policy? My recommendation would be no. That is not good administrative policy.

Mr. MILLER. I mean you seem to have or it is odd that you were asked to testify with respect to a matter pending before the courts and to give basically a legal argument, the same legal argument that you made before the courts, but one obvious difference between appearing before this Committee and appearing before the court is before the court there will be more than one argument. There will be another lawyer there representing the other point of view, isn't that right?

Dr. GLASER. Certainly before the court there will be multiple points of view expressed. You do have to understand that the cases that you are talking about in court have been challenged. EPA's regulations have been challenged by a very large segment of the business community. There are states' pros and con, there is EPA on one side, there are interveners. The court will definitely hear a variety of arguments. I can't dispute that.

Mr. MILLER. All right. And another important distinction is before courts, you will be appearing before a neutral judge with no interest, not before politicians who have received large campaign contributions from your clients?

Dr. GLASER. I am going to dispute that last part, but I would agree with you that there are definitely differences between the legislature and the judiciary. No question.

Mr. MILLER. Okay. Mr. Chairman, it appears I do not have any time, but if I do, I will yield it back.

Chairman HALL. Thank you. The Chair at this time recognizes Mr. Bartlett, the gentleman from Maryland, for five minutes.

Mr. BARTLETT. By way of full disclosure, I would like to note that I think the EPA frequently makes erroneous assumptions which lead to wildly excessive regulations.

I think that it is probably not easy to increase greenhouse gases without increasing general air pollution, and I am having some trouble understanding why everybody wouldn't like to be breathing cleaner air.

I gather that most of those who are opposed to the case for global warming or climate change would simply like to continue our aggressive exploration and use of fossil fuels. There are three groups that have common cause and the solution that those who are concerned about global warming or climate change have. Of course, the solution to their problem is stop using so many greenhouse gases that emit CO_2 and start using alternatives. There are two other groups that have common cause in this. They have very different problems with exactly the same solution. One of those groups is those that are concerned about our national security. We have only two percent of the world's oil. We use 25 percent of the world's oil. We import about 2/3 of that and much of that from countries that don't like us a whole lot. The solution to that problem, of course, only one solution to it, that is either find more oil here, and we have been producing less and less oil every year since 1970, so that isn't going to happen in any meaningful terms here, or to move to alternatives. So this group has exactly the same solution to their very different problem.

The third group is a group that recognizes that fossil fuels are finite. By the way, the first person I think to recognize that, probably the first person to recognize that was M. King Hubbard in 1956 who predicted that in 1970 the United States would reach its maximum oil production. We did that right on schedule, and in spite of drilling more oil wells than all the rest of the world put together, today we produce half the oil that we did in 1970. And by 1980 we knew that that had happened because looking back in 1980 we could see we were already over the other side of Hubbard's hypothesis.

I cannot understand how rational people could just stand by and not conclude that if the United States reached its maximum oil production in 1970 that someday the world was going to reach its maximum oil production. That is a given. The only uncertainty is when would the world reach its maximum oil production, and that is a question that was not asked.

There is now abundant evidence that the world has reached its maximum ability to produce oil on a daily basis at about 84, 85 million barrels a day. Obviously, the solution to that problem is to move away from fossil fuels which just aren't going to be there in the future and to move to alternatives.

So we have these three groups, very different problems. Common interest, same solution. Move away from fossil fuels to renewables. Why aren't these three groups locking arms and marching forward? Why are we sitting here today with many of us concerned about national security? A few of us—concerned about peak oil. Why are we here criticizing the premise of others? They may be dead wrong. It is irrelevant to me whether the global warming climate change people are right or wrong because the solution to their problem is exactly the right solution to two other very real problems. One of those is the national security problem. We have got to move away from fossil fuels in our country. They just aren't there. And the other is the peak oil people who understand that the energy just isn't going to be there.

By the way, I led a codel of people. Nine of us went to China just a bit over four years ago to talk about energy. They began their discussion of energy by talking about post-oil, and they had a five-point plan. And that fifth point in that five-point plan was international cooperation. They knew as many of you noted that we can't do it alone. Well, they plead for international cooperation. They planned it as if there won't be any.

Very little time remaining. Sir, I would like your comments. And you know, why am I wrong?

Dr. MONTGOMERY. Thank you, Mr. Bartlett. I remember appearing before this Committee a couple of years ago, and I enjoyed an interchange with you, and I am looking forward to it again.

I think the main place that I would disagree with you is they are not the same solutions. Climate change in the near term, if this body decided it wanted to make a serious reduction in U.S. greenhouse gas emissions, to be cost-effective, that would have to be occurring as Mr. Hall suggested by reducing the amount of coal that is used for electricity generation. The substitute for that is likely to be natural gas which is itself to some extent produced domestically but is also something that we import.

A cost-effective solution for climate change has next to nothing to do with our consumption of oil. So it is different.

Mr. BARTLETT. I think I talked about fossil fuels generally. Oil we have been following more precisely. Gas is finite, sir. That, too, will run out. So does coal.

Dr. MONTGOMERY. So there are three problems. The problem of climate change needs to be addressed over a longer term period with R&D and it really, largely involves getting off coal for power generation. That doesn't help with the national security part. The national security part, you are right, we need to produce more. We need to use Canadian oil, and we need to deal with the regulations like low carbon fuel standards that could prevent us from using an oil deposit that is larger than Saudi Arabia's and is sitting right north of us. We might think about a gasoline tax to discourage consumption. But peak oil is a problem that the market will take care of.

So the problem is there are different solutions to all these real problems.

Mr. BARTLETT. Just in closing, Mr. Chairman, the market will not take care of peak oil. Remember I said it here.

Chairman HALL. Make a note of that. Mr. McNerney, the gentleman from California for five minutes.

Mr. MCNERNEY. Thank you, Mr. Chairman, and I personally want to thank the witnesses for coming today. It is a contentious issue, so it is good to have this interchange. There is going to be some moments, but I appreciate your attendance here this morning and your testimony.

Dr. Christy, do you deny that the IPCC process is open and transparent?

Dr. CHRISTY. I would say the IPCC is not open and transparent as the experience, as a lead author and what went on behind my back as a lead author in that very chapter.

Mr. MCNERNEY. Well, there were two major reviews, including your comments in the 2007 report. So that doesn't agree with what you are saying.

Dr. CHRISTY. There is confusion here about what peer review is and what IPCC is. The lead authors of the IPCC have what is called review authority. They review their own material.

Mr. MCNERNEY. So there were no outside reviews of the IPCC?

Dr. CHRISTY. There were outside reviews, but remember, after that, there were further edits by the lead authors.

Mr. MCNERNEY. So in previous Congressional hearings, you have discussed your processing codes for generating satellite based estimates of tropospheric temperature change but when asked if you had made your codes freely available for scrutiny by other scientists, you said it was too complicated for other scientists to understand. Is that still the case?

Dr. CHRISTY. No, in fact we are releasing—we already released some of the code to the National Climatic Data Center, and by June they will have all the parts. There are about ten parts, many thousands of lines of codes that they don't understand. And so we are in the process of——

Mr. MCNERNEY. I have been a computer modeler, computer forecaster. I know what is involved. But it is very important that your code be available for others to examine. And so right now today you are saying that your code is going to be available and freely transparent for other scientists to examine?

Dr. CHRISTY. Yes.

Mr. MCNERNEY. Good. Now, you said that the data was fraudulently included in IPCC reports. I just heard you say that this morning. Do you still believe that?

Dr. CHRISTY. I don't believe I said fraudulently.

Mr. MCNERNEY. You said fraudulently. I heard you say it this morning. Fraudulent. I wrote it down. I was shocked that you said that.

Dr. CHRISTY. I will have to look at my testimony. I don't remember typing——

Mr. MCNERNEY. It is not in your written testimony, it is in your verbal testimony.

Dr. CHRISTY. Right. I have that right here. Referring to which part because I don't remember saying anything like that.

Mr. MCNERNEY. Well, your conclusion was that there is fraudulent data in the reports. That is what I heard you say this morning.

Dr. CHRISTY. What I said this morning was biased, false, overconfident and/or misleading.

Mr. MCNERNEY. That was one statement, and you said another statement and you included fraudulent.

Dr. CHRISTY. Well, okay. We can look at the tape on that but——

Mr. MCNERNEY. All right. I am going to——

Dr. CHRISTY. —if you have a question——

Mr. MCNERNEY. —move on here.

Dr. CHRISTY. —about the particular thing I was talking about, I would be happy to answer it.

Mr. MCNERNEY. Well, I am going to move on. Mr. Montgomery, or Dr. Montgomery, excuse me, you criticized studies suggesting that forward-thinking climate policies will create jobs suggesting that the studies are the product of a biased group. But it is well-documented that large oil companies spent massive amounts funding the studies that question climate science. Now isn't it true that you served as an expert eyewitness on behalf of Exxon Mobil and which according to one well-known report spent $16 million funding initiatives to spark doubt on climate science?

Dr. MONTGOMERY. I can't quite put that together, but I have testified as an expert witness on entirely unrelated issues about market shares in regard to other—sorry. I have testified as an expert witness on behalf of Exxon Mobil on entirely unrelated cases that have absolutely nothing to do with my opinions here, nor have I stated in, and I think I probably should have done as Mr. Glaser pointed out, that I am appearing today on my own behalf. I am not being compensated by anyone for this testimony. I have my——

Mr. MCNERNEY. Okay. Well, I——

Dr. MONTGOMERY. —own opinions, and I don't expect to be paid attention to here because of who I represent. I expected to because of the logic of the arguments that I present.

Mr. MCNERNEY. You said that there is no benefit to the U.S. for taking action on climate change.

Dr. MONTGOMERY. I believe that that is a conclusion that I am——

Mr. MCNERNEY. No——

Dr. MONTGOMERY. —perfectly happy to discuss with you at greater length. The point of that is that——

Mr. MCNERNEY. My personal experience——

Dr. MONTGOMERY. —what the U.S. will do——

Mr. MCNERNEY. —contradicts that because I have worked in the wind energy field. We created technology here in these United States, and it went to Germany because they had climate policies that encouraged local utility companies to buy those wind turbines. We are now buying their manufactured products, manufactured by Germans, we are buying that product in the United States. So no, I disagree with you.

Dr. MONTGOMERY. And you were doing exactly what I described in my testimony. You were telling precisely half the story. You are not looking at what the people who were producing those wind turbines would have been doing if there were not a renewable portfolio standard that put them to work producing equipment that is a more expensive way of producing electricity than the alternative. They would have been producing other things which would have

led to a higher level of GDP and no difference in employment. That is an economic argument. I am perfectly happy to carry it out, but it has nothing to do with whether Exxon funds bad science. It is an argument about economics, and it is an argument about facts and data, not about who pays for what.

Mr. MCNERNEY. Well, I know that research money that was spent in these United States is now developing products, is now manufacturing products in Germany because they had policies that encouraged them to buy wind power and green power so——

Dr. MONTGOMERY. Actually, what is happening is exactly what I described in my testimony. The United States is creating a demand for renewable energy, but actually China is producing it because they are subsidizing their industries, and that is so well-documented that we filed a 301(b) case against them.

Mr. MCNERNEY. Right, and they are going to be importing their product to us as well.

Dr. MONTGOMERY. Yeah. They are going to be exporting it to us, but they are going to be exporting it to us because we have regulations that force people to use it and we have higher costs of producing it than they do.

Mr. MCNERNEY. Well, I guess my time is up.

Chairman HALL. Final question you want to close with.

Mr. MCNERNEY. Mr. Chairman, I don't even know where to begin with my next question, so——

Chairman HALL. All right. Well, thank you, Mr. McNerney. The Chair at this time recognizes Dr. Broun, gentleman from Georgia.

Mr. BROUN. Thank you, Mr. Chairman. I will direct my questions to Dr. Christy, but I am from Georgia, and if the others on the panel want an interpreter, I am sure the Committee will be glad to provide you an interpreter. Dr. Christy, in your testimony you speak in great lengths about process issues associated with climate science in general, the processes used by some at the University of East Anglia's Climate Research Unit and the IPCC as a whole. As a scientist who actually builds data sets, and as someone who has witnessed what you call "my side bias" or "groupthink", would you trust data from individuals trying to "hide the decline", refine peer review when inconvenient and destroy documents, rather than comply with the law?

Dr. CHRISTY. I wouldn't, but I would say that because the process has become more open that I think those doing these data sets now are a little bit more concerned about the fact that they will be exposed if they do make any mistakes.

Mr. BROUN. I hope so. We have seen all those e-mails, but several relating to the state of the unlined computer code haven't received as much attention. The desperate e-mails of a computer programmer offer us a glimpse into the data control issues at CRU with quotes such as, "What the hell is supposed to happen here? Oh, yeah? There is no 'supposed'. I can make it up, so I have." Another quote, "You can't imagine what this has cost me, to actually allow an operator to sign false WMO codes. Well, what else is there in such situations? Especially when dealing with a master database of dubious prominence." The next quote, "Oh"—F-bomb—that is not what it says here. "Oh, F this. It is Sunday evening. I worked all weekend, and just when I thought it was done, I am hitting yet an-

other problem that is based on the hopeless state of our databases." Next quote, "This whole project is such a mess."

In his testimony, Dr. Emanuel states that all of this is nonsense, just as he did before any review was actually conducted. Does any review of the Climategate issue actually address the underlying science?

Dr. CHRISTY. Well, I think the exoneration panels that have occurred have not addressed the underlying science, nor the actions of the people there. You don't have the typical things you do in the legal proceedings, where you cross-examine the evidence and witnesses, and anyone can be called to testify, and so on. That has not occurred. Your description of those computer—as a programmer myself who has written thousands and thousands of lines of code on these very kind of station records, and Dr. Muller probably understands this too, is that it is a nightmare looking through data coming from different countries in different formats, and mistakes that are made. Fahrenheit, Centigrade, missing 100 or something like that, it is really problematic.

Mr. BROUN. So it is all a mess, obviously. Has any re-do—review of the Climategate issue addressed the entirety of the allegations that were raised?

Dr. CHRISTY. Well, not in my opinion. I think much more could be done, but hopefully the peer review literature, as we go along, will just make that unnecessary. I hope we just get to the point we can trust what we publish these days.

Mr. BROUN. As a scientist myself, I hope so too. Do you believe an independent review of these allegations is warranted?

Dr. CHRISTY. I would rather see just an independent assessment of climate, as the IPCC has done, but without the IPCC cadre, the establishment. I think you could have a very reputable and credible report that would come to slight—somewhat different conclusions than the IPCC has.

Mr. BROUN. Well, as a scientist, again, I hope we do that. To the best of your knowledge, has the IPCC adopted all of the recommendations from the IAC review conducted last summer?

Dr. CHRISTY. Well, obviously not, because the first thing they recommended was that the head leave, and he is still the head. So, starting from there, they have not.

Mr. BROUN. Very good. I have just a half minute left. Dr. Emanuel, it should be noted that MIT received 100 million from the Cokes for Cancer Research Institute. MIT is a prestigious organization, with a world class reputation in science, but according to logic we are witnessing here today, its research should be dismissed because it receives any funding from the organization that the party dislikes. Would you agree with that? What are you asking me?

Mr. BROUN. I am asking about—have you all—have you received funding——

Dr. EMANUEL. Yes. MIT has, yes. I don't, of course, do cancer research, but I am well aware of what you are saying.

Mr. BROUN. So, in other words, the—calling in question people who have—entities that have received funding, seems that some would call their testimony in question today, and I just wanted to point out that you all have too. Thank you very much. My time has expired. I will yield back, Mr. Chairman.

Chairman HALL. Thanks, Doctor. This time i recognize Mrs. Edwards from Maryland. Recognized for five minutes.

Ms. EDWARDS. Thank you, Mr. Chairman. What a shock, I thought I wasn't quite up yet. I just want to clarify for the record that I have here, and we have entered these into the record before, Mr. Chairman, seven scientific, you know, independent reports that have evaluated this question of—and some describe Climategate e-mails that have really exonerated the—these individuals in question, in terms of their research and research capacity. And I just think that we need to get off of this and really get down to the real questions in front of us.

I just want to be clear, and each of you can as—answer this individually. I want to be clear whether any of you have been paid or compensated for any of your research, analyses, testimony or a speech in any form, at any entity, by a company or trade association that is represented by the oil, coal or energy industry? Dr. Armstrong? That is a yes or no.

Dr. ARMSTRONG. Well, I received $3,000 from the State of Alaska for a report, but that did not result in a published paper.

Ms. EDWARDS. I asked about the industry, not a State government.

Dr. ARMSTRONG. Yeah. No, ——

Ms. EDWARDS. I didn't——

Dr. ARMSTRONG. —my way down here.

Ms. EDWARDS. Thanks so much.

Dr. ARMSTRONG. I have had no——

Ms. EDWARDS. Dr. Muller?

Dr. MULLER. Yes.

Ms. EDWARDS. And who paid you, and how much?

Dr. MULLER. I am sorry, I don't have those figures available——

Ms. EDWARDS. Who paid you?

Dr. MULLER. I have been a consultant for BP. I have done a lot of work with—does the U.S. Department of Energy count? They have given me a lot of funding.

Ms. EDWARDS. Company, trade association, with the industry. With the oil, coal or energy industry.

Dr. MULLER. I believe—it is really hard to pull this out without——

Ms. EDWARDS. Okay. Please——

Dr. MULLER. —anticipating——

Ms. EDWARDS. —submit for the—please submit for our record any compensation that you have received from the oil, coal or energy industry for the work that you do. Thanks so much——

Dr. MULLER. I believe——

Ms. EDWARDS. —Dr.——

Dr. MULLER. I believe it was only BP, and that was——

Ms. EDWARDS. Just submit it for the record. Dr. Christy?

Chairman HALL. Ma'am, please, let him answer, please.

Ms. EDWARDS. He——

Chairman HALL. Go ahead——

Ms. EDWARDS. He can't pull it out of his head, and I would like it for the record. And that is true, if you can't just remember it, I would appreciate it if you could submit it for the record. Dr. Christy?

Dr. CHRISTY. No.

Ms. EDWARDS. Mr. Glaser?

Dr. GLASER. As an attorney, I have represented and been compensated by energy industry companies.

Ms. EDWARDS. Thank you.

Dr. GLASER. That is a fact.

Ms. EDWARDS. Dr. Emanuel?

Dr. EMANUEL. No.

Ms. EDWARDS. Dr. Montgomery?

Dr. MONTGOMERY. As an individual, I cannot remember ever being compensated directly. Of course, I have made my living for 20 years as a consultant doing a very large number of things, and my company had as clients just about every company in the United—in—just about every large company in the United States, including energy——

Ms. EDWARDS. Great. I would appreciate if you would submit that for our record, your compensation from representatives, trade associations or corporations associated with the oil, coal or energy industry. Thank you very much.

Dr. MONTGOMERY. May I——

Ms. EDWARDS. Let me just——

Dr. MONTGOMERY. —question? I believe what I said was I have received no direct compensation. My company's record—the company's records, I am no longer an employee there, and I have absolutely no way of providing you with information about what Charles River Associates received over the years, and I am sure they would object to it in any event. But I cannot do that.

Ms. EDWARDS. And you haven't received any compensation as a consultant for any of those in the industry?

Dr. MONTGOMERY. My salary is paid by Charles River Associates—was paid by Charles River Associates, and I have not received direct compensation as an individual from anyone except Charles River Associates for about 20 years.

Ms. EDWARDS. Thank you very much. Just as my time is running out, I think that in any field of science there is continual study of science. We see breakthroughs, we see setbacks. There is an evaluation process that goes forward, and we never stop asking questions, because that is the nature of science, and so I think we have to be willing to change. Change policy, change direction, continue that kind of analysis, because you never quite get to an end—to the end to it. We look at those things all the time here on this Committee.

I represent a district where the county that I live in is the home to NASA Goddard and also to NOAA. They have—they play an extreme—a really important role in the analysis and use of climate research, and it is important to me that—and should be important to people here that we keep this investment in the field of climate research in our monitoring capacity and satellite capabilities and research abilities, because otherwise—I share the view of my colleague from Maryland, Dr. Bartlett, that we are never going to solve these big problems by just burying our heads in the sand. And just as I close here, for the scientists who are on the panel, Doctors Muller, Christy, and Emanuel, I hope that you would agree that we need to continue investment in climate research, even

though you might quibble about whether your minority view was included in a particular evaluation or assessment. And with that, I yield.

Chairman HALL. Gentlelady does a good job of representing her district. She went right exactly five minutes. Dr. Armstrong, did you get to answer her question?

Dr. ARMSTRONG. Yes, I did. The answer is no.

Chairman HALL. You yield back, Ms. Edwards? Do you want to follow up anything?

Ms. EDWARDS. No. Dr. Armstrong did answer the question.

Chairman HALL. Okay.

Ms. EDWARDS. Thank you.

Chairman HALL. Dr. Harris is next, recognize you for five minutes.

Mr. HARRIS. Thank you very much, Mr. Chairman. Thank you for holding the hearing today. First, Dr. Emanuel, thank you very much for appearing here. Your summary of written testimony, number five, there is no scientific basis for the confidence expressed by some that the effects of climate change will be benign. Do you believe the converse is true too, that there is no clear scientific basis for the confidence expressed by some that the effects of climate change will be risky?

Dr. EMANUEL. I don't tend to believe anybody who is confident about this at all. I——

Mr. HARRIS. Okay. Well, then, in your—thank you. In your statement, though, you actually say—in your very statement, the first paragraph, you said, "It is incumbent on us to take seriously the risks that climate change poses." It doesn't say climate change might pose, says climate changes poses. And actually, you also say, with regards to the report by the Department of Defense, that the U.S. should commit to a stronger national and international role to help stabilize climate change at levels that will avoid significant disruption to global security and stability, clearly implying that there will be significant disruption to global security and stability. So are you skeptical about those statements as well, which don't say might do it, or——

Dr. EMANUEL. Well, Representative Harris, I think there is a confusion between forecasts and an assessment of risk. If I say that I feel that there is certain risk in my house burning down and buying——

Mr. HARRIS. Right.

Dr. EMANUEL. —an insurance policy, I am not forecasting either that my house will burn down or not burn down. But I would take seriously any actuarial information that gave me information about the probabilities of risk. That is what——

Mr. HARRIS. Sure.

Dr. EMANUEL. —I am referring——

Mr. HARRIS. Thank you very much. Mr. Glaser, you make a great point, I think, that, you know, public health—if you graph use of energy and use of greenhouse gases versus public health, you would probably also see, you know, an advantage in that. For instance, I assume that what you mean by that is that—when we mean increased greenhouse gas, we mean use of energy. We produce energy so that we do things like have energy for refrigera-

tion, which has made great public health advances keeping food safe. We have energy to, oh, buy gas for ambulances, or diesel for ambulances, that actually bring people to a hospital a little quicker in an emergency. Or, you know, we have MRIs at our hospital with these huge electric cables going into them. I am assuming that, you know, energy does good things, it doesn't just do bad things. Is that your point, that these good things aren't taken into consideration?

Dr. GLASER. Yes, that is—I think that is exactly my point, and it is not a coincidence that the 20th century witnessed an explosion in all of the benefits that we consider to be a part of modern life. At the same time, the greenhouse gas emissions were increasing. The underlying cause is the same. The underlying cause is the use of energy. 85——

Mr. HARRIS. Sure.

Dr. GLASER. —percent of the energy we use in the United States comes from fossil fuel.

Mr. HARRIS. Sure.

Dr. GLASER. That is where the energy comes from.

Mr. HARRIS. Thank you. That is what I thought your point was. Dr. Montgomery, to close with, you know, we have got this situation in our state, and, you know, you mentioned about how frequently the economic costs of these subsidized, you know, creating these greenhouse jobs and these things like—you know, we have got a situation in our state where there is a move to put offshore wind farms, which would require an economic subsidy. Interestingly enough, the bill that is now in front of our legislature would cap somehow the cost of the—that you could add to someone's electric bill when you build a windmill, as though, you know, I guess we could pass a law that says everybody ought to pay $10 a month for electric. I mean, I guess that is the same economic sense.

But let me summarize what it sounds like to me what we are doing with some of these subsidies, particularly in what we are going to do off our coast if this passes. We are going to borrow money from the Chinese to pay for these subsidies, because we have no money here. We are broke. We borrow money, China is our biggest exterior—external lender now. So we are going to buy these funds from the Chinese, perhaps to buy either German or Chinese windmills, because, as the Congressman from California suggested, these really aren't made in the United States predominantly, and then we are going to place them in our economy, causing our electric prices to go up, then placing us at competitive disadvantage to China.

So we borrow the money from China, we buy the windmill from China, and then we pay more for domestic electric, putting our homes and our businesses at competitive disadvantage. Is that kind of what you are getting along when you say, you know, when we create these green jobs that sound good, when you scratch a little deeper, what you see are real problems in a global competitive world economy?

Dr. MONTGOMERY. Yes, Mr. Harris, I would say that that is correct, that Congress and regulators can move around who pays for something, but they can't make the cost disappear. And the cost to the United States of these subsidies is basically more expensive forms of generation that provide exactly the same service of mak-

ing MRI machines work, but that are absorbing resources that otherwise could be used for producing something that people will enjoy and be able to use.

Mr. HARRIS. That is what I thought. And how can you imagine, you know, how can you cap the cost of an—of a, you know, you build a windmill that costs a certain amount to produce energy, exactly how do you cap that cost—I mean, as an economist, this must be frustrating to you, because in the laws of the marketplace, there must be—there is no way to cap a cost—that your impression?

Dr. MONTGOMERY. If you require an—a company that is under your jurisdiction to do something and then say, you can only charge for this less than it costs you, it is either a taking, or you are simply saying their shareholders are going to pay for it, and their shareholders are everybody.

Mr. HARRIS. Sure. That is what I thought. Thank you, Mr. Chairman. Yield back.

Chairman HALL. All right. Chair recognizes the gentleman from Michigan, Mr. Clarke, for five minutes.

Ms. WOOLSEY. Mr. Chairman, I have a parliamentary inquiry.

Chairman HALL. State your inquiry.

Ms. WOOLSEY. Yes. There is a letter that has been presented to the minority staff from the majority staff. It is a letter from a Mr. Anthony Watts that he requested would be read in—read and entered into the record of the hearing. And as I understand it, the letter purports to try to set straight some errors that Professor Muller made in his testimony. This is highly unusual for the Committee to receive a correction to a witness's testimony before the testimony has even been delivered to the Committee.

So my question is, is it your intention to enter this document into the record?

Chairman HALL. It is my understanding we have not yet asked it to be in the testimony.

Ms. WOOLSEY. Well, okay.

Chairman HALL. Is that the basis of your inquiry?

Ms. WOOLSEY. We would like to know if it is—because—since we heard his testimony without the corrections, is this going to be entered into the record? And has Dr. Muller even seen this document? Does he want to add comment to the record, and how does this impact his testimony?

Dr. MULLER. Is that a question addressed to me?

Ms. WOOLSEY. I am asking my—this is between the Chairman and myself. The Chairman that I love very much and myself.

Chairman HALL. You are showing it.

Ms. WOOLSEY. Just to keep you on edge.

Chairman HALL. Well, I respect this lady very much, and she knows it. I understand that you have seen it, and you have the letter. Now, are you asking now to submit it into the——

Ms. WOOLSEY. No, we want to know if you are going to submit it into the record, and if it is——

Chairman HALL. I don't even know what it says.

Ms. WOOLSEY. Well, that is the point. I mean, you—Congressman Miller was told—his testimony—I mean, he had something to add into the record. You hadn't seen it yet——

Chairman HALL. Yeah.

Ms. WOOLSEY. —so you said no, you—it couldn't go into the record——

Chairman HALL. Yeah.

Ms. WOOLSEY. —until you had read it.

Chairman HALL. And Congressman Miller is a very famous lawyer from his district, and he knows that when we say we haven't seen it yet, that we hadn't seen it yet. He didn't question——

Ms. WOOLSEY. Well, you haven't seen this yet either, so——

Chairman HALL. I haven't seen it yet, so it is not admissible into the record.

Ms. WOOLSEY. Thank—that is what we want. Thank you.

Chairman HALL. Now, do you want to put it in the record? Would you like to put it in the record?

Ms. WOOLSEY. No, sir.

Chairman HALL. All right. The lady withdraws her request. Who is up—who is next? Mr. Clarke, I will recognize you for the second time. That doesn't mean you have 10 minutes, but you have been very patient with us, so we recognize you at this time, sir.

Mr. CLARKE. Thank you, Mr. Chair. And the reason why I am patient, because I have firsthand have seen the pain and suffering caused by the decline of our market share of U.S. manufactured vehicles in the United States, a market share that we lost to Asian imports. I represent metro Detroit. I am born and raised in Detroit, and we knew that this threat was coming, and that we had to be competitive. But those concerns weren't effectively heated, and young guys like me back in the '80s couldn't even get a job in the auto plants because there wasn't anything available. And I am—that is why I am very grateful that this administration did provide aid to General Motors, and now they have seen four consecutive quarters of profitability, and I believe that that is evidence that the taxpayers' investment is going to pay off.

But in the same way, I am concerned right now that we could be missing a huge opportunity to export great new green energy technology globally. And I am concerned, because of recent findings, that for the very first time U.S. investment in new green energy technology has now fallen from first place globally. Now China is in first place. Not only that, we are not even in second place, "Germany is. We are now in third place.

Some of you have indicated in your testimony that you believe that green jobs is just a pipe dream. Here is my concern with that. You have got great companies like General Electric, they are investing very heavily now in wind, in solar, in energy efficiency. You have corporate CEOs, such as the CEO of GE, stating that we are at risk of losing out to other countries, like China. Is China wrong to invest? Is Germany wrong? Are executives like the CEO of General Electric working contrary to their bottom line when they say we have got to invest in new green energy technology? I welcome any of your feedback on this.

Dr. MONTGOMERY. If I could start—I have spent some time in my career looking at various forms of industrial policy. I think where I would start is a quotation from Professor Richard Schmalensee, who was dean of the Sloan School at MIT. "We can't regulate our way into prosperity." If we feel that—the United States economy does not need the government to tell each industry, or to provide

industries with regulations and subsidies in order to make them succeed. Our economy grows on its own, and industries depend on the government to create a market for themselves at their own risk. And this is what we have seen consistently in the past when we have tried to create industries, the United States or other countries, through industrial policy.

Denmark decided to take the lead on wind industry—on wind energy. Its wind energy industry has collapsed, and has moved almost exclusively to China. China is a—I mean, China is an enigma. China has clearly decided to put subsidies into one particular industry. But I remember the fear that we were—that our—that we were going to collapse as an economy if we didn't fight off the Japanese effort to produce high definition TVs back in the '80s, when I was at the Congressional Budget Office. It was a terrible decision for Japan to make. They have lost tons of money on it. The industry was nowhere near ready to go on technology.

I think it is critically important for the U.S. to invest in R&D, but I see no reason that the—that a company like General Electric would want to—okay.

Mr. CLARKE. —but I appreciate what you are saying. Back many decades ago, after the Wright Brothers, with their great innovation in creating flight, we lost competitiveness to Europe, in terms of airplane technology. President Wilson decided to respond, and we subsidized air mail routes, which resulted in the growth of air flight technology here in the U.S. Same with Bell Labs and their technology in semiconductors. It was the U.S. military that was their strongest customer. So, in light of that track record, we have got to compete. We can't lose this opportunity. I yield back.

Chairman HALL. Chair recognizes Mr. Cravaack, gentleman from Minnesota.

Mr. CRAVAACK. Thank you, Mr. Chairman. Thank you for all our distinguished people that are involved in this today. I would like to start off with Dr. Christy. Dr. Christy, you seem to be of my genre, and back when I was graduating from high school, I remember the great global cooling. Is this great global cooling very similar to the great global warming that is going on today?

Dr. CHRISTY. Well, I don't know what you mean by genre. Anyway—I have four grandkids, but—in this sense, yes. Our ignorance about the climate system is just enormous, and we have much to learn and much to do.

Mr. CRAVAACK. Yeah. I remember the time when I was going through high school the polar caps were going to expand, and the whole world was going to flip upside down and everything else. It is kind of funny how history just repeats itself, except instead of freezing to death, we are all going to fry. So it is amazing how this has gone through. I would also like to talk to Dr. Montgomery, if I could. Sir, I come from Minnesota, in the 8th District of Minnesota, which has a very proud tradition of mining. Can you tell me how this regulation of CO_2 is going to affect mining operations within the United States?

Dr. MONTGOMERY. For the next decade or two, there is no way to achieve deep cuts in greenhouse gas emissions without substantially cutting down the use of coal for power generation. Every ton of coal that is not burned in the power plant is a ton of coal that

is not going to be mined, so it translates directly. Best we can see is a valley of death for the coal industry in which, after shrinking back as gas and other technologies replace coal in the short run, it might be able to revive, if clean technologies, like carbon capture and sequestration, come along in the future. That could be avoided with a different pace of control, but in the next decade or so, it is—coal mining is going to be where the reductions occur.

Mr. CRAVAACK. Okay. Thank you, sir. Dr. Christy, if I can bounce back to you again? If everybody—if all the United States—we go totally green, but other countries throughout this world, they don't follow suit, can you tell me what kind of tick that is even going to put on the CO_2 emissions?

Dr. CHRISTY. Well, I have run those scenarios for a number of different situations, and you are looking, at most, at a tenth of a degree after 100 years.

Mr. CRAVAACK. So a tenth of a degree after 100 years?

Dr. CHRISTY. Yes. And global temperature changes by more than that from month to month.

Mr. CRAVAACK. Okay. And could you be positively—could you positively state that because of what—the United States going totally green would actually commit to that tenth of a degree?

Dr. CHRISTY. That is a good point. You might claim it is a tenth of a degree, but you never could devise an experiment to attribute it to your legislative action.

Mr. CRAVAACK. Okay. All right, sir. So—Dr. Montgomery, back to you now, sir. So for that tenth of a degree, that we are not sure actually was attributed by the United States going totally green, can you tell me the economic impact that that would have upon the United States if we are the only ones that went green and the rest of the world did not?

Dr. MONTGOMERY. Yes. I have to look back in my memory for a study that was comparable to what Dr. Christy is talking about, but I would say the kind of work we did last year on the Waxman-Markey Bill would suggest costs in the range of 1,000 to $2,000 per household, a lost of one to two percentage points of GDP, what it would be otherwise, and perhaps a—close to a doubling of electricity prices.

Mr. CRAVAACK. Could you even comment on the amount of jobs that would be lost within the United States of America?

Dr. MONTGOMERY. Well, I am not sure about jobs, but I can say that the impact on compensation to workers would be really substantial. Some industries it would happen in the form of lower wages, keeping people at work. Other industries, where that can't happen, people would be losing their jobs, but it would be a couple of percentage points off the total compensation to labor, and—figure out how much of that is job loss in the long run, and how much of it is just you have less money to take home in your paycheck.

Mr. CRAVAACK. Okay. All right, sir, I think—Mr. Chairman, I think I have answered my questions. I yield back my 32 seconds, sir.

Chairman HALL. Thank you. And do you recollect when Dr. Holdren was here? He is the President's advisor on sea level rise, and his testimony was that it would rise 12 feet, you know, when the ice all falls and melts into the ocean. And the proper person

measured it—as you know, the very next year, the so-called gold standard of scientific consensus by global warming advocates projected that the oceans would rise between seven and 23 inches. So that is who is advising the President. That is the reason we are in all the trouble we are in right now with all this. Does that help your record any?

Mr. CRAVAACK. Well, we can't let a crisis go to waste, sir, so there you go.

Chairman HALL. Thank you. Now I would recognize the gentlelady from California for five minutes——

Ms. WOOLSEY. Thank you, Mr. Chairman.

Chairman HALL. —10 minutes, whatever she wants. Ms. Woolsey is a very valuable Member of this Committee, and gives me an awful lot of trouble, but I respect her highly.

Ms. WOOLSEY. Thank you. Mr. Chairman, this morning the Democratic caucus had the privilege of hearing from and asking questions of Dr. Steven Chu, the Secretary of Energy, and then I came right from there up here. I feel like I am living in a parallel universe. I mean, it has got my head going boing, boing, boing. It is tough.

So, my first question is based on Dr. Armstrong's testimony, who—he said—Dr. Armstrong, you said, I believe that EPA's decision to ban DDT was based on bad science. So I would like to ask the rest of you, would you reintroduce DDT into our world now, today, if you could?

Dr. ARMSTRONG. You are not asking——

Ms. WOOLSEY. Yes or no?

Dr. ARMSTRONG. You are not——

Ms. WOOLSEY. Oh, no, I think I got—you said no. You thought it would—should—we should not have done what we did in the first place. I can ask you would you reintroduce it? Sure, I would be glad to. I just didn't want to waste your time. Just yes or no.

Dr. ARMSTRONG. Yes, I definitely would——

Ms. WOOLSEY. Would reintroduce it. Okay. Dr. Muller?

Dr. ARMSTRONG. —DDT, yeah.

Dr. MULLER. It is way beyond my credentials to answer that professionally. I have read books on the subject—or read articles on the subject, and I think there is—I have seen a reasonable case that introducing it would actually save lives.

Mr. WOOLSEY. Dr. Christy?

Dr. CHRISTY. I have lived in Africa, saw people die of malaria. Absolutely, yes.

Mr. WOOLSEY. Mr. Glaser?

Dr. GLASER. I have no idea, and have no opinion.

Mr. WOOLSEY. Dr. Emanuel?

Dr. EMANUEL. Far beyond my expertise.

Ms. WOOLSEY. Dr. Montgomery?

Dr. MONTGOMERY. I have read a good bit on the subject. Roger Bate, I think, is a great expert. I agree with Dr. Christy. Millions of millions of children and poor people in Africa are dying because of the lack of DDT to—as an effective way of getting rid of disease vectors.

Ms. WOOLSEY. Well, okay, I didn't want to go too much farther on this, except I am on the—I served on the Africa World Health

Subcommittee. We have just about, using other technologies and other methodologies, done away with malaria, if we provide the right preventions for African people, like we would have had to provide DDT. So I think it has proven itself, from my opinion.

Dr. Emanuel, I understand that you have not always—I mean, that you didn't—you weren't born recognizing the link between greenhouse gas emissions and climate change, so how did you get to where you are today? How did you form your current beliefs on climate change?

Dr. EMANUEL. Well, Representative Woolsey, science is based on evidence, and evidence is often ambiguous. It evolves with time, it changes. Science progresses, but it doesn't progress monotonically. It goes up and down. In the '80s, when I first started to study the issue of climate change, back in those days I didn't feel that the evidence was conclusive. I didn't have the opinion that this wasn't happening or otherwise. But in the intervening 20 years, because of the wonderful work done in paleoclientology, to some extent because of models—my own involvement with the physics, radiative transfer, convective heat transfer, I and many of my colleagues came to the conclusion that the evidence is very strong for this.

And let me take the opportunity to say that one has to distinguish between what groups of scientists come to over a long period of time, and what a few say that get amplified by the press. We heard that there was no difference between the scare of cooling in the '70s and the concern of warming. That couldn't be further from the truth. To the best of my knowledge, not one scientific organization back in those days raised any alarm. It was a few scientists that expressed some concern amplified hugely by a big cover in Time magazine. It is not comparable to today, not at all, all right? One should not make that mistake.

Mr. Chairman, I think you misquoted Mr. Holdren. He was referring to what would happen if all of Greenland's ice disappeared. That is not projected to happen, but his numbers are correct. If it did, we would see a sea level rise of about 22 feet. Unfortunately, it is a risk. It is way out there because we don't understand the physics of ice, but I think that is what he was referring to.

Chairman HALL. We will add on to your time. We won't take from you the time, but in a recent interview Dr. Holdren was sitting right where you are there, and I told him—he stated that the Republicans needed to be educated on the issue. In an August of 2006 interview with the BBC News, he reportedly said that if the current pace of change continued, the catastrophic sea level rise of four meters, that is 13 feet, not 12 feet, I was wrong, was within the realm of possibility, and while you were going to the interview, how sure were you about your prediction? And the hard cold facts were the very next year the so-called gold standard of scientific consensus by global warming advocates projected that the oceans would rise between seven and 23 inches between now and 2100. How sure was the scientific community of their prediction? That is my recollection of it. You probably know more about it than I do.

Dr. EMANUEL. I mean, I would only simply add to that, the IPCC, in making that projection, very explicitly excluded any calculation of the melting of land ice. They—I think they were wise to do that, because we don't understand the physics very well.

Chairman HALL. All I was trying to emphasize was that he guessed at 13 feet, and he is just 12 feet wrong.

Dr. EMANUEL. I don't—I think his statement that it was within—correct.

Chairman HALL. —I am not very good at math.

Dr. EMANUEL. No.

Chairman HALL. There are three things I couldn't do, and that is add and subtract.

Dr. EMANUEL. I think—but the notion that it is within the realm of possibility is correct on his part.

Chairman HALL. Okay.

Dr. EMANUEL. That is different from a projection.

Chairman HALL. All right. So you made your point. You made a good point. You have been a good witness. I am sorry I haven't been as good a Chairman.

Ms. WOOLSEY. On that, Mr. Chairman, I will yield the remainder of my time.

Chairman HALL. Okay. Now, let us see, we have Mo Brooks from Alabama. Gentleman from Alabama.

Mr. BROOKS. Thank you, Mr. Chairman. It has been most entertaining seeing you folks act up on the higher row. Dr. Christy, would it be fair to say that pretty much the one constant about the weather is that it is always changing?

Dr. CHRISTY. The climate is always changing.

Mr. BROOKS. And in looking at Earth's climatological data, have there been cooler periods than what we are now experiencing?

Dr. CHRISTY. Yes.

Mr. BROOKS. And do you have any way of expressing a judgment as to how often the world has experienced cooler periods of what we are now incurring?

Dr. CHRISTY. If you go back through the entire history of the world, most of the periods have not been cooler than today. They have been warmer.

Mr. BROOKS. Well, let us get into the warmer periods. Have there been warmer periods?

Dr. CHRISTY. Yes, much warmer, yeah.

Mr. BROOKS. And do you have any way of expressing a judgment as to how often, during whatever period of time you want to use, that it has been warmer than what it is today?

Dr. CHRISTY. I cannot give you a percentage of time, but it is—just to say most. I can't call up that graph in my brain right now.

Mr. BROOKS. And looking at the materials that you all handed to us, this one is by Dr. Christy, I am going to read a part of it. "To compound this sad and deceptive situation, I have been quite impressed with some recent results by Doll, Jensen, et al, in which Greenland ice bore hole temperatures had been deconvolved into a time series covering the past 20,000 years. This measurement indeed presented intercentury variations. Their result indicated a clear 500 year period of temperatures warmer than the present centered around 900 AD, commonly referred to as the medieval warming period." When it says "warmer than the present", does that mean that consistently for that five century period of time, according to the Greenland ice bore hole measurements, we had had a global warming period then?

Dr. CHRISTY. Yes, in a smooth and average period. About a century smoothing. Each one of those centuries are considered to be warmer than the present.

Mr. BROOKS. So the temperatures that we are experiencing right now, do you consider them to be an aberration, or just a part of the Earth's normal warming and cooling cycle?

Dr. CHRISTY. I think most of all they are part of the normal ups and downs of climate.

Mr. BROOKS. And do you have a judgment as to what has been the warmest climatological year in the past two or three decades?

Dr. CHRISTY. That would be—in the bulk atmosphere, 1998.

Mr. BROOKS. And would it be fair to say, then, that there has been cooling of global temperatures at least over the last 13 years, compared to 1998?

Dr. CHRISTY. Well, I can say that there certainly hasn't been a warming of temperature since that time.

Mr. BROOKS. And the last four or five years, have they been cooler or warmer?

Dr. CHRISTY. They have been up and down. Some have been cold, some have been warm.

Mr. BROOKS. And Congressman Cravaack kind of jumped on some turf I wanted to hit on. It is nice to have these little cell phones where you can pull up things, and I couldn't help but pull up the Time magazine front page article dated April 28, 1975, where we have a penguin on the cover, and it says, "How to survive the coming ice age". And those are the days back when I was on the Grissom High School and Duke University debate teams, back in the early '70s. Of course, this was one of the topics that came up from time to time in extemporaneous speaking, so I happen to recall that. For you young folks, I envy you not having that recollection, but for us older folks, you know, we can remember that far back. How do you compare that global cooling claim versus today's global warming claim? Is there any consistency or inconsistency?

Dr. CHRISTY. Well, I think the consistency there is—like I said before, there is a large amount of ignorance about the climate system, and that is just the way it is. It is such a complicated system. I think there has been too much jumping to conclusions about seeing something happen in the climate and saying, well, the only way that could happen is human effects. When you look at the possibility of natural unforced variability, you see that can cause excursions that we have seen recently.

Mr. BROOKS. Would it be fair to say, then, that within the scientific community it literally is asking too much of them for them to be able to tell us whether 10, 20, 30, 40, 50 years from now Earth's temperatures are going to be warmer or cooler, much like it is pretty unreasonable to ask a meteorologist whether we are going to have rain in Washington just two or three weeks from now?

Dr. CHRISTY. Well, there are some differences in that kind of thing, but I do yield to Dr. Emanuel over here in the sense I agree with him that it is very risky making predictions that far out.

Mr. BROOKS. Well, if I could just make this one concluding statement, in my judgment, based upon what I have heard and learned over the decades, the fact of the matter is nobody knows whether

we are going to have global cooling or global warming over the next half century or century, but we are being asked to undermine America's economy based on this guesswork, speculation and surmise. And we need to be very careful as a Congress before we start eliminating jobs that people in our nation so badly need. And with that having been said, I very much appreciate the time each of you all have spent with us today.

Chairman HALL. Yield back your time? Was Dr. Armstrong trying to get his attention? Okay. Anyone else? Thank you, Mo. Thank you for your——

Mr. BROOKS. Thank you.

Chairman HALL. —good questions. Chair at this time recognizes the very patient Mr. Sarbanes. And you won't be last today. It is the gentleman from Maryland, five minutes.

Mr. SARBANES. Thank you, Mr. Chairman. Thank you to the witnesses. Your testimony is helpful, and this is a complicated issue. I wonder who among you would be prepared to declare that climate change is not happening. Is there anyone at the table who would say that? Okay.

Dr. ARMSTRONG. Do you mean in either direction, or—I mean, my position is it is just as likely to go up as down, so I am sure it is going to change. It is absolutely certain it is——

Mr. SARBANES. Okay, but you are not refuting the notion that climate change is occurring?

Dr. ARMSTRONG. Definitely not.

Mr. SARBANES. And who among you would dispute that human activity has some role to play in climate change? Okay. What is interesting to me about the testimony is, when I look at each of the witnesses, Dr. Christy, you clearly have concerns about the IPCC, the process, whether they are taking into account all the things that they should, including some of the things that you have urged upon them and so forth. But you don't appear to reject out of hand the possibility that human activity can be a factor in climate change. You are not predicting it necessarily one way or the other, but you are not rejecting that out of hand. Is that correct?

Dr. CHRISTY. Yeah, that is correct.

Mr. SARBANES. Okay.

Dr. CHRISTY. Carbon dioxide is increasing. That will——

Mr. SARBANES. All right.

Dr. CHRISTY. —have some effect.

Mr. SARBANES. And then, Mr. Muller, you also had some concerns about the IPCC, but appear to recognize climate change is very real, as being caused or heavily driven by the greenhouse gas emissions. I accept your point that it is fair to worry about whether other countries are going to take steps to meet this challenge, and whether we are sort of going to be out there on our own if we push for it, and that is a subject for discussion and formulation of policy. But you have clearly acknowledged climate change and a human activity component to that.

Dr. MULLER. That is correct. I——

Mr. SARBANES. Okay.

Dr. MULLER. The degree of the human component——

Mr. SARBANES. Fair enough.

Dr. MULLER. —is, in my mind——

Mr. SARBANES. Fair enough.

Dr. MULLER. —quite uncertain.

Mr. SARBANES. Right. And, Mr. Armstrong, you also challenge the IPCC. Obviously that is one of the parts of the agenda here today is to raise questions, and I am going to come back to that. But, again, don't appear to be dismissing—as you just indicated, not dismissing out of hand the connection of climate change and potential human activity's influence there. Dr. Glaser, you are a—I mean—Dr. Glaser, you are a lawyer. Well, that—you are a doctor. But you are not really here to speak to the science so much as raise questions about the EPA and the Clean Air Act and all the rest of it. And Dr. Montgomery, you are focusing on the economics, but, again, don't appear to be issuing a major challenge to the underlying science when it comes to climate change and the potential connection to that of human activity.

So I think it is important for us to recognize this. It is fair to raise questions and have a debate on the process by which we are trying to reach some good judgment as we make policy with respect to climate change. But the public needs to understand that climate change is real, that human activity is a contributing factor to that, and that that is—that it is fair to gather up that kind of information going forward.

Now, Dr. Emanuel, I would like to ask you—what emerges to me from these discussion of what, you know, some mistakes that were made by some of the folks involved with the IPCC's—and, you know, we can say that, but what I get the impression of is that the IPCC, you know, can take it. That this is a group that, you know, is made up of a significant number of scientists that participate over almost 200 countries that participate. And they recognize the importance of the work they do, and they are going to make corrections to try to make sure in going forward that they are an important resources.

My time is running out, but I did want you to confirm for me that, in addition to the IPCC being a robust source of expertise with respect to climate change, there are others that we rely on, because the suggestion was made earlier in the hearing that we are sort of putting all our eggs in one basket. There is the Inter-Academy Council, is there not, which has issued some important recommendations with respect to climate change, and there is the U.S. Global Change Research Program, among many others, that are there as well. Can you just confirm that there is a lot of different and independent sources of conveying this real concern about climate change?

Dr. EMANUEL. There are indeed, and let me simply remind the Committee that the IPCC is not a research organization. It communicates published research. You could throw away the IPCC, throw away that one graph that some people are focused on, that had one piece of one curve a minute. The evidence remains very strong, very robust, and very worrying. And anyone who says that we shouldn't be worried is just kidding himself. Is the outcome certain? We have heard here, we all agree, it is not. But to suggest that we are not facing a significant risk going forward, and that we should not sacrifice immediate economic goals in order to deal with that risk, I think is being colossally irresponsible.

Dr. GLASER. Mr. Chairman, if I could just respond? Mr. Sarbanes characterized his view of what I am saying here, and I just want to be precise about this. My view on the science is that the record that the Environmental Protection Agency created in the endangerment finding does not provide a basis for EPA to make that endangerment finding, and therefore to regulate. I don't want my silence otherwise—to be construed otherwise. Thank you.

Chairman HALL. I think your emphasis is what I believe is Mr. Sarbanes is saying, that this hearing really is about process. And that is what we would hope it would be about, because that is the only honest way to approach it. And, Mr. Sarbanes, you can add on to any question or statement you want to make.

Mr. SARBANES. I will yield back my time.

Chairman HALL. All right. I thank you. Gentleman yields back. Recognizes the gentlelady from Florida, Sandy Adams——

Mrs. ADAMS. Thank you, Mr.——

Chairman HALL. —for five minutes.

Mrs. ADAMS. Thank you, Mr. Chair. And I do want to talk about the economics of it. Based on our economy today, and the fact that I don't believe that there is—I think there is some kind of correlation between the regulation, the unemployment rate, the high spending rates in the Congress, all of this is going up at record rates together. Our debt, our deficit, I think it is all correlated together.

Dr. Montgomery, I want to discuss the questions with you, and it is on the economic side because, as many of my colleagues have said, we are broke. We are looking at it. We have a high record of unemployment. People are making very hard, tough decisions in their homes today on how to pay the bills, and, if they can't pay all the bills, then how to prioritize their bills. So, with that, I have a couple of questions. I want to know if any of your data that you used to formulate your opinions about the economic impacts of the climate related to regulations have ever been called into question?

Dr. MONTGOMERY. No. Economists, like other researchers, have disagreements about the emphasis to put on different things, but the models and the data that we have used have been accepted in major peer reviewed groups. We have published them. We have argued, but they have been accepted by all of our colleagues, and I think the academic community.

Mrs. ADAMS. Okay. Does the so-called danger posed to the economy by not acting to reduce what some may call—some call man made effects on climate change outweigh the economic costs to the country, in your opinion?

Dr. MONTGOMERY. No, it does not.

Mrs. ADAMS. Will the proposals that we have heard about from this administration, such as the cap and trade regimen create jobs and stimulate the U.S. economy?

Dr. MONTGOMERY. No, it will not.

Mrs. ADAMS. Will it lose jobs, will it cost jobs?

Dr. MONTGOMERY. In the short run, I think you raised all of the right issues, that we are looking at a problem of deficits that are hanging over the economy and discouraging investment because of the prospect we have to pay them back someday, we have to pay more taxes. I think that the onslaught of additional regulatory re-

quirements are imposing costs on business and making them unwilling to hire. And I think that adding additional regulations at this point is going to have an effect on employment.

In the long run, people are going to have work. People are going to find work. The question is, how much will they be producing, and how much will they be earning for it, and how much does the country as a whole get out of their effort? And that, clearly climate change regulations will diminish.

Mrs. ADAMS. And we have already been at a record high of months—coinciding months, side by side, of unemployment, so this would just add to it, is basically—on the short term?

Dr. MONTGOMERY. Yes, and if I could add to that, there have been a number of claims that we need to have environmental regulations because it is a way of getting more spending to happen. If we need more spending, which I would question in terms of our overall fiscal policy, then that is the issue, and the issue needs to be looked at in terms of fiscal policy and whether it makes sense or not. Using regulatory measures to force businesses to spend money on things that we cannot justify for other reasons does not make sense as a stimulus measure.

Mrs. ADAMS. And I think earlier someone asked you about if we were, in the U.S., to bring our carbon emissions down to zero within 20 years and invest all of this, even though countries such as China, India and the EU do not, there would not be much of a difference in what is going on today, correct?

Dr. MONTGOMERY. We would not notice a difference to the U.S. in anything that was happening to us because of climate.

Mrs. ADAMS. If the Kerry-Boxer Bill, which it was rightly rejected by last year's Congress, had passed, and we were on track to lower U.S. emissions by 20 percent, below 2007 levels by 2020, do you think the economic damage created by that bill would have been worth the carbon emissions decrease it was estimated to achieve?

Dr. MONTGOMERY. No, because they were very similar, very small reductions to ones that I mentioned, and that Dr. Christy mentioned, that the costs of that by itself would have far outweighed any benefit we could have gotten from those fiscal changes.

Mrs. ADAMS. Okay. I am going to quickly conclude with these two questions. How much of an investment in research and development initiatives would you estimate is necessary for us to cut its emissions in half by 2035, our emissions, and if we were successful, how much would global emissions decrease as a result of that success?

Dr. MONTGOMERY. I have no idea of what it would take for R&D, and I am not sure that 2035 is a target that R&D would get us to in any event, but in none of these cases would it change global emissions. Where the R&D could pay off is if it developed over the longer term the kind of technologies that we need much further out in the future to get our—to get the world completely to a zero carbon economy. And we have to remember, that is the goal. It is not a little bit of change now, it is a wholesale change in the entire world's energy system that you commit yourself to when you say, we are going to go for preventing global warming.

Mrs. ADAMS. Thank you. I yield back.

Chairman HALL. Thank you. Ms. Lofgren? I think she just stepped out. Somebody tell her she is up next. Yeah. She waited a long time. You want to make him right now? She is asking if we have closing remarks, and we don't usually, but if—I have been waiting 30 years to be Chairman so I could make closing remarks, and I don't have any closing remarks, but—because you all have been so generous with your time, and—let me tell you, don't be discouraged by the empty chairs here because this is all taken down. The gentleman right over there is taking everything down, and your total testimony will be in the record for all the other Members to read, and they will be read, so you are not wasting your time on empty chairs. This is the lady that is worth waiting for. She has been in——

Ms. LOFGREN. You are so nice.

Chairman HALL. —Congress for a long, long time, and we recognize you now for—if you are ready to go.

Ms. LOFGREN. I am ready to go, and I apologize. I was on the phone. This has been a—quite a busy morning. I was unable to be here during the delivery of the testimony because of—I am the ranking Member of a Subcommittee that was meeting at the same time, but I did have the opportunity to read the written testimony.

And, you know, I—as I am listening to some of the questions here, Dr. Emanuel, it seems like some people are confused about the difference between climate and weather, and I am wondering if you could give us a short summary of what the difference is.

Dr. EMANUEL. Well, my favorite answer that I have heard to this question that you raise is one that was given by my late colleague, Ed Lorenz, the father of chaos theory, who says climate is what you expect and weather is what you get. It is a murky line. One of the things that one tries to do is to look in climate records at long term fluctuations, and depending upon what is causing the climate to change, you have to average over a lot of weather—a good example is the weather in Washington today. A few weeks ago, it was very warm, right? The trees were blooming. The temperature is clearly lower today than it was a few weeks ago, but nobody in this room would say, okay, because of that, we are not going to have summer here in Washington. They don't make that mistake. They understand that we are looking at a short term fluctuation. The temperature of the planet was very hot in 1998 because we were experiencing a very large El Nino that year. And people say, well, it has gotten cooler since then. It is true. It means nothing, on the other hand, about the longer term changes.

What we are relatively sure of is to see what is happening with carbon dioxide, its influence, we need at least 30 years of time series. And looking at what has happened over the last five or ten years is virtually meaningless.

Ms. LOFGREN. One of the things that—the—in terms of my reading—and I read as a lay person. I mean, I am not a scientist, but if you take a look at some of the historical records, it seems that the influence—temperature influence in global climate change does relate to sunlight and variability of the sun, but right now we have got a decrease, and yet an increase, an up ramp. And I remember about a decade ago, decade and a half ago, I went to Stanford, and

the analysis that they were doing is—just look at the planet chemistry. Don't worry right now about measuring the temperatures, look at the planet chemistry. And everybody, I think, agrees that the amount of carbon dioxide in the atmosphere has spiked.

And—but one of the concerns I have is how conservative scientists are by nature. You don't want to predict something that you can't prove. And yet, if these things are occurring—I worry about methane. When you take a look at the melting of permafrost, I mean, if we were to stop all emissions today, we are still going to have a very large spike in carbon dioxide, methane, and other greenhouse gases.

Let me ask you about whether the scientific community is in a posture where—I mean, you can't prove that the ice on Greenland will melt. I mean, no one knows that. And yet, were that to happen, that would be a rather catastrophic event. Can you explain to me where the scientific community is, relative to risk analysis, when you can't prove an unknown such as that?

Dr. EMANUEL. You have put your finger on what makes the whole enterprise so difficult. So one thing we do know beyond much doubt is that current levels of carbon dioxide in the atmosphere have not been experienced for at least a million years on our planet. We also know that that Greenland ice disappeared naturally in one of the previous interglacial periods over the last 800,000 years, so we know it can happen.

And you had mentioned, and I think it is true, that science tends to be conservative. I personally think that, you know, people say the IPCC will turn out to be wrong. Yes, but with equal probability it will turn out that they have underestimated the effect, rather than overestimated. So in the last IPCC report, scientists who were the authors of that report concluded that they understood the Greenland ice problem so poorly that they weren't even able to venture. And I said, well, we are going to project an increase in sea level just based upon what we know reasonably well, which is the thermal expansion of sea water. And they said, we are not going to consider the ice.

But if you want to consider the full range of possible outcomes, given that Greenland ice has largely disappeared in the past, one has to regard that as John Holdren correctly did, as a possibility. You are talking about seven meters of sea level rise. I think it is these issues that keep us all awake at night.

Ms. LOFGREN. Well, it certainly does me. And I will—I know my time is up, but I would just like to say, I come from Silicon Valley and, you know, some—the hottest part of our economy right now is green technology. I mean, it is employing thousands of people. It is a fast expanding part of technology, venture backed. And so when I hear, gosh, you know, this is an economic problem, wow, where I come from, it is an economic opportunity. So—and I just think it is important that someone point that out. I thank you, Mr. Chairman, for allowing me to come back and still ask my questions, and I yield back.

Chairman HALL. Thank you. You are always worth waiting for. And then—yeah. Mr. Rohrabacher, the gentleman from California, recognized for five minutes.

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

Chairman HALL. And you have been patient too.

Mr. ROHRABACHER. Well, this is a very significant issue, and deserves the type of honest debate that—we have seen some of that here today, but we have also seen examples of some of the type of debate that we have had in the past on this issue. Let me note that Dr. Emanuel's statement earlier about the disinformation and some of—have been going on in terms of posturing and—which had not been conducive to a good scientific discussion.

There is some validity to what you had to say there, Dr. Emanuel, but let me just note, I have sat through two decades of having those people who disagree with your position—seen them belittled, seen their arguments dismissed without having to address the actual scientific judgments that is based—we have all heard case closed. How many of us have not heard the phrase case closed, which is nothing more than an attempt to shut off debate and honest discussion? Over and over again we have seen these tactics. During the Clinton Administration, we saw this even reach the extent where people who I know were complaining that research grants were not available to people in the scientific community unless they had a predisposition towards proving man made global warming.

Mr. Chairman, what we have needed in this issue is an honest debate and an honest discussion. I think today was a first good step. Let me note that even with this first good step, my colleagues on the left have been unable to prevent themselves from trying to call into question the integrity of the people who disagreed with them. One of my colleagues from North Carolina just mentioned that—basically talking about unethical lawyers or whatever, but could not prevent himself from suggesting that campaign donations have something to do with people's honest disagreement with his position. Well, people could honestly disagree with this. And what is the central issue? The central issue is whether or not mankind is causing a change in the climate, especially with mankind's use of fossil—what is called fossil fuels, and whether or not man made CO_2 is actually having a major impact on the climate of this planet. And it is not whether it has some impact. Everything has some impact. It is whether or not it has a major impact.

And I would just like to ask our scientists here, Dr. Armstrong, do you believe that the sun and natural causes may have more to do with the climate cycles that the Earth is going through, including the current one, than mankind's use of fossil fuel?

Dr. ARMSTRONG. I work with Willie Soon, who does a lot of research on this particular topic, and that is what he tells me. I actually try not to learn a lot about climate change. I am the forecasting guy.

Mr. ROHRABACHER. All right. Well, I would ask that everyone—I would like to make a couple more points before we ask—by the way, just so you will note, again, asking people whether or not they have received any money—research money from any corporation I think, again, is an attempt to basically steer away from the arguments as to whether someone has a scientifically based argument, and what that argument is, and trying to instead poison the well so you don't have to confront the actual science.

And that is why, frankly, Dr. Emanuel, when you started belittling people as making mascots out of scientific mavericks, well, no, you can't dismiss someone as a mascot. Maybe some of these scientific mavericks have something to say worthwhile without having to be belittled by calling them mascots. And I have been—we have been sitting through this dishonest debate on this issue for 20 years. And thank God we have at least one forum that present—is presenting the other side today. What about you, Dr. Christy and Dr. Muller? Do you think that the sun and natural causes has at least as great an impact as humankind on climate change that has always existed?

Dr. CHRISTY. Well, actually, the natural unforced variability, which is not really the sun or volcanoes or anything, but just the complexity of the system itself can create those variations on its own.

Mr. ROHRABACHER. Dr. Muller?

Dr. MULLER. The amount of global warming we have had so far, one degree Celsius, is hardly enough for anybody to even notice, other than scientists who are bringing together large numbers of instruments and measurements. I would say that claims that global warming has harmed the Earth so far as not scientific.

What worries me, however, is not that we have had global warming which has impacted us. I worry that the excess reported by the IPCC, this fact that the solar activity has turned down a little bit, but the warming has gone up, is simply a risk. It is a risk for the future. We have not had significant global warming, enough to have many of the effects that are attributed to it. But that doesn't mean that the carbon dioxide is going up on a way that has been unprecedented during human existence.

Mr. ROHRABACHER. Um-hum.

Dr. MULLER. And that concerns me, and I think it means we need to take a measured look at it and take—have a measured response.

Mr. ROHRABACHER. Well, we have had a—and by the way, Dr. Emanuel, you are just excusing the manipulation of information, calling it poor judgment rather than unethical activity on the part of the——

Dr. EMANUEL. Absolutely correct.

Mr. ROHRABACHER. It is shocking.

Dr. EMANUEL. And many panels——

Mr. ROHRABACHER. Hold——

Dr. EMANUEL. —who are in much better position to know than you——

Mr. ROHRABACHER. Doctor——

Dr. EMANUEL. —concluded the same thing.

Mr. ROHRABACHER. It is my time, let me just note, and I am going to give you a chance to answer that, but I do want—I—I am running out of time right now because I wanted to get to a science thing, but—an actual science question.

Chairman HALL. We will give the witness time to answer, if he chooses——

Mr. ROHRABACHER. Okay. Thank you. Dr. Christy, there was a period—this—what we call this medieval warming period. Is there any suggestion that that was caused by an increased level of car-

bon—CO_2, especially by human beings? And if not, if the use of CO_2 was actually less than it is now, how can we then—and it was warmer then, how can we say that, scientifically, that today's cycle, it seems to be a little bit warming anyway, is caused by CO_2?

Dr. CHRISTY. I think you are thinking like a lawyer. It is hard to convict carbon dioxide of warming back then when it wasn't there.

Mr. ROHRABACHER. Right.

Dr. CHRISTY. So the crime happened without the presence of carbon dioxide. If you think of it as a crime, I think the——

Mr. ROHRABACHER. Okay.

Dr. CHRISTY. —we might like warmer, actually.

Mr. ROHRABACHER. And I will be happy to let Dr. Emanuel answer my challenge to his dismissal of the significance of the alteration of information by scientists in presenting their case to the American public and the world.

Dr. EMANUEL. Thank you for the opportunity to make some clarifications. Let me first state that, if you read my testimony, I was very careful to say that mavericks are a very, very important part of the scientific enterprise. I, in other issues, am a maverick, and I know many of them, they appreciate——

Mr. ROHRABACHER. But you are not a mascot.

Mr. EMANUAL. I was criticizing extra-scientific organizations who made mascots out of mavericks, and that is a very different matter. And I just simply want to be clear about that. Now, on the issue of this one proxy record, let us talk about what it is. It was a tree ring proxy record, and the—there is a well known problem that had been published for several years before this report came out that noted that several of the tree ring proxies diverged from the instrumental record in modern times. There is clearly a problem. It is discussed all over the literature. It is called the divergence problem.

And the graph in question, the authors chose—and this was not part of a peer reviewed report, by the way. It was supposed to be kind of a popular report. They chose to take away that part of one proxy record that was demonstrably false. I think what they should have done, and what we all feel they should have done, was taken that whole proxy away because it was provably wrong, all right? There is no question that that was scientifically wrong.

What we concluded, that there was not, on the other hand, an intent to deceive anyone. If it was, it was very poorly conceived, because anybody who wanted to could immediately find, and did find, the original records. You could throw all of that away. You could take away all the science done by anybody in that group that you thought was questionable, and it wouldn't change anything about the conclusions, because the weight of the rest of the evidence is so large.

Chairman HALL. —have an answer from any of the others, have you? Do you want to answer, Doctor?

Dr. CHRISTY. I would just say I think that minimizes what actually happened in that situation. It was the icon of the TAR, the third assessment report. And what the tree ring record did, in showing that it did not agree with temperatures, indicated that the icon itself, which was based primarily on tree rings prior to the

16th century, was therefore not very good at explaining what the temperature was. So both were improperly shown as—one was cut off, and one was shown as a correct representation of temperature when it really wasn't. Had no scale on that thing.

Chairman HALL. Go ahead.

Dr. MULLER. Thank you. I was trained in science by Luis Alvarez, who not only won the Nobel Prize and lots of other discoveries, but is sort of a hero. He was over Hiroshima, measuring the size of the blast when it happened. Luis Alvarez taught me the fundamental scientific rule, which is you have got to show everybody your dirty laundry. I remember vividly the first time I was at a seminar in his home when Lena Gautieri, a great physicist, got up there, and I heard she had made a discovery. And she spent the first 35 minutes of her 45 minute talk showing all of the evidence against what she was going to claim. In the end, when she showed her evidence, it was compelling because it was stronger than everything else.

My problem with the way the hockey stick was derived was that there was none of this. Luis Alvarez taught me that if you hide something, if you don't show something, that you are afraid people will draw the wrong conclusions, the person you are most likely to fool is yourself.

Chairman HALL. Thank you.

Dr. GLASER. May I respond too, Mr. Chairman? I think—a couple of things here. First of all, Climategate was about a large number of things. The hockey stick has gotten all the publicity, as rightly it should, because the hockey stick was the fundamental way—it was the fundamental piece of evidence on which climate change was presented to the public in the IPCC report. So Climategate is about that, that is fundamental, but Climategate is about a bunch of other things as well. It is a large pattern of activity. And I think we have heard discussion today about the various review panels that were undertaken, mostly in England, and there are a few things that you need to understand about those review panels.

First of all, the fact that the English felt that it was necessary to investigate what had happened is something that we wish EPA had done as well. They felt that there was enough here to take a look and to have some kind of process, and that is all that we have asked EPA to do here, is just take a look at this, let the public comment. EPA looked at it and said, nothing here. We are not even going to let the public comment. That is a process flaw. That is number one.

Number two, none of these review panels, including the Oxboro panel, operated according to any kind of procedures that would even remotely approach the standards that we would use here in the United States. We have heard about interviews that weren't made public, failure to hear dissenting points of view. That is all important also.

And then the third thing I would have to say is that although this doesn't get publicized very much, all of those review panels, in fact, were very critical of a lot of the procedures that were used by the scientists that they were reviewing, including the review panel that Dr. Emanuel served on that said in specific that they were actually very surprised. And that the statisticians in question, or the

climatologists in question that were producing material like the hockey stick, which is fundamentally a statistical analysis, did not think it necessary to consult with disinterested professional statisticians.

There was concern expressed across all of these review panels about failure to respond to Freedom of Information requests, operating in a culture of secrecy, not providing information to scientists who didn't share their views. That is ultimately what Climategate is all about, and that is why it is created so many questions.

Chairman HALL. Does that do it? Mr. Montgomery?

Dr. MONTGOMERY. Just one thought, which is that even if all of the climate science was accepted as good science, we still need to worry about the bad economics and bad policy analysis that have been used to leap from conclusions—to leap to conclusions about what should be done from that basis.

Chairman HALL. Okay. Mrs. Woolsey is—wants to make a closing remark. Recognize you for——

Ms. WOOLSEY. A minute.

Chairman HALL. —for a couple or three minutes. Whatever time you take, as long as you don't take over five minutes.

Ms. WOOLSEY. I won't, I won't. Thank you, Mr. Chairman. I would like to respond to Mr. Rohrabacher about today's panel representing the other side, because I don't think that that is the conversation we have had today, because every single person said that global warming is happening. Every single person said that human activity is a factor, and that science must be continued. I think there is agreement in that. And I think the challenge is exactly how we are going to have science that is understandable and acceptable. So—without giving up real science.

So—now, you know, it is clear, Mr. Chairman, this debate has focused a lot on the IPCC, but, you know, even if you reject the report—I don't, but I need to point out that there are many other reputable sources of scientific information, like the United States National Academy of Sciences, and we have to—we accept their reports. In addition, every significant relevant scientific society has put out statements that are in agreement with the mainstream view of climate science. And, obviously, all of those groups cannot be wrong.

So as I said when I came in, after hearing the esteemed Secretary of Energy, Secretary Steven Chu, this morning at nine o'clock, and then came in here, I really could be living in a parallel universe, and I thank you for keeping me sane through it.

Chairman HALL. Gentlelady's time has finally expired.

Dr. ARMSTRONG. Could I make a comment on that? I think I was misrepresented by her.

Chairman HALL. I recognize you for a minute, two minutes if you need it.

Dr. ARMSTRONG. She said every single person was recognizing that global warming was happening. I did not say that. I said it had happened, and that we would have no idea whether the temperature is going to go up or go down. Secondly, the whole notion of voting by scientists is not scientific method. In fact, it is antiscientific method. It is the way that scientists prevent change.

Chairman HALL. Okay. Let me just say that this is a group that I had heard had some questions about the science. You have expressed that somewhere, or you wouldn't be here. We have asked you to come. Dr. Montgomery, your testimony has been very valuable because in a mile of here there is probably 1,000 places of business. Every one of them have a door people walk through. They go in there and they pick out something, and what is the next thing they have to do? They have to pay for it. They have got to go by a cash register.

And I ran into some witnesses about five or six weeks ago had they ever been to Wal-Mart, and had they—they said yes. Did you buy anything? Yes. And what did you next do? They didn't know, or they just didn't say anything. Did you see anything unusual? And—did you see a thing called a cash register? And I had a dictionary with me, and I wrote—I called out to these Phi Beta Kappa people what a cash register was, read them two or three paragraphs of it, still didn't agree.

You know, we have spent 30 billion dollars, and we are in debt 14 trillion right now on our children, and we have only got pamphlets to show for this since it came out in the '90s. And we needed this hearing today, and we are going to have other hearings that will give those other folks a chance to justify their findings and answer the question just like you all have. We are going to put them under oath. I hope they will come. I hope they are as kind as you all have been in giving us your time. And I certainly want to thank you for that.

And I will just close with this. I was a paperboy in the '30s, and I served Bonnie and Clyde one time from a drugstore. I gave them curb service. They wanted two Coca-Colas, a carton of Old Golds and all of the newspapers we had. And—anyway, I called the Greenville Police—it was just one road from Los Angeles to Miami then, that was Route 66, came right through my town—told them that they were headed in that direction. And they said, well, dogs been killing some sheep out on the north part of town. We are going out there and shoot them dogs, so—you can always do the wrong thing with good information.

But we also had—let me finish. I haven't used up all my time. We also had a fellow named Dr. Something that came to Dallas with something that we had never heard of before. He was a weather predictor, and he had a sling cyclometer. My God, I had no idea what it was, but he would use that sling cyclometer six o'clock every morning on WORR and tell what the weather was.

Now, we used the word maverick up there. There was a maverick projector up at Paris, Texas. He listened to him, and he predicted just the opposite. He didn't have a sling cyclometer or anything, and he was right 80 percent of the time. I guess that is the way it goes.

Thank you very much for your time. Thank all of you, and I thank you for your valuable testimony and answering the questions. The Members of this Committee may have additional questions for any one of you, and we will ask you to respond to those in writing. Record will remain open for two weeks for additional comments from Members. Witnesses are excused, and this hearing is adjourned.

Whereupon, at 1:05 p.m., the Committee was adjourned.]

Appendix I:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. J. Scott Armstrong, Professor of Marketing, the Wharton School, University of Pennsylvania.

Response to The Honorable Ralph Hall

J. Scott Armstrong. May 24, 2011

1. **The three most glaring violations of standard forecasting procedures involve failures to:**
   1) fully disclose methods and data and to respond when asked for such information
   2) properly validate procedures by simulating the actual forecasting situation
   3) demonstrate an important causal relationship between the variable being forecast (global temperatures) and the proposed policy variable (human emissions of carbon dioxide) and to demonstrate a causal relationship between proposed policies and net social benefit.

   a) **Impact on the overall science?** These are basic violations of the scientific method such that those who forecast dangerous manmade global warming are not doing science.

   b) **Comparison?** Population growth, resource shortages, and famine (Ehrlich 1968)

2. **Would a climate model that has simulated past climate conditions be one that has been properly validated?**

   No. While this is counter-intuitive, there is little disagreement about the evidence. The ability to fit past data is not indicative of the ability to forecast. In fact, it tends to go the other way. Complex models can fit the past data well, yet they fail when it comes to forecasting.

   Necessary criteria? To simulate the forecasting process by making ex ante forecasts and to compare the forecasting accuracy of forecasts from alternative evidence-based forecasting methods.

3. **Debate over the 140 principles?**

   The principles were published a decade ago. They were based on work by about 40 experts in various academic fields and drew upon nearly a century of published research. They were reviewed by 123 outside reviewers and were checked my many of those who were involved in the original research. So while they are very surprising to those who are unfamiliar with the research, they are not surprising to those who know the research. They were published in 2001 in the *Principles of Forecasting* handbook. While I served as the messenger, the principles are a testament to the many excellent comparative studies to find out what works in what situation. The principles were also published online at http://forprin.com and those with conflicting information were asked to submit it. The only principle that I would say is controversial is related to statistical significance and it has been changed

since the publication of the book. It now states "statistical significance should not be used by forecasters." (This is more extreme than the original principle that limited the use of statistical significance.) This change was due to further information on the topic that was revealed since 2001. In particular the review by Ziliak and McCloskey (2008), along with the fact that we have been unable to find a single comparative study to show that the use of statistical significance can improve decisions.

4. **Expertise in forecasting vs. those working in atmospheric physics.** This is true for all my work in forecasting whether it involves terrorism, political elections, health care, or automobiles. I rely on information from domain experts in each field if need be. For climate change, we have relied on Willie Soon, one of the leading experts on climate change, and the physical science literature. Experts on politics, health, climate, and automobiles cannot forecast accurately unless they know and use the proper forecasting tools and techniques.

5. **Value of forecasting in complex and uncertain situation given experts are of "no value"?**
   We do not assume that experts have no value in forecasting. The point is that if they are unaided by evidence-based procedures for forecasting, they can do no better that people with little expertise and usually a bit worse than simple rules. This research dates bask to the 1930s, and I am not aware of any studies that have challenged it.

   We do have evidence-based procedures that can provide accurate forecasts for many situations and that are in all cases better than unaided expert judgment. Forecasts from best practice procedures are needed in order to make rational policy decisions.

6. **Value of simple models in complex uncertain situations.**
   a) **Why**? Yes, counter-intuitive at least to those who do not know the evidence. What happens is that complex models tend to fit random variation. Thus, they fail when subjected to forecasting for new data because they do not properly model the situation.
   b) **Effectiveness of simple models.** This was a basic theme in my review of the evidence in my book, *Long-Range Forecasting*. We demonstrate the value in Green, Armstrong and Soon (2009), Validity of Climate Change Forecasting for Public Policy Decision Making, *International Journal of Forecasting*, 25, 826-832

7. **Assumption that the data used by the IPCC were reliable and accurate.** There is some evidence that the data we used exaggerates warming over recent decades. Despite this, our evidence-based forecasting procedures were 12 times more accurate for long-term forecasts (91 to 100 years) than were the IPCC projections. Correction to the data would, of course, show

that the IPCC forecasts were even worse than shown in our validation study.

8. **IPCC references**
   a) We did not attempt to assess the purposes of the references, but simply whether they referred to evidence-based forecasting literature; they did not.
   b) The IPCC report did not describe the forecasting procedures that were used in any way that would enable someone to replicate them. Despite the apparent complexity of their procedures, their published forecast was a simple 2 degree centigrade per century extrapolation. We inferred from this and other information in their report that in practice their forecasts were their unaided expert judgments and that the complex and expensive computer models were adjusted until they were consistent with the authors' judgments.
9. **Scenarios.**
   a & b) Scenarios are stories (speculations) about what might happen; they are the product of the imagination of the story teller. Little validation has been done on their use for forecasting, but what has been done shown that they tend to bias judgmental forecasts. See Gregory and Duran's chapter in the *Principles of Forecasting* handbook (Armstrong 2001).
   c). Scenarios are used to gain the attention of decision makers and to persuade them to believe the predictions incorporated in the scenario.
   d) It would be unethical to base policy on scenarios. Rather policies should be based on scientific forecasts of all costs and benefits of alternative polices, including doing nothing (see publicpolicyforecasting.com).
10. **Proper testing of forecasting procedures (models).**
   It is of no value to average forecasts from improper forecasting methods. Scenarios are not forecasts. Also, the IPCC authors' report excluding forecasts of declining temperatures from their averages as obviously wrong.

Response to The Honorable Randy Neuberger

J. Scott Armstrong, May 24, 2011

Will we ever be able to take all variables into account? To date, nearly all attempts to use complex models have failed to improve forecast accuracy. This has been attempted in trying to forecasting economics, individual behavior, and climate change. The barrier seems to be due to the use of non-experimental data and to regression models.

We are currently working on an approach called "index models" that can handle an unlimited number of variable. They depend upon having good data and good knowledge about the direction of effects. We have successfully applied this method to forecasting elections. (See for example, and J. Scott Armstrong & Andreas Graefe (2011), Predicting elections from biographical information and candidates: A test of the index method, *Journal of Business Research* 64, 2011, 699-706, and Andreas Graefe & J. Scott Armstrong (2010), Conditions under which index models are useful: Reply to Bio-index Commentaries 693-695.)

An application to climate change would be interesting. Currently, however, I am overwhelmed with other tasks. I also face the problem that, other than about $3,300 from the State of Alaska, I have had to fund my own research on climate change.

Response to The Honorable David Wu

J. Scott Armstrong, May 24, 2011

I am not aware of evidence that there is now an increased consensus among scientists with relevant knowledge on any of the three items listed. Of course, scientists who believe these things are inclined to claim that scientists who do not are not appropriately qualified.

Wherever the balance of opinion falls, there is a diversity of scientific opinion on these matters among senior scientists and this should provide a caution to forecasters that the situation is complex and uncertain and that neither unaided expert judgment nor complex models are appropriate methods with which to generate forecasts for policymakers.

Response to The Honorable Donna F. Edwards

J. Scott Armstrong, May 24, 2011

1. Compensation for my research, etc. from the oil industry or associated entities....

Unfortunately, I have not.

2. NA

3. Expert witness?

About 12 cases, but none related to climate change.

4. NA

Responses by Dr. Richard Muller, Professor of Physics, University of California, Berkeley and Faculty Senior Scientist, Lawrence Berkeley Laboratory

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Climate Change: Examining the Processes Used to Create Science and Policy

Thursday, March 31, 2011

Questions for the Record
The Honorable Ralph Hall

1. In your testimony, you note that access to affordable and abundant energy, in fact, is clearly correlated with the quality of life enjoyed by a society. This appears obvious throughout our society. For example, inexpensive electricity allows refrigerators to prevent food from spoiling and energy-consuming hospitals save lives with all of their electronic equipment.

a. Can you provide some other examples of the social benefit of affordable and abundant energy?

The most important necessities often are the cheapest. Most people in the United States pay little for water and yet could not live without it. That is a very desirable state of affairs, as long as the use of water is not subsidised to encourage wasteful use. Thus we can say with confidence that what water is worth far exceeds what it costs. The same is true of energy. Although on the margin, there are discretionary uses of energy, most of the energy we use makes contributions to our lives far greater than what we pay for it. Coming into a warm home in winter is worth far more than the fuel bill, the flexibility and freedom of travel that we gain from readily available energy is "priceless" as the credit card advertisement puts it, and raising the price of energy means we must make do with less of these enjoyments or less of something else. With forces we cannot control driving up the price of some forms of energy, any government action that will raise those costs further needs to be scrutinized very carefully to make sure that it provides more than it takes away from the American consumer.

b. Do economic models that calculate the cost of climate-related policies adequately take into consideration the higher social cost resulting from more expensive energy?

Some do and some do not. Mainstream economic models like EPA's ADAGE model and the MRN-NEEM model that my colleagues and I have used in studies of climate policy do so. This class of models recognize that society's resources are limited, and that choosing to make energy more expensive will divert those resources away from producing other goods and services that consumers want. The loss of other good things – or having to make do with less comfort and convenience from using energy – is the social cost of more expensive energy. Other models do not. The kind of models used by organizations like PERI to support claims that regulations that make energy more expensive also create jobs completely ignore the social costs of more expensive energy.

2. Over 1.6 billion people – 25 percent of the world's population – do not have access to electricity. Many of them soon will, thanks to expanded use of coal, which is forecast to increase 50 percent by 2030. The affordable electricity provided by coal will enable economic development and help alleviate poverty in places such as China, India, and Africa.

a. How will U.S. efforts to reduce greenhouse gas emissions have any impact on climate change give the expected dramatic increases globally? Should the U.S. impose higher energy costs on its citizens if the benefits are negligible?

Unilateral actions by the U.S. will not have a noticeable impact on climate change worldwide, and therefore they can only provide negligible benefits to U.S. citizens. We do have a responsibility toward the poor, in the U.S. and worldwide, but policies to reduce greenhouse gas emissions will do the poor in the United States no good at all, and worldwide we would do far better to spend what climate regulations would cost us on direct aid to the neediest.

3. Some advocates of international action have pointed to China's commitment to reduce greenhouse gas emissions as an indication they are willing to participate in a binding international agreement. Do you agree with this hypothesis?

No, nor do I see any evidence of a real commitment by China to undertake effective policy measures to reduce their emissions below levels that are already in their economic interest. What we have is a political statement in the Copenhagen Accords that is neither binding nor, in terms of its magnitude, likely to represent any sharing of real costs by China.

4. Should China, in response to an international treaty, commit to some sort of carbon restriction; is there reason to believe China would adhere to their commitment, given their repeated disregard of other international agreements, such as enforcement of intellectual property rights?

No. Indeed there is no reason to believe that any nation will adhere to the kinds of commitments that are now being discussed in negotiations to extend the Kyoto Protocol, because just about every study of how those commitments relate to national interests find that such an agreement would be unstable. Moreover, it is far from clear given the nature of the Chinese political system that the central government could enforce such a commitment even if it did believe it was in China's national interest. Regional governments in alliance with their regional industries seem to be the real power in China's economy. This alliance of government and industry has directed China's growth since market reforms in the direction of massive investments in heavy industry, which are largely responsible for the continuing growth in China's greenhouse gas emissions. They can do so despite creating massive overcapacity because of the access of local governments to loans from State banks, which they use to support uneconomic local industries. Without some way of breaking up this crony capitalism there is little chance that Beijing could greatly change the direction of emissions growth in China.

5. A lot of discussion relating to mandating a "clean energy" market surround the increased manufacturing base that would appear due to the newly mandated market. Yet, if energy costs increase substantially, as expected from such a mandate, is there reason to believe energy-intensive manufacturing companies wouldn't follow previous industries across the border or overseas?

Absolutely not. Mandating purchases of "clean energy" through regulation is ineffective in creating an increased manufacturing base. Manufacturing will take place in the region that has

the greatest comparative advantage, and raising energy costs through clean energy mandates only reduces the U.S. advantage in manufacturing. We are seeing this already, as a large share of the wind and solar equipment now being installed in the U.S. as a result of renewable energy standards is being manufactured overseas. And Europe, despite its massive subsidies to use of renewable energy, is having the same problem keeping manufacturing of the equipment at home.

6. President Obama recently proposed instituting a "Clean Energy Standard" of 80% energy from clean sources by 2035, presumably with the goal to reduce greenhouse gas emissions. As an expert economist, how do you anticipate such a standard would impact the economy?

First, it would be exceptionally difficult to meet because getting from the current level of renewable use to 80% requires an unprecedented and premature turnover of the capital stock, the adoption of very costly or technically unproven technologies, and a level of use of intermittent and uncontrollable resources like wind and solar that would threaten the reliability of electricity supply. Moreover, being renewable does not mean that an energy source is without environmental problems of its own or that the indirect effects would be benign. The continued support for corn-based ethanol despite its making global warming worse and raising the cost of food is a case in point. Taking all this into account, the result would be a large increase in energy costs and likely massive unanticipated environmental problems and impacts on food supply.

7. A key assumption in the process of economic modeling is the availability of carbon offsets. Presumably, widespread availability of offsets would allow for a reduction in greenhouse gas emissions to be achieved at a cheaper cost by having another entity do so.

a. Can you outline why you believe carbon offsets will not be as widely available as assumed by many economic models?

Carbon offsets can either be plentiful or valid, but it is hard to devise a system that can achieve both those goals. Any carbon offset represents the difference between what is actually happening and what would have happened otherwise, and determining that counterfactual is always to an extent arbitrary and likely to create moral hazards that lead to gaming the system. Moreover, the most prolific source of offsets is expected to be from reduced deforestation in developing countries. But the reason for that deforestation is largely the lack of adequate institutions like property rights in land and effective governance in the countries where deforestation is occurring, and without fundamental institutional change those countries will be unable to deliver credible offsets. Finally, valid offsets from forestry and prevented deforestation are likely to be competing with use of land for food production, and therefore will be costly to the world's food supply and likely to run into severe opposition when that is realized.

b. Outside of the availability of such offsets, can you comment on the concept of "additionality" and its impact on the ability to produce tangible environmental benefits?

"Additionality" is the requirement that a program bring about reductions in emissions that would not be achieved in its absence. Some such requirement is necessary to make sure that there are tangible environmental benefits, but it is an area where "the best is the enemy of the good." The tighter the requirement to demonstrate "additionality," the less likely it is that useful real world

measures will be credited with reducing emissions. For example, nuclear power in the U.S. is an accepted technology so that building additional nuclear powerplants might not count as "additional" emission reductions, even though significant policy aid is required. Also, in programs like the Clean Development Mechanism (CDM) a project will satisfy additionality only if it is not economically feasible without CDM credits. But if a host country adopts a broader policy, such as raising gasoline taxes, that make some projects economic, they will no longer qualify. The opposite kind of gaming has been observed in countries that use different feed-in tariffs to pay for electricity from different sources; those countries can make any project comply with the "additionality" rules by lowering the feed-in tariff until it is uneconomic without CDM credits. Thus additionality is a worthy idea that has produced great mischief in application.

8. In your discussion of economic impacts, you neglect to mention the often-cited "Stern Report," conducted by British economist Nicholas Stern. Can you mention some of the flaws in the process of the Stern Report?

Despite the charge to the Stern Commission to review the economic issues, the Stern Report turned into an advocacy report supporting a particular set of attitudes toward climate policy. Although there is some good thinking buried in the body of the report, the overall summary and in particular its conclusion that the benefits of radically reducing emissions far exceed the cost are highly misleading. Numbers are twisted and distorted in ways that have no support in the economics profession to come up with the conclusion about benefits versus costs, largely because the report fails to mention that the benefits will accrue to future generations far richer than ourselves, while the costs fall on current generations, and that as a percentage of income we give up far more than the future generations gain. Sir Nicholas organized reviews of his draft report by leading American environmental economists, among which I was included, and the universal message to him was that the calculations in the report were absurd and would destroy its usefulness in enlightening policy. He ignored that advice.

9. A recent report by an English business consulting firm examined the costs and benefits of government policy to support the renewable energy industry in United Kingdom. It found that for every job created in the UK in renewable energy, 3.7 jobs are lost.
[http://www.bbc.co.uk/news/uk-scotland-12597097]

The primary reasoning in support of this conclusion is that the opportunity costs associated with pushing consumers to more expensive renewable energy greatly outstrips any benefit from the creation of "green jobs."

a. What is your reaction to this conclusion that the push for "green jobs" is economically damaging?

It is correct. To the extent that renewable energy makes economic sense, either because it can be produced more cheaply than fossil fuels or is a cost-effective way to comply with environmental performance standards, it will be adopted without specific support for renewable energy. For the most part, neither of these conditions hold. There are more cost-effective ways to meet environmental goals, and renewable energy costs significantly more than available alternatives to meet energy needs.

Questions for the Record
The Honorable Randy Neugebauer

1. Dr. Montgomery, even President Obama has said that under his climate change policies, "electricity prices would skyrocket." Some estimates of the benefits of even the most drastic climate change initiatives find that we would abate global temperature increases by less then one degree Fahrenheit by 2100. Based on the scientific and economic information we have available to us, how would you describe the cost-benefit analysis of imposing massive subsidies and mandates on energy producers and consumers?

The costs are high and the benefits are nearly non-existent. Although there are many uncertainties and disagreements about climate science, there is no dispute about two calculations: the U.S. will be contributing a declining share of global emissions over the next century no matter what we do, and President Obama's climate policies will make next to no difference in global concentrations of greenhouse gases and temperature change. No matter how costs are minimized by proponents of specific positions, including the frequent statement by EPA that "even 1% of GDP is only half of a year's growth" or Al Gore that "it's a postage stamp a day," the clear conclusion from the numbers is that the benefits to the U.S. of those actions are even smaller.

Questions for the Record
The Honorable David Wu

1. If you surveyed climate scientists in 1990 and then again in 2010, would the results indicate:
   a. an increased consensus that climate change has been occurring?
   b. that climate change is due to an increase in greenhouse gases?
   c. that the increase in greenhouse gases in primarily due to human activity?

I have seen so many widely differing "surveys" purporting to state the views of "climate scientists" that I have no clear answer. Looking just at historical data, there does appear to be an increasing likelihood that recent temperatures are not just normal random fluctuations but it is by no means an unambiguous signal. That an increase in greenhouse gases in the atmosphere will lead to an increase in temperature has never been in dispute, at least since Arrhenius. Whether the increase in greenhouse gases up to now is primarily due to human activity is a question that I never thought was worth worrying about, since it is clear that there will at some point in the future be large increases that are attributable to human activity.

Questions for the Record
The Honorable Donna F. Edwards

1. Have you ever received either direct or indirect compensation for any of your research, analyses, publications, testimony or a speech in any form, at any entity, by a company, trade association, institute or foundation that is represented, supported or funded by the oil, coal or energy industry?

I was employed for most of the past 21 years by a consulting firm, Charles River Associates, and received all my compensation from that company. CRA had many clients from the oil, coal and energy industry, but overall its energy practice represented only a small fraction of its business.

2. If you answered yes to question #1 above please indicate:
   a. The name of the entity that provided this compensation?
   b. The year it was provided?
   c. The amount of the compensation?
   d. A brief description of what specifically you were compensated for doing?

I cannot answer this question. All client engagements were covered by a confidentiality agreement between CRA and the client, and I am bound by my own confidentiality agreements with CRA. Even if I were not under that obligation, I no longer have access to information about CRA's revenues from any engagement because I am no longer employed by CRA.

3. Please indicate if you have ever appeared as an expert witness in a civil or criminal court case?

I have.

4. If you answered yes to question #3 above please indicate:
   a. The name of the court case?
   b. The name of the court where the case was held?
   c. The name of the plaintiff or defendant that you testified for?
   d. Please indicate the amount of compensation you received either directly or indirectly for your testimony in each case mentioned above and the name of the entity that paid your compensation.

All the information requested in questions a, b, and c was provided in my resume delivered to the Committee before my testimony. I am unable to answer question d. for the same reason that I am unable to answer question 2. Moreover, since I was paid a salary and bonus at the discretion of my employer, I have no knowledge of what the connection between my compensation and any of these engagements might have been. Nor would it matter, because I have always conducted my own independent research in every engagement, and stated my own conclusions objectively and honestly no matter who my client was.

Responses by Dr. John Christy, Director, Earth System Science Center, University of Alabama in Huntsville

Questions submitted by Chairman Ralph Hall

Q1. In your testimony, you describe that lead authors of IPCC chapter are usually experts in the field the chapter discusses. While this would make sense on its face, you also state that since the lead author has essentially the final say on what goes in the chapter, it creates a conflict of interest if there is information submitted that is counter to the views of the lead author.

a. How could the process be changed to remove that conflict of interest and allow for differing views to be incorporated into the final product?

A1 (a) I have suggested a number of ways to improve the process. First is to remove the controlling bureaucracy from being led out of the U.N. Second is to create an electronic climate assessment system in which there is much greater transparency and acceptance of alternate views with the decision-process for conclusions made visible to the community. Third, is to explicitly provide a means, i.e. a chapter or two, whereby alternate views to be expressed (which to date have been shut out) by credentialed scientists which deal with the scientific evidence for, as examples, low climate sensitivity, inappropriate paleo-reconstructions, the role of natural unforced variability, and the lack of evidence for catastrophic weather and climate developments. Oversight would be governed by those who do not have an agenda to promote (i.e. no conflict of interest), but are careful to see that fairness is adhered to. For an issue that has such tremendous impact on the economy, the Congress needs to see the full range of evidence regarding climate change. Given the lack of diversity in the current IPCC process, I would recommend the U.S. congress ask for its own assessment developed along the lines above. Please note that those who perform research under federal programs may be viewed as "conflicted" because the current system is biased to support those trying to make a case for dangerous human-induced climate change rather than understanding natural, unforced variability.

b. Has there been anything suggested to or adopted by the IPCC that would alleviate this conflict of interest problem?

A1 (b) I understand that there is a new document that appears to make some effort at reducing conflict of interest problems (see discussion here http://rogerpielkejr.blogspot.com/2011/04/ipccs-proposed-coi-policy.html). However, as suggested in Pielke's report, rulings regarding COI will be rather non-transparent. And, as mentioned, one wonders if scientists who are government employees or do research on government grants (of governments with strong agendas regarding greenhouse-gas controls) would ever qualify as not having COI. I suspect not much will actually change here as the IPCC continues to be led by an establishment of scientists and bureaucrats who believe humans are having a catastrophic impact on the climate system and who desire strong greenhouse gas controls. It is important to remember that the IPCC provides one view of climate change and that there are other views equally backed-up by evidence but which have been marginalized or eliminated from the IPCC venue. As such, at least one other venue independent from the IPCC, such as a "Red Team," is necessary.

c. Have other lead authors expressed this concern or pointed out this deficiency as well?

A1 (c) I would point to Dr. Richard Lindzen and Dr. Richard Tol as two former Lead Authors of the IPCC and Roger Pielke Sr as a former CCSP Lead Author who are critical of the methodology and conclusions of the IPCC. This may seem to be a small group, however, scientists critical of the IPCC process are, in effect, excluded from the opportunity to serve as Lead Authors since the IPCC itself selects whom they want. There are certainly many other scientists who were never asked to serve as Lead Authors whose credentials are exemplary and are well-qualified to provide climate science information.

Q2. You discuss in your testimony Climategate email exchanges between the lead author in the third assessment report with other scientists regarding the Hockey Stick graph.

a. Are you aware of any group discussion about this matter with all the lead authors and coauthors present?

A2 (a) To my knowledge, the elimination of the "decline" in Briffa's tree-ring data was not discussed with all of the Lead Authors in an open session—I certainly don't recall such a discussion. From the now exposed email evidence, the deletion of the Briffa data (because it disagreed with the Hockey Stick) occurred in late Sept. 1999 -after the IPCC meeting in Arusha Tanzania and before the meeting in Auckland NZ—through behind -the-scenes email discussions. These behind-the-scenes exchanges were never entered into the formal review process.

b. Does the IPCC spell out a process requiring discussion of an issue like this between all the authors or is there no process at all thereby allowing a great amount of discretion to the lead author?

A2 (b) Controversies were intended to be discussed in the open. However, much of what the Lead Authors did for the IPCC was rather ad hoc, and of course done on a voluntary basis (if one is not a government scientist.) At the time of the writing of the TAR, the Lead Authors had considerable authority over the text and the review process, and there was really no serious oversight on what individuals did relative to formal review procedures. In this case a Lead Author with some close associates somehow managed to truncate data without the rest of the Lead Authors' knowledge.

c. The IPCC has stated it has changed some of its processes in response to the report by the Interacademy Council. Was this process deficiency addressed in the changes recently implemented?

A2 (c) Yes and no. The IPCC has announced changes, but it remains to be seen how openly and honest the authors will be or how well they will adhere to the new guidelines including rules about conflict-of-interest. It must be understood that the IPCC is a well-established organization with a need to affirm its past activity and to bolster the perception that its documents are the best science on climate change available today. The IPCC will continue to control its own message, and will do so by selecting Lead Authors who will support this emphasis. That basically implies that they will not address past failures and will seek to make ever-more confident announcements about their view of climate change. This is one of the reasons that a separate climate science assessment be initiated with one of its missions to expose past IPCC failures (which the IPCC will not do on its own, e.g. the Hockey Stick and the Yamal paleo-record.)

Q3. I'd like to ask you about the "hide the decline" trick referred to in the Climategate emails.

a. Am I correct in saying that this trick was to use tree ring data to show temperature changes, but only up to a certain date, after which satellite or surface temperature data was used to finish the graph?

A3 (a) There are three issues tied up together here that are discussed to some extent in the Climategate emails. (1) The first issue concerns the problem created when Mann's Hockey Stick and the Briffa's tree ring result did not agree—Briffa's result showed a decline in temperatures after 1960. But, Briffa's result was legitimately constructed and published. To avoid showing this disagreement, the Briffa result was simply chopped off after 1960 to "hide the decline" so it wouldn't disagree with the Hockey Stick. (2) The second issue then dealt with the splicing of thermometer readings into the various proxy depictions in one way or another even though the proxy records didn't agree with the thermometer records. This gave the impression of a rapidly rising temperature after 1960 even though the proxy records did not have such a feature. To describe this as a "trick" is accurate. (3) The third issue deals with the Hockey Stick itself and the poor mathematics and data utilized in that product.

b. How would one be able to discern what part of the data set was from proxy data and what part was from real measurements?

A3 (b) One would never know about the real measurements from the Briffa proxy dataset because they were amputated after 1960. The intentional splicing-in of instrumental data was done in various ways at various times during this period, so I can't be more specific here. However, the splicing was a relatively minor problem compared with the brutal truncation of data after 1960 in Briffa's dataset and the poor analysis that went into the Hockey Stick.

c. Is this accepted scientific practice?

A3 (c) Eliminating data which were never shown to be "wrong" is not acceptable scientific practice, indeed this is the antithesis of the scientific method. Splicing in-

strumental data onto proxy data in this way is comparing apples to oranges, and not acceptable in my view.

Q4. The IPCC describes itself as a scientific organization. Would you agree with this characterization? If not, how would you describe the IPCC and the assessment reports it generates?

A4. The IPCC is an organization of IPCC-selected authors and editors, many of whom are scientists. The IPCC is not a scientific organization in the sense that it does not sponsor or perform scientific research. See also response to 2.c. above. The assessment reports by the IPCC are simply one version of climate science generated by a U.N. body and do not represent the complete view of evidence on climate change.

Q5. The 2006 National Academies report on temperature reconstructions indicated that there were methodological problems in reconstructions that have led to uncertainties which were subsequently underestimated. Although you did not participate in the Fourth Assessment Report, did you find that these methodological problems were addressed by the IPCC when they reviewed temperature reconstructions? Or did the reconstructions used in the IPCC report reflect the same deficiencies identified by the National Academies report?

A5. I participated in the AR4 (Fourth Assessment Report) as a "Contributing Author", however, I did not participate in the section referred to in this question (reconstruction of paleo-temperatures.) What was disappointing in the AR4 was the fact they did not address the problems from the previous IPCC report (outlined in the NAS report) concerning the Hockey Stick and "hide the decline" even though they were asked to do so in the review process. In AR4, they continued to NOT show the full Briffa tree ring series, (i.e. continuing to "hide the decline.) This truncation of data was done over and over -see Briffa and Osborn (Science 1999), Jones et al (Rev Geophys 1999), Briffa et al (JGR 2001) Plate 3, Jones et al 2001 Plate 2A, Briffa et al 2004 Figure 8, Hegerl et al Figure 5b. (CRU conceded most of this in their March 1, 2010 submission to Muir Russell, see page 38). [From http://climateaudit.org/2011/03/31/disinformation-from-kerry-emanuel/]

There continued to be another important deficiency, only obliquely mentioned in the NAS report, regarding proxy reconstructions and the common practice of selective use of tree rings (Yamal) which bolstered a Hockey Stick shape while ignoring much larger and robust tree ring samples (Polar Urals and Taimyr) which did not support Hockey Sticks (see http://climateaudit.org/2011/04/09/yamal-and-hide-the-decline/). This amounts to selective use of input data to provide an output that is agreeable to the researcher. The IPCC AR4 did not address this selective use of data. As one paleoclimate researcher (Jan Esper) astoundingly admitted, "The ability to pick and choose which samples to use is an advantage unique to dendroclimatology." Picking and choosing allows the bias of the scientist to create the result he/she desires but this is not the way science should be performed.

Q6. In your testimony, you describe a situation where text was inserted by the lead authors after the close of peer review. Could you please elaborate how the peer review process in the IPCC is supposed to work and its importance to the legitimacy of the overall assessments?

A6. Fundamentally, the way the IPCC review process works is "trust us, we are Lead Authors." In this sense, the IPCC peer-review process boils down to whether a Lead Author can be completely objective about the material. As indicated elsewhere, this was not to be.

It must be understood that the IPCC is not a peer-reviewed document in the classical sense. The Lead Authors of the IPCC KNOW that their work will be published, largely as they wish it to be published. One would hope that the Lead Authors would accommodate the reviewer comments in fairness, even if they did not agree with them. However, having the "final word" after the review is closed prevents this fairness from occurring. Then, one would hope that the handful of IPCC Review Editors would raise red flags when something was amiss. However, Review Editors were largely ineffective since the Lead Authors were the main authorities for determining the content. Indeed, in an email from IPCC Chair Susan Solomon who responded to a question (arising out of a FOI request from David Holland) states on 14 Mar 2008 the following:

The review editors do not determine the content of the chapters. The authors are responsible for the content of their chapters and responding to comments, not

REs [Review Editors]. Further explanations, elaboration, or re-interpretations of the comments or the authors responses, would not be appropriate.

In the way that the IPCC operates, it really comes down to whom the IPCC selects to serve as Lead Authors as to the type of content and emphasis contained in the final report. As I've noted several times in the past, there was a disturbing homogeneity-of-thought in those who were selected in the AR4 and now AR5.

In the case referred to here concerning Ross McKitrick, the IPCC authors made a specific, but unsubstantiated, statistical claim in response to criticism of their own dataset. This was done perhaps to give them the comfort of providing cover for their own work, but to which they knew there would be no rebuttal since the IPCC "expert peer-review" process was over. It was only through the incredible efforts of McKitrick that the information was eventually published (McKitrick, R., 2010: Atmospheric oscillations do not explain the temperature-industrialization correlation. Statistics, Politics and Policy, Vol 1, No. 1, July 2010) which demonstrated the IPCC authors apparently fabricated their response for the official text (see also McKitrick, Ross R. (2011) "Bias in the Peer Review Process: A Cautionary and Personal Account" in Climate Coup, Patrick J. Michaels ed., Cato Inst. Washington DC.)

During the Muir Russell Inquiry in the UK, IPCC Author Jones was asked if he could produce the statistical basis of the claim he and his chapter coauthors had inserted. He was unable to do so, and even claimed no such evidence was necessary (http://www.cce-review.org/evidence/15%20April%20Jones%20follow%20up.pdf). The peer review process at academic journals would almost surely have prevented unsubstantiated material like this from going into print. By contrast the IPCC process shielded it from review. For this reason the current IPCC process should be seen as detracting from the legitimacy of the overall assessment, and certainly does not qualify as peer-reviewed science in the traditional sense.

Q7. Dr. Christy, you state that the current establishment dismisses information that questions the belief that greenhouse gases are the dominant cause of observed climate change. Would you agree that a generally accepted methodology of the scientific process is that theories gain credibility if they are rigorously tested, supported by multiple lines of evidence and can rule out competing explanations? If that is the case, can the actions of the climate establishment of dismissing contrary information be considered as ruling out competing explanations? How is this not adhering to the accepted process of scientific inquiry?

A7 Dismissing contrary evidence based on opinion does not qualify as rigorous hypothesis testing of multiple lines of evidence. If the question here refers to the disagreement between models and observations regarding temperature trends in the tropics, the evidence is substantial that models fail a direct hypothesis test. Multiple publications and multiple lines of evidence have demonstrated this disagreement. However, the IPCC establishment seems to be impenetrable to these results because they demonstrate a critical model failure – and models are the basis for the IPCC alarm.

Q8. For its endangerment finding, EPA relied heavily on the IPCC and the U.S. Climate Change Science Program and the U.S. Global Change Research Program.

a. Are these groups independent of each other?

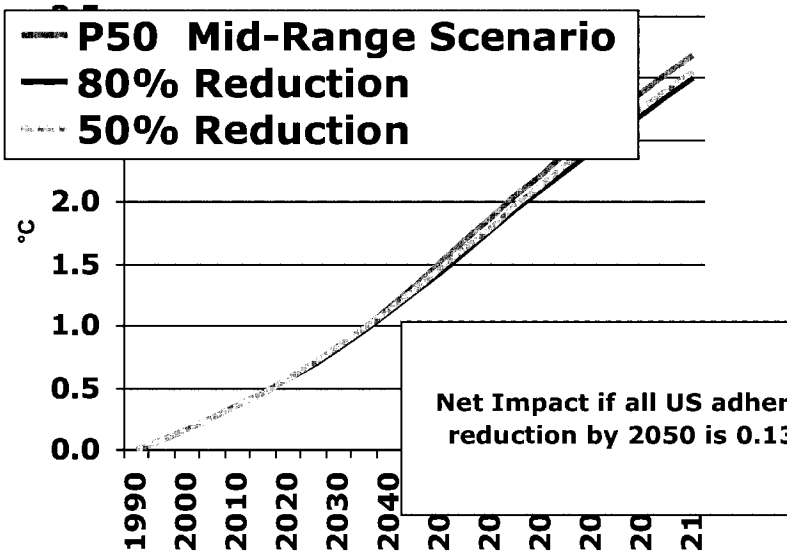
A8 (a) Absolutely not. If one reads the authorship and those who had key roles in drafting these various reports, one will find the same names again and again and the same material used in all three.

b. Can you tell us how much of the information generated for the IPCC came from the U.S. programs and vice versa?

A8 (b) With regard to the one CCSP (U.S. Program report) addressing surface and upper air trends, the CCSP report came out first, and the IPCC adopted it almost entirely.

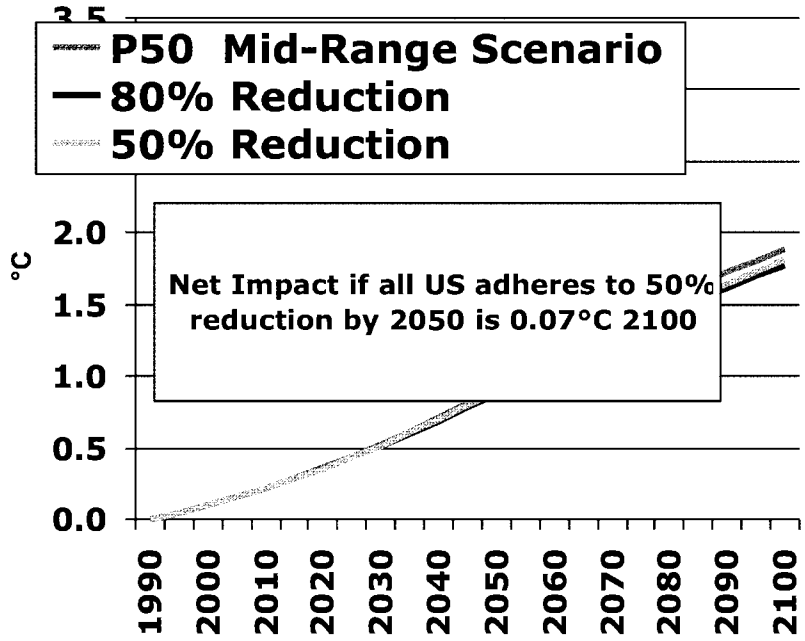
Regarding the EPA report in general, the Finding indicates at the outset that it relied on the IPCC for the basis of its conclusions.

Q9. During the hearing, you mentioned that you have estimated the impact of the proposed reductions in U.S. greenhouse gas emissions on the global temperature. Can you provide your analysis for the record?



a. What climate sensitivity is assumed in your analysis? Why did you choose that level?

A8 (a) The result above uses the IPCC median climate sensitivity (about +3.0 °C for CO_2 doubling) and shows virtually no impact even with drastic emissions reductions from the United States and even if one accepts the IPCC model simulations. This climate sensitivity was selected as it was the "best estimate" used in the IPCC assessment.



This result uses the sensitivity that is closer to that which has been observed (about +1.5 °C for CO_2 doubling), and shows even less impact from drastic U.S. emission reductions (0.07 °C by 2100 for 50% reduction and 0.11 °C for 80% reduction.)

Both studies utilize the MAGICC climate model tool also used by the IPCC.

Questions submitted by Representative Randy Neugebauer

Q1. Supporters for a political action sometimes utilize extreme and alarmist actions to gain favor with the public in order to encourage government officials to act. Does the science currently available to us prove, beyond a reasonable doubt, that human activity will result in catastrophic and irreversible climate changes and disasters in the very near future?

A1. In my opinion the evidence does not support catastrophic and irreversible climate changes due to enhanced greenhouse gas concentrations. I have examined numerous datasets of such "change" parameters (i.e. temperature, storms, tornadoes, snowfall, hurricanes, etc.) and do not find remarkable changes outside of natural fluctuations. Indeed, direct calculations of one key aspect of climate sensitivity indicate the climate is not very sensitive to rising greenhouse gases.

Q2. Even if one believes that human activity makes some contribution to changes in the environment, is it possible to be fully confident that it is the one driving force behind those changes or is the modeling of such change too complicated?

A2. The climate system is extraordinarily complex, and no one can say for certain what the cause and effects are when it comes to any particular observation or whether greenhouse gases might be partly responsible. Thus attributing an observed change in climate to greenhouse gases is almost impossible to do. This is so because similar events (i.e. a few-decade rise in temperature, a series of storms, etc.) have occurred in the past so that an increase in greenhouse gases can't be blamed. This provides evidence that greenhouse gases might not be the guilty party in any current "change." Fundamentally, natural, unforced variability is a key and large uncertainty in any attribution exercise. The climate system contains within it all of the freedom to generate extreme events or long-term trends through natural,

unforced variability. And, since such variability is poorly modeled, one cannot assume climate models tell the truth about cause and effect.

Questions submitted by Representative David Wu

Q1. If you surveyed climate scientists in 1990 and then again in 2010, would the results indicate:

a. an increased consensus that climate change has been occurring?

A1 (a) "Consensus" is a political notion, not a scientific notion, thus the question deals with a political idea and is mostly irrelevant to science. I would speculate that every scientist would say that climate change is occurring because the climate is never stationary – it is always changing (with or without human intervention.) No matter what period one might choose from the history of our planet, one would find a changing climate.

b. that climate change is due to an increase in greenhouse gases?

A1 (b) What scientists believe as expressed in polling exercises and what is real can often be two different things. I have not seen specific polling data on this question (nor do I suspect the term "climate scientist" is ever accurately assessed.) This is a rather odd question as it asks for survey of opinion rather than hard facts. However, I can speculate that a majority of those individuals who thought of themselves as climate scientists in 1990 and still do in 2010 would tend to think that increasing GHG concentrations is at least partly a cause of some temperature rise (whether that might be called "climate change" is another matter.)

c. that the increase in greenhouse gases is primarily due to human activity?

A1 (c) Without any regard for what the climate might be doing, it is clear that the increase in GHG concentrations is due primarily to human progress through (again primarily) carbon-based energy production which is directly related to the improvement of human civilization and the reduction of the terrible consequences of energy poverty. The human desire to be free from the poverties of food, health care, light, transportation, etc. is exceedingly strong, and it is energy that alleviates those poverties.

Questions submitted by Representative Donna F. Edwards

Q1. Have you ever received either direct or indirect compensation for any of your research, analyses, publications, testimony or a speech in any form, at any entity, by a company, trade association, institute or foundation that is represented, supported or funded by the oil, coal or energy industry?

A1.:

Research–No.

Analysis–No.

Publications–I don't believe so.

Testimony–No.

- Speeches–My policy is that I do not take honoraria for speeches that may be viewed as supported by the energy industry. It is possible that in 2003 I received an honorarium from participating in a debate (i.e. not a speech) sponsored in part by the CATO Institute.

Q2. If you answered yes to question number one above please indicate:

A2 I have not found records of the 2003 event noted above, but will try to answer.

a. The name of the entity that provided this compensation?

A2 (a) CATO

b. The year it was provided?

A2 (b) 2003

c. The amount of compensation?

A2 (c) I don't remember

d. A brief description of what specifically you were compensated for doing?

A2 (d) I participated as one side of a debate about climate change.

Q3. Please indicate if you have ever appeared as an expert witness in a civil or criminal court case?

A3. Yes, as an expert witness in U.S. District Court, Case Number 2:05–CV–302 and 2:05–CV–304.

Q4. If you answered yes to question #3 above please indicate:

a. The name of the court case?

A4 (a) Green Mountain Chrysler-Plymouth-Dodge-Jeep v. George Crombie, et al.

b. The name of the court where the case was held?

A4 (b) United States District Court for the District of Vermont

c. The name of the plaintiff or defendant that you testified for?

A4 (c) Green Mountain Chrysler Plymouth Dodge Jeep; Green Mountain Ford Mercury' Joe Tornabene's GMC; Alliance of Automobile Manufacturers; Daimlerchrysler Corporation; and General Motors Corporation

d. Please indicate the amount of compensation you received either directly or indirectly for your testimony in each case mentioned above and the name of the entity that paid your compensation.

A4 (d) No compensation for the testimony.

Responses by Mr. Peter Glaser, Partner, Troutman Sanders, LLP

PETER S. GLASER
202.274.2998 telephone
202.654.5611 facsimile
peter.glaser@troutmansanders.com

TROUTMAN SANDERS

TROUTMAN SANDERS LLP
Attorneys at Law
401 9th Street, N. W., Suite 1000
Washington, D.C. 20004-2134
202.274.2950 telephone
troutmansanders.com

May 5, 2011

VIA ELECTRONIC MAIL

Hon. Ralph M. Hall
Chairman
House Committee on Science, Space, and Technology
231 Rayburn House Office Building
Washington, D.C. 20515-6301

Re: Hearings on *Climate Change: Examining the Processes Used to Create Science and Policy*
Responses to Questions

Dear Chairman Hall:

Thank you for the follow-up questions in your April 20, 2011 letter. Here are my responses:

Questions for the Record
The Honorable Ralph Hall

1. Dr. Christy has testified about the processes of the IPCC giving rise to an insular community that was able to act as "gatekeepers" to scientific information to ensure the view advocated by the lead authors was the one that came through in the final assessment reports. Given the EPA Administrator's level of reliance on the IPCC assessment reports and her acknowledged lack of review of the scientific literature that could have yielded contrary results, it would seem that the endangerment finding was based on an incomplete review of the science. Can you please explain how this violated the Data Quality Act? Are you aware of any similar situation occurring during other rulemakings?

A. EPA is subject to rigorous data quality obligations under the Information Quality Act ("IQA"), Pub.L. 106-554, and EPA's IQA Guidelines, *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency* (Oct. 2002).[1] Since the Endangerment Finding meets EPA's definition of "influential information" (information having "a clear and substantial impact (i.e., potential

[1] The Guidelines are available tat http://epa.gov/quality/ informationguidelines/documents/ EPA_InfoQualityGuidelines.pdf.

change or effect) on important public policies or private sector decisions," *id.* at §6.2, the Endangerment Finding is "subject to a higher degree of quality (for example, transparency about data and methods) than [other] information...," *id.* at §6.3. The substance of the information underlying the Endangerment Finding must be "accurate, reliable and unbiased," requiring use of "the best available science and supporting studies conducted in accordance with sound and objective scientific practices, including, when available, peer reviewed science and supporting studies; and (ii) data collected by accepted methods or best available methods (if the reliability of the method and the nature of the decision justifies the use of the data)." *Id.* at §6.4.

The IPCC reports, however, were based on material that was not "accurate, reliable and unbiased." For instance, as demonstrated in great detail in the Petition for Reconsideration that accompanied my testimony, the IPCC frequently relied on "studies" that were not peer reviewed, that were unscientific, and that were in fact prepared by advocacy groups such as the World Wildlife Fund, Greenpeace, and other similar groups.

Nor were the IPCC reports peer reviewed with the same rigor as occurs with publication in a scholarly peer-reviewed journal. A journal peer review typically requires the author of a draft article to respond to critical reviews to the journal editor. The journal editor serves as an impartial referee and decides whether the author must modify his or her draft in response to criticism. By contrast, IPCC Lead Authors—those who write the chapters in the IPCC reports—are the ones who decide whether to accept or reject critical reviews, and they can change text on their own and without further review after the review period is closed. Hence, there is no neutral scientist standing between the author and reviewer to ensure that reviews are judged dispassionately and that there are no backroom rewrites after the close of the review period. Authors thus are often in the position of reviewing not only their own work, but also that of their critics, a clear conflict of interest. As a result, the central function of the peer review process, to ensure that peer reviews are taken into consideration by the author, was not present in IPCC peer review. It is perhaps unsurprising that, the IPCC review process was characterized by flagrant instances in which authors disregarded dissenting views, as Dr. Christie explained.

Another typical practice in the preparation of these reports that undermines objectivity is the citation by report authors of their own papers and those of report reviewers. This practice represents another instance in which conflicts of interest are not held in check to ensure that the report provides a completely neutral summary of all views of the science. As one commenter on EPA's Endangerment Finding showed, the authors of the IPCC Chapter that addressed attribution routinely cited their own work and that of their co-authors.

Moreover, the Endangerment Finding was not subject to independent peer review as required by EPA's IQA Guidelines. Those Guidelines incorporate a "Peer Review Policy" under which EPA was required to obtain independent peer review of the Endangerment Finding, which qualifies as a "major scientifically and technically based work product[]...related to Agency decisions." IQA Guidelines at §4.2. According to this Peer Review Policy, the purpose of peer review is "to ensure that activities are technically supportable, competently performed, properly

documented, and consistent with established quality criteria." EPA Peer Review Handbook (3rd Ed.),[2] at §1.2.3, and is not just "another 'hurdle' in the Agency decision making processes," *id.* at §1.2.1 (emphasis supplied). The essence of peer review is independence: "[p]eer review is conducted by qualified individuals (or organizations) *who are independent of those who performed the work*, and who are collectively equivalent in technical expertise (i.e., peers) to those who performed the original work." *Id.* at §1.2.3 (emphasis supplied). Thus, in answer to the question, "Can Someone Who Provided Peer Input Become an Independent Peer Reviewer for the Same Work Product Later in the Process?," EPA in the Peer Review Handbook responds, "Generally, the answer is no as that expert is no longer independent, but rather a contributor to the work product." *Id.* at §1.2.6.

EPA, however, ignored its policy of independent peer review in the Endangerment Finding by retaining peer reviewers who were all government scientists many of whom had worked on what EPA called the "assessment literature," including the IPCC reports EPA did this intentionally. According to EPA, since the Administrator had relied on the "assessment literature" as the fundamental basis of the Endangerment Finding the only purpose of peer review of that Finding was "to ensure that the TSD accurately summarized the conclusions and associated uncertainties from the assessment reports." Response to Public Comments I-10. But by using peer reviewers who had participated in the preparation of the "assessment literature," EPA not only failed to receive independent peer review of that literature, it did not receive independent peer review of the Endangerment Finding which was so heavily reliant on that literature. EPA could not have ignored its own peer review policy more completely.

Additionally, under EPA's IQA Guidelines, §6.3, the Endangerment Finding, as "Influential Information," was required to have "a higher degree of transparency regarding (1) the source of the data used, (2) the various assumptions employed, (3) the analytic methods applied, and (4) the statistical procedures employed." Climategate revealed the hollowness of EPA's claim that IPCC met this same level of transparency, as key IPCC authors routinely relied on their own studies while simultaneously refusing to disclose to other scientists the data underlying those studies. The history of this refusal to disclose data has been widely chronicled elsewhere.

2. You assert that Section 202(a) of the Clean Air Act requires that the Administrator of the EPA use her own judgment to determine whether or not greenhouse gas emissions endanger public health and welfare. By her own admission, the Administrator relied heavily on assessment literature. How does this not count as using her own judgment? What is the standard generally used to comply with that part of the law?

A. The degree of the Administrator's reliance on what she called the "assessment literature" amounted to an abdication of her responsibility to exercise her own judgment based on an independent review of the science. Indeed, the Administrator rejected comments asking her to

[2] The peer review handbook is available at http://www.epa.gov/peerreview/ pdfs/peer_review_handbook_2006.pdf.

make "a new and independent assessment" of climate science. 74 Fed. Reg. at 66,511/2. She said she believed that she could rely on the IPCC based on her review of the IPCC procedures which she said demonstrated that the IPCC has the same high standards for ensuring information quality as the standards to which EPA is subject. But climategate showed that the IPCC did not adhere to rigorous information quality standards.

3. Both Dr. Armstrong and Dr. Christy have testified how the failure of the models and IPCC to adhere to accepted process has allowed poor or false information to be incorporated into the IPCC assessment reports. If, during the review of the scientific literature for a National Ambient Air Quality Standard like lead or ozone, information was found to be incorrect, what would the EPA need to do in order to rectify the problem of reliance on wrong information?

A. EPA would be required to reformulate the NAAQS, and I assume EPA would want to do so voluntarily as soon as the defective information was discovered.

4. EPA denied requests to extend the public comment period beyond the 60-days. Why was this a concern in this particular case?

A. The concern was the enormous complexity of climate science. As EPA said, there is a "very wide range of risks and harms to be considered." 74 Fed. Reg. at 66509/3. Sixty days was not enough time to formulate comments in light of the number of complex issues involved. Moreover, EPA limited the comment period to 60 days based in part on the Agency's view that the public had had an opportunity to comment on the IPCC and CCSP reports to those bodies when those reports were being prepared. *Id.* at 66,503/3. Whether or not the public had an opportunity to comment on those reports is irrelevant, since neither of those bodies were making endangerment findings that would trigger regulation. The number of comments on the CCSP reports, for instance, was far fewer than the number for the Endangerment Finding. Moreover, there was no public comment process in preparing the IPCC assessment reports.

5. In your testimony, you talk about how the Administrator claimed she did not make a judgment as to the quality and transparency of the information used in the assessment literature, instead she relied on reviewing the processes used by the IPCC to determine if their procedures would guarantee the quality and transparency of the information. Dr. Christy has testified that the fundamental structure of the IPCC procedures that yielded a situation that was rife with conflicts of interest and lack of transparency.

a. Do you think EPA's obligations under the Data Quality Act allow for a review of processes in a vacuum, or would you interpret it to mean that a review of the processes and procedures as they were implemented would be necessary to satisfy EPA's obligations?

A. Certainly when the climategate information became public, the Administrator should have realized that the IPCC's information quality procedures were either not being followed or were insufficient to ensure information quality as the Administrator believed. The Endangerment Finding was not final when the climategate information became available, and the Administrator could and should have convened new proceedings to ensure a full and public review of the material before the Endangerment Finding was finalized.

6. In your statement, you mention that EPA included additional information to the Endangerment Finding docket after the finding was finalize [sic] in order to provide additional support for their decision. Is including information to a docket without a public comment period after a rule finalized a part of EPA's normal and accepted rulemaking process? Are you aware of any other instances in which this occurred?

A. It is not normal and acceptable for an Agency to rely in its decision on information that it placed in the docket after the comment period closed, unless the public is given an opportunity to comment on the information through reconsideration or other proceedings. Agencies like EPA are required to act on the record, and that record must be compiled in a publicly available docket for purposes of facilitating public comment and judicial review.

7. Does the Clean Air Act allow for the promulgation of regulations without considering the costs and benefits? Are you aware of any other situation in which regulations were issued and a cost benefit analysis was not conducted?

A. EPA may not promulgate a National Ambient Air Quality Standard (NAAQS) based on consideration of the cost of compliance. Nevertheless, EPA routinely produces an assessment of the costs and benefits when it promulgates a NAAQS for informational purposes. Here, EPA was not promulgating a NAAQS but instead made a finding that triggered regulation of greenhouse gas emission both from motor vehicles and stationary sources under the "PSD" and Title V programs. Regulations under the PSD program specifically require economic impact analyses. See Clean Air Act § 317(a)(4). Thus, by not conducting an economic impact analysis for the impacts that greenhouse gas regulation would have on stationary sources, EPA did less than it was required to do and less even than it does for informational purposes when promulgating a NAAQS.

Questions for the Record
The Honorable David Wu

1. If you surveyed climate scientists in 1990 and then again in 2010, would the results indicate:
   a. an increased consensus that climate change has been occurring?
   b. that climate change is due to an increase in greenhouse gases?

c. *that the increase in greenhouse gases is primarily due to human activity?*

A. I am not qualified to answer this.

Questions for the Record
The Honorable Donna F. Edwards

1. Have you ever received either direct or indirect compensation for any of your research, analyses, publications, testimony or a speech in any form, at any entity, by a company, trade association, institute or foundation that is represented, supported or funded by the oil, coal or energy industry.

A. The law firms in which I have been a partner have been compensated for representing energy companies and trade associations of energy companies for work in which I have been involved.

2. If you answered yes to question #1 above please indicate:
- *a. The name of the entity that provided this compensation?*
- *b. The year it was provided?*
- *c. The amount of compensation?*
- *d. A brief description of what specifically you were compensated for doing?*

A. The attorney-client privilege prevents me from disclosing clients my law firms were retained by, the specific types of work performed for clients, and the amount of compensation received. However, we can provide publically available information of clients my firms have represented in litigation or administrative proceedings in which I have been involved.

3. Please indicate if you have ever appeared as an expert witness in a civil or criminal court case?

A. No.

4. If you answered yes to question #2 [sic: 3 (?)] above please indicate:
- *a. The name of the court case?*
- *b. The name of the court where the case was held?*
- *c. The name of the plaintiff or defendant that you testified for?*
- *d. Please indicate the amount of compensation you received either directly or indirectly for your testimony in each case mentioned above and the name of the entity that paid your compensation.*

A. N/A

5. *Please indicate the specific names of clients you have had any role in representing from the oil, coal or energy industry. Please include both past clients and current clients. Please indicate the year you represented them and if the case went to court please indicate the name of the court case, the name of the court and the case identification number.*

A. Please see response to question 2. The firms in which I have been an attorney over my 30-year career have represented numerous energy companies that have been involved in numerous lawsuits and proceedings. I will not be able to catalogue them all here. A representative sample of recent lawsuits and proceedings in which I have been counsel for energy companies or energy company trade associations includes:

- *Coalition for Responsible Regulation v. EPA*, No. 09-1322 (D.C. Cir.) (energy industry clients: Peabody Energy, National Mining Association);
- *Coalition for Responsible Regulation v. EPA*, No. 10-1073 (D.C. Cir.) (energy industry clients: Peabody Energy, National Mining Association);
- *Coalition for Responsible Regulation v. EPA*, No. 10-1092 (D.C. Cir.) (energy industry clients: Peabody Energy, National Mining Association);
- *State of Wyoming v. EPA*, No. 11-9504 (10th Cir.) (energy industry clients: National Mining Association, Wyoming Mining Association).
- *AEP v. Connecticut*, No. 10-174 (Supreme Court) (energy industry clients: National Mining Association).
- *Wildearth Guardians*, No. 10-129 (Interior Board of Land Appeals) (energy industry clients: Peabody Energy).
- *Comer v. Murphy Oil*, No. 07-60756 (5th Cir.) (energy industry clients: National Mining Association).
- *In Re Liberty Coal Company, LLC*, No. 07-60756 (SD Il.) (energy industry clients: Western Fuels Service Corp., Western Fuels Illinois, Inc., Liberty Trust).
- *NRDC v. EPA*, No. 07-1151 (D.C. Cir.) (energy industry clients: National Mining Association).
- *UMWA v. Brushy Creek Coal Company*, No. 06-2324 (7th Cir.) (energy industry clients: Brushy Creek Coal Company, Western Fuels-Illinois, Inc.).

TROUTMAN
SANDERS

Please do not hesitate to call me if you need further information.

Sincerely,

Peter S. Glaser

Responses by Dr. Kerry Emanuel, Professor of Atmospheric Science, Massachusetts Institute of Technology

Questions submitted by Chairman Ralph Hall

Q1. You state in your testimony that the controversy over the "hide-the-decline" email is much ado about nothing, and that data excluded by scientists was "provably false." Dr. Muller had a different take, stating in a widely circulated Internet video that the "justification [for erasing the data] would not have survived peer review in any journal that I'm willing to publish in."

a. Please explain how the "hide the decline" data is "provably false."

A1. The "hide the decline" remark appeared in an informal email communication and has been widely taken out of context. The graph that it was referring to was published in Science, among other places, and Richard Muller has published in that journal. The heart of this issue is the comparison between directly measured temperature and temperature inferred from proxies, in this case, tree rings. Proxy inferences are almost never perfect, and often multiple proxies are used to make the best possible estimates of temperature in the period before the instrumental record begins in the middle of the 19th century. There are certain tree rings, especially in the northern part of Russia , that agree well with the instrumental record up until about 1960, at which point they "decline" while the directly measured temperature increases. No one in the climate profession would prefer a proxy-derived inference to a direct measurement, so when I said that the proxy records in question were "provably false", I meant that they would be regarded as false by anyone in the profession when they disagree with directly measured temperature.

The serious question in publishing a proxy with problems such as that mentioned above is whether to exclude the whole proxy record when it is demonstrably false for part of the period in question. A case can be made to omit only the false part of the record, if, for example, there was something unusual about the period during which the proxy fails. If the graph is published, it is imperative to state carefully that a part of the record has been dropped and to state the reasons for dropping it. In the peer-reviewed literature on this subject, for the most part, such descriptions were either made explicitly or were implicit, in that other graphs in the same paper showed the whole record. But in a (non peer-reviewed) report published by the World Meteorological Organization in 1999, a graph was presented without such qualifiers. While graphs are often simplified for non peer-reviewed reports directed at broader cross-sections of the public, one might legitimately question the judgment of omitting the qualifiers in this case. But if this was a conspiracy to deceive, it was poorly conceived since the graph with the qualifications was (and is) readily available in published literature for anyone with a serious interest in the subject.

Q2. In response to comments questioning the independence and objectivity of the people selected to peer review the EPA's endangerment finding, the Administrator said that she relied on people who were familiar with the assessment literature, even if those people participated in the creation of that assessment literature.

a. Would you consider an editor of a journal having a co-author of a paper review their own paper and calling it peer review since that co-author was familiar with the paper an analogous situation to the actions of the Administrator?

A2 (a) I would not. If I understand the question correctly, the EPA sought peer review of the EPA's endangerment finding from scientists some of whom were authors of assessment literature (and not authors of the endangerment finding). I am not sure why being an author of an assessment disqualifies one from peer-reviewing an endangerment finding.

b. Does this practice fall within the normal and accepted processes of peer-review?

A2 (b) Again, I am not sure how to compare the normal process of peer review of scientific literature with peer review of a finding by the EPA. If the peer review of the finding had been conducted by authors of the finding, this surely would have been outside normal accepted practice.

Q3. The National Academy of Sciences' (NAS) Guide to Responsible Conduct in Research states that "When a scientific paper or book is published, other researchers must have access to the data and research materials needed to support the conclusions stated in the publication if they are to verify and build on that research . . . [G]iven the expectation that data will be accessible, researchers who refuse to share the evidentiary basis behind their conclusions, or the materials

needed to replicate published experiments, fail to maintain the standards of science." (http://www.nap.edu/catalog.php?record id=12192)

a. What steps can the Federal government take to ensure that these scientific data sharing standards are upheld and enforced?

A3 (a) In my view, the culture of and policies concerning sharing data and research materials work quite well in this country. For a more comprehensive statement of current policy, I refer you to the American Meteorological Society's statement on this issue, Free and Open Exchange of Environmental Data:

http://www.ametsoc.org/policy/freeopenexch—final.html

This statement does not cover the issue of the availability of such items as computer programs and other tools that researchers might develop in the course of their work. This is murkier territory. For example, it would be unreasonable for a researcher in chemistry to demand that another researcher make available his entire experimental apparatus, though it would not be unreasonable to request a detailed description of the apparatus. At the moment, most of us consider computer programs we write to be our own property, but many of us share them on request anyway.

There are more serious problems in other parts of the world, and in Europe in particular. In many western European nations, environmental data collected by governments are regarded as proprietary, and members of the public, of other nations, and even of scientific research communities are often forced to purchase the data, sometimes at very high cost. At the time they purchase the data, they are usually forced to sign nondisclosure agreements that prevent them from redistributing the data. Thus they are legally prohibited from giving the data they purchased to another researcher. Most American scientists (and indeed many European scientists) hold these policies to be destructive of the ends of science, and at various times since these policies originated in the 1980s the U.S. government has pressured governments of western Europe to abandon them in favor of the U.S. model of free and open exchange of research data.

b. Should researchers that refuse to uphold the Academies' standard requiring sharing of data and materials necessary to support research conclusions continue to receive Federal funding?

A3 (b) In my view, it would be counterproductive to move these issues into the legal arena. There are some delicate cases where judgment is called for, so that upholding a simple standard is not always straightforward. Here is an example: A scientific researcher devotes many years of his professional life to the development of an instrument to fly on a space mission. Finally, the mission is flown, and scientifically valuable data are collected using the researcher's instrument. Should that data become immediately available to all researchers, so that the fruits of the instrument designer's labors are reaped by another researcher? It is the practice, at least here in the U.S., for the federal agencies that fund the instrument development to grant the developer a short period of exclusive rights to the data. This issue is addressed in the above-quoted AMS policy on free and open exchange of environmental data. I believe that handling issues like this is best left up to the agencies. I might add that a hypothetical gross violation of the National Academy policy you quoted in your question would cast the offender in a very poor light and would almost certainly induce the agency that funded the collection of the data to take action. I do not personally know of any instances of this nature here in the U.S.

c. Should such research be excluded from use in authoritative scientific assessments such as those prepared by the Academies or the IPCC?

A3 (c) I find it difficult to imagine that an authoritative assessment would quote research results that were regarded by the scientific community as unreproducible. If they did, they would soon be taken to task for it.

Q4. Dr. Emanuel, you strongly defend the IPCC in your testimony. Our other witnesses are much more critical. For example, Dr. Christy notes that "after the close of peer review, the lead authors inserted text into the IPCC report that was simply an assertion with no evidence, and that the assertion was later quoted by the EPA in its Endangerment Finding.

a. Do you believe it is acceptable for IPCC lead authors to insert text into IPCC reports outside of the peer review process?

A4 (a) It is important to understand that the IPCC reports are reviews and syntheses of published articles and reports, and is contributed to by about 1,200 au-

thors and 2,500 scientific expert reviewers. Without asking Dr. Christy directly, I cannot be sure what he was referring to, but I suspect he was talking about the summary for policymakers that is included in the reports and is the main content on which policy makers rely as they seldom have time to read the entire report. The authors and expert reviewers typically contribute to small pieces of the whole report. The topic of climate science is so broad that there are few if any individual scientists whose expertise allows them to comprehensively review the whole report. The summary for policy makers (to which I think Dr. Christy must be referring) is written after the main body of the report and summarizes only that material from the body of the report that the vast majority of contributors agree to, leaving out the more detailed or controversial aspects. While the language is necessarily original, it does not introduce any science that is not contained in the body of the report. Before being accepted by the IPCC, the summary for policy makers must be agreed to by representatives of all the governments present at a meeting where the report is finalized. This makes the summary rather bland, since any points that any country's representatives regard as controversial or incorrect cannot be included. Consequently, the summary is frequently criticized by those representing minority views, but it does contain findings that are robust enough to be used by policy makers.

b. If it is not acceptable, shouldn't such text be avoided for use by policymakers? If the IPCC process itself is broken with respect to peer-review and inclusion of data, why should we have any confidence in the product that is the result of a broken process?

A4 (b) Please see my response to (4) above. The contributions to the IPCC report from so many scientists make the report rather conservative, overly so in the opinion of many scientists. For example, the most recent report omitted any projected contribution to sea level rise from oblation of land ice (mainly Greenland and Antarctica). This may prove to be the main contribution to sea level rise over the coming centuries.

Q5. You state in your testimony that the four assessment reports issued by the IPCC continue the conservative tradition of science.

a. Did you believe the IPCC was conservative in its estimate of Himalayan glacier retreat prior to the discovery and admittance that this information was incorrect?

A5 (a) The inclusion of an erroneous number in the report is of course highly regrettable. However, a mistake of this kind should not be regarded as either a "liberal" or a "conservative" estimate; it is simply a wrong number. As I am sure you are aware, the IPCC has taken concrete steps to reduce the probability of errors of this kind in its future reports.

b. Did you believe the IPCC was conservative with its inclusion of the hockey stick in the third assessment report, a graph that has been subsequently discredited?

A5 (b) While the graph in question has been challenged by a number of groups and corrections have been made, including in the more recent AR4 report of the IPCC, this does not amount to discrediting the figure in question. Here is the figure, as published in the IPCC third assessment report:

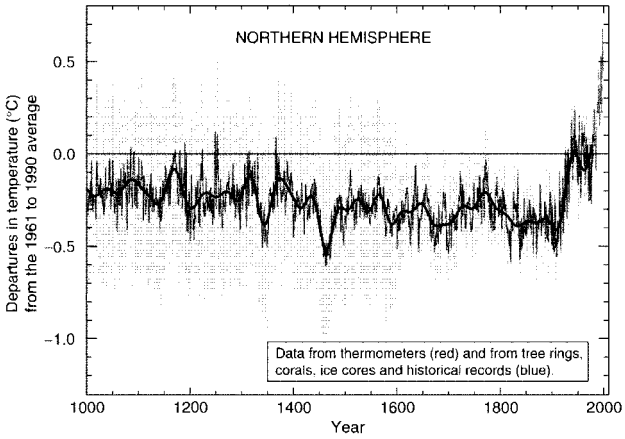


Figure 1: Temperature reconstructions over the past 1000 years. Blue curve shows a synthesis of proxy-based inferences, and the gray shading indicates the uncertainties associated with these. The red curve is from the instrumental record. This was published in the IPCC Third Assessment Report.

By the time of the IPCC Assessment Report 5, criticisms of some of the proxy-based records of the Third Assessment Report had been addressed, and other proxy data not available to the TAR had been added:

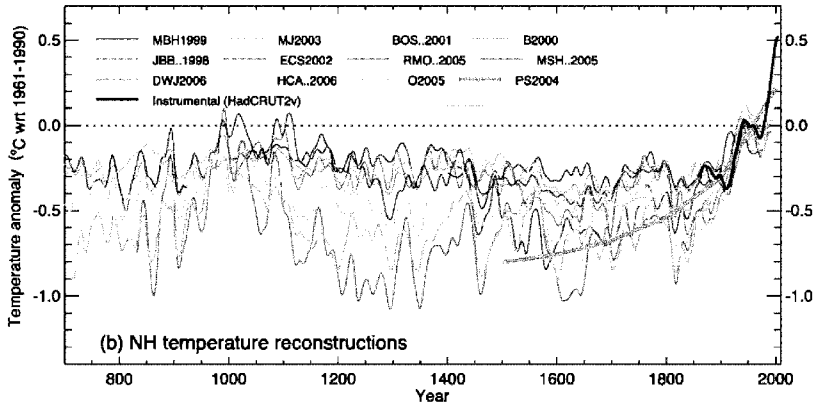


Figure 2: Showing various proxy-based reconstructions of northern hemisphere temperature (different colored curves as well as the light gray curve, which is from borehole measurements). The instrumental record is shown by the black curve. This was published in the IPCC Assessment Report 5 and includes proxy data not available for the third assessment report.

Comparing the updated figure to the figure published in the IPCCTAR, it is a subjective judgment whether the TAR figure has been "discredited". Certainly, the most important findings, that the recent temperatures are almost certainly unprecedented over the past 1000 years, and that the recent rate of increase is also unprecedented, remain intact.

Q6. You note in your testimony that you investigated scientists working at the University of East Anglia Climate Research Unit (CRU) as a result of the Climate

Gate emails and that you couldn't find any evidence of scientific misconduct. Below are portions of three emails out of dozens sent by Phil Jones, the head of CRU, to other climate scientists:

a. *"Can you delete any emails you may have had with Keith re AR4? .. Keith will do likewise. Can you also email Gene and get him to do the same?"*

b. *"If they ever hear there, is a Freedom of Information Act now in the UK, I think I'll delete the file rather than send to anyone . . . We also have a data protection act, which I will hide behind."*

c. *[email from Phil Jones referencing inclusion of papers from rival scientists in IPCC report]: "Kevin and I will keep them out somehow-even if we have to redefine what the peer-review literature is!"*

T1These emails are just a sampling, but they include clear actions to hide scientific information from review, including deleting data in violation of the Freedom of Information Act, and conspiring to "re-define" peer review literature to block publication of unwanted science.

Did you consider this correspondence as part of your investigation? Please explain how each of examples a, b, and c reveal "no evidence" of scientific misconduct?

A6. We did not consider this correspondence as part of our investigation. The investigation of the activities of the CRU was divided into three parts: the investigation by the House of Commons Science and Technology Committee, the independent Science Assessment Panel, and the Independent Climate Change Email Review, headed by Sir Muir Russell. I served on the second of these, the Science Assessment Panel, whose charge was to review CRU science as reported in a set of peer-reviewed publications. As I noted in my testimony, our panel found no evidence of scientific misconduct. The third investigative body, the Independent Climate Change Email Review, was charged with investigating any misconduct revealed by the emails, some of which you quoted above.

Here are the main findings of the Muir Russell Commission quoted directly from their report [1] (emphases are as in the original report):

- Climate science is a matter of such global importance, that the highest standards of honesty, rigour and openness are needed in its conduct. On the specific allegations made against the behaviour of CRU scientists, **we find that their rigour and honesty as scientists are not in doubt.**
- In addition, we do not find that their behaviour has prejudiced the balance of advice given to policy makers. In particular, **we did not find any evidence of behaviour that might undermine the conclusions of the IPCC assessments.**
- **But we do find that there has been a consistent pattern of failing to display the proper degree of openness,** both on the part of the CRU scientists and on the part of the UEA, who failed to recognise not only the significance of statutory requirements but also the risk to the reputation of the University and, indeed, to the credibility of UK climate science.

And,

- On the allegations that there was subversion of the peer review or editorial process we find no evidence to substantiate this in the three instances examined in detail. On the basis of the independent work we commissioned (see Appendix 5) on the nature of peer review, we conclude that it is not uncommon for strongly opposed and robustly expressed positions to be taken up in heavily contested areas of science. We take the view that such behaviour does not in general threaten the integrity of peer review or publication.

But the Commission did find that CRU scientists were not always helpful in responding to FoIA and EIR requests:

- **On the allegation that CRU does not appear to have acted in a way consistent with the spirit and intent of the FoIA or EIR, we find that there was unhelpfulness in responding to requests and evidence that e-mails might have been deleted in order to make them unavailable should a subsequent request be made for them.** University senior management should have accepted more responsibility for implementing the required processes for FoIA and EIR compliance.

[1] The Independent Climate Change E-mails Review. http://www.cce-review.org/pdf/FINAL%20REPORT.pdf

Personally, I find the language of the scientists you quote to be vulgar, but talking about taking certain actions in what was considered to be private and informal email correspondence is not the same thing as actually taking such actions, and the Muir Russell commission found no evidence that such actions were taken, though there was on occasion some unresponsiveness to FoIA requests. As is well known in the U.S. legal profession, FoIA is frequently used as an instrument of harassment and there is some indication it was being used this way against CRU and other scientists. While the language of the CRU scientists you quoted in your question is certainly unpleasant, it does not by itself rise to the level of scientific misconduct.

Questions submitted by Ranking Member Eddie Bernice Johnson

Q1. As it has been noted, science is an ever-evolving field and we should be willing to be flexible in our thinking as the findings of science change. Dr. Emanuel it is my understanding that you have not always believed in the linkage between greenhouse gas emissions and climate change.

a. As a political conservative atmospheric scientist, Dr. Emanuel please explain your journey to accepting the scientific findings of climate change.

A1. First let me state that I do not think science is about belief; it is about evidence. Nor do I think that one's personal politics have much if anything to do with one's activities as a scientist. When I first became involved in climate science in the late 1980s, I did not at the time judge that the evidence then available pointed conclusively to anthropogenic causes of climate change as it had been delineated at that time. I recognized, as did all of my peers, that climate theory had long ago demonstrated that adding long-lived greenhouse gases to the atmosphere should warm the climate, but the feedbacks were not well understood, the models at the time were fairly primitive, and proxies for past climate change were not very well developed. In the mean time, there have been enormous advances in the field of paleoclimate, in both simple and complex models, and in satellite-based observations of the earth. At the same time, another 25 years have been added to the instrumental record of the earth's climate. The evidence for an anthropogenic contribution to climate change is now very compelling.

Q2. Dr. Emanuel, in your testimony you stated "Those nations that are first to develop sensible technology and policies to deal with climate change and pollution will likely attain great economic advantages. The market for clean energy in China alone is of staggering proportions. Nations that invest in energy research and in novel ideas in such fields as carbon sequestration and that foster enterprises that are in a position to sell such technologies to rapidly developing countries will prosper."

a. Indeed, there is more we need to learn about climate change but in your opinion, with what we already know, should we start developing clean technologies now?

A2. I will answer your question as a citizen who, by profession, knows something about climate, but I do not claim to be an economist. The evidence points to an increasing demand for clean energy technology, if not here in the U.S., then abroad. One does not have to accept the compelling evidence for anthropogenic climate change to recognize the growth in this demand. To the extent that enterprises in the U.S. can meet this demand competitively, they, and by extension the U.S. economy, should benefit.

Questions submitted by Representative Donna F. Edwards

Q1. Have you ever received either direct or indirect compensation for any of your research, analyses, publications, testimony or a speech in any form, at any entity, by a company, trade association, institute or foundation that is represented, supported or funded by the oil, coal or energy industry?

A1. No.

Q2. If you answered yes to question #1 above please indicate:
a. The name of the entity that provided this compensation?
b. The year it was provided?
c. The amount of compensation?
d. A brief description of what specifically you were compensated for doing?

Q3. Please indicate if you have ever appeared as an expert witness in a civil or criminal court case?

A3. No.

Q4. If you answered yes to question #3 above please indicate:
a. The name of the court case?
b. The name of the court where the case was held?
c. The name of the plaintiff or defendant that you testified for?
d. Please indicate the amount of compensation you received either directly or indirectly for your testimony in each case mentioned above and the name of the entity that paid your compensation.

Questions submitted by Representative James Sensenbrenner

Q1. On page 2 of your written testimony you stated: "Global climate models were first developed in the 1960s and have advanced rapidly over the past few decades; they are used as tools to help us understand and predict climate, but it is not the case that they are the single or even most important tool for these purposes." Please list what, in your view, are the main tools for understanding and predicting climate, and which one is the most important.

A1. The contemporary understanding of climate rests on a number of important tools:

- *Basic physics.* The physics of radiative and convective heat transfer were well established more than a century ago. By 1896 the Swedish chemist Svante Arrhenius was able to do a calculation that doubling the carbon dioxide content of the atmosphere would lead to a global annual mean temperature increase of 5–6 degrees centigrade. He did these calculations entirely by hand. Also, the physics governing the earth's orbit and rotation have established very precisely how the distribution of sunlight across our planet has changed over geologic time; together with paleoclimate records (discussed below), this has allowed us to come to understand the underlying cause of the great glacial cycles over the past 2 or 3 million years.
- *The instrumental records of meteorological variables such as temperature and precipitation.* Such records tell us how climate is changing and together with theory and models allow us, to some degree, to attribute changes we observe to purely natural, random variability and to changes in radiative forcing of climate by both natural agents (such as changing sunlight and volcanic eruptions) and manmade agents such as greenhouse gases and aerosols.
- *Paleoclimate records.*There have been rapid advances in paleoclimate techniques and applications over the past few decades. We have learned, for example, how to use the isotopic composition of ice and of the fossil shells of microorganisms to estimate temperature and sea levels of the past. We now have detailed records of sea level and atmospheric composition going back many hundreds of thousands of years. We have also started to learn how to use such proxies as tree ring width and density and coral characteristics to reconstruct records of temperature going back hundreds of years.
- *Simple models.* Relatively simple models that embody the basic physics of climate have been used for many decades to help understand and predict climate change. Some of these are so simple that they can be solved with paper and pencil; others require very small computers (e.g. laptops). Among the most important of these are "single-column" models that treat the globally averaged atmosphere as a function of time and altitude. Models like these were a basis for the first comprehensive study of climate change by the National Academy of Sciences in 1979 [1]. These models give predictions of the response of global mean temperature to changing atmospheric composition that are in good accord with those produced by far more complicated global models.
- *Global climate models.* As mentioned in my testimony, these are relative newcomers and allow one to explore the roles of atmospheric and oceanic transports of heat, water, and momentum and to make predictions of the spatial patterns of climate change.

[1] Carbon Dioxide and Climate: A Scientific Assessment. National Academy of Sciences, Washington, D.C., 1979.

All of these tools are important in understanding climate and so it is difficult to rank their importance. But the scientific community would be concerned about human-induced climate change even if there were no such thing as a global climate model, based on evidence from the other approaches listed above.

Q2. On page 3 of your written testimony, you say: "One of the more robust consequences of a warming climate is the progressive concentration of rainfall into less frequent but more intense events."

a. Are you referring to model projections or observations, or both?

A3 (a) I am referring to observations, theory, and model projections.

b. Please cite some published literature indicating whether observed rainfall events have become less frequent and more intense in the United States over the past century.

A2. Observational evidence that rainfall is becoming more concentrated into more intense events:

a. Karl, T. R., and R. W. Knight, 1998: Secular trends of precipitation amount, frequency, and intensity in the USA. Bulletin of the American Meteorological Society, 79, 231–241.

b. Groisman, P. Y., R. W. Knight, D. R. Easterling, T. R. Karl, G. C. Hegerl, and V. N. Razuvaev, 2005: Trends in intense precipitation in the climate record. Journal of Climate, 18, 1326–1350. doi:10.1175/JCLI3339.1.

Basic theory and the robust response in precipitation in climate models:

a. Held, I. M., and B. J. Soden, 2006: Robust responses of the hydrological cycle to global warming. Journal of Climate, 19, 5686–5699. 1 Carbon Dioxide and Climate: A Scientific Assessment. National Academy of Sciences, Washington, D.C., 1979.

Q3. On page 3 of your written testimony, you state: "The potential for political destabilization of these regions is large and is matter of great concern to our Department of Defense, as outlined in their 2007 report National Security and the Threat of Climate Change." But, the inside cover of the report states: "This document represents the best opinion of The CNA Corporation at the time of issue".

a. Is it not true this report was prepared The CBA Corporation, and not the Department of Defense as implied by your testimony?

A3. Yes, I did quote from a report prepared by the CNA corporation and thus I stand corrected. (I assume that "CBA" in the question is a typo.) But here is what the Department of Defense had to say in their February 2010 Quadrennial Defense Review [2]:

"Assessments conducted by the intelligence community indicate that climate change could have significant geopolitical impacts around the world, contributing to poverty, environmental degradation, and the further weakening of fragile governments. Climate change will contribute to food and water scarcity, will increase the spread of disease, and may spur or exacerbate mass migration.

While climate change alone does not cause conflict, it may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world. In addition, extreme weather events may lead to increased demands for defense support to civil authorities for humanitarian assistance or disaster response both within the United States and overseas."

Q4. On page 4 of your written testimony you say "In assessing risk, scientists have historically been notably conservative. It is part of the culture of science to avoid going out on limbs, preferring to underestimate risk to provoking the charge of alarmism from our colleagues." At the same time, on page 3 of written testimony you quote at length from pages 6 and 7 of the CNA Corporation report "National Security and the Threat of Climate Change," as follows:

A4. Economic and environmental conditions in already fragile areas will further erode as food production declines, diseases increase, clean water becomes increasingly scarce, and large populations move in search of resources. Weakened and failing governments, with an already thin margin for survival, foster the conditions for internal conflicts, extremism, and movement toward increased authoritarianism and radical ideologies. And, The U.S. and Europe may experience mounting pressure to

[2] http://www.defense.gov/qdr/images/QDR__as__of__12Feb10__1000.pdf

accept large numbers of immigrant and refugee populations as drought increases and food production declines in Latin America and Africa.

Q4(b.) Do you personally endorse these forecasts? Would you describe them as "conservative"?

A4. Estimating the political and social consequences of climate change is far removed from my own field of expertise, and so I am not in a position to assess whether the authors of the CNA or DoD reports cited in this question and in my response to the previous question are conservative or not. It has not been my personal observation that, historically, DoD concerns have been overblown.

Q5. On page 5 of your written testimony you state: "Consider as an example the issues surrounding the email messages stolen from some climate scientists. I know something about this as I served on a panel appointed by the Royal Society of Great Britain, under the direction of Lord Oxburgh, to investigate allegations of scientific misconduct by the scientists working at the Climate Research Unit of the University of East Anglia." Please provide a copy of the terms of reference for the Oxburgh Panel established by the Royal Society, together with a copy of the letter or any other correspondence from the Royal Society appointing you as a member of the panel.

A5. I attach all the relevant material in my possession as a zip file. I did not include email correspondence but am happy to do so if requested.

Q6. Page 1 of the "Report of the International Panel set up by the University of East Anglia to examine the research of the Climatic Research Unit, (Oxburgh Report) states that "the eleven representative publications that the Panel considered in detail . . . were selected on the advice of the Royal Society." However, subsequent inquiries have demonstrated that the eleven publications were selected by Trevor Davies, Pro-Vice Chancellor for Research and Knowledge Transfer at the University of East Anglia. Please explain the basis for the Oxburgh Report's claim that the eleven publications had been selected by the Royal Society.

A6. As a member of the Scientific Assessment Panel (SAP), I was indeed asked to review eleven publications and was told that they had been selected with the advice of the Royal Society. I had no reason to question this information. In the event, we went beyond this mandate and asked questions based on other material we reviewed.

Q7. During the hearing you were asked if the Oxburgh Panel interviewed any outside critics of the Climatic Research Unit of the University of East Anglia (CRU).

a. Can you confirm that neither you nor any other member of the Oxburgh Panel conducted any such interviews, and that none of the information supplied to you by CRU scientists was shown to outside critics for response or rebuttal?

A7 (a) Prior to the meeting, I informally sent emails to two critics of the CRU work asking for their input. Specifically, I sent emails to Roger Pielke, Sr. and Stephen McIntyre, on March 27th 2010. (I am willing to supply the Committee with copies of these emails.) Dr. Pielke responded very soon thereafter with material that I found very helpful in querying CRU members about corrections to individual meteorological station data. Mr. McIntyre did not respond until after I had returned from Norwich, and then only to say that he would see what he could do.

b. If, as you state on page 5 of your written testimony, the Panel's task was to "investigate allegations of scientific misconduct," did any member of the Panel, at any time, recommend that, as part of the investigation, interviews should be conducted with critics of the CRU or with individuals making the allegations of misconduct?

A7 (b) The allegations of misconduct at that time focused on comments by CRU staff contained in email correspondence. Reviewing such emails was not in the purview of the SAP on which I served but rather on the Independent Climate Change Email Review, headed by Sir Muir Russell. (Please see by response to Question 6 of Representative Hall.) I do not remember hearing a specific suggestion that we conduct interviews of critics of CRU, though we were familiar with the points raised by such critics.

c. Did any member of the Panel request that interviews with the scientists under investigation be recorded and released?

A7 (c) No, not that I remember.

d. Can you also confirm that the Panel did not issue a call for evidence or hold public hearings, and if not, why not?

A7 (d) There was never any discussion by anyone involved about a call for evidence or a public hearing. Having participated on both sides of academic department reviews at MIT, these have never been open to the public; doing so would have greatly impeded the frank discussion and questions that are necessary to the conduct of a review of this nature. This was an investigation, not a trial.

e. Do you believe that you, as a member of the Panel, were sufficiently knowledgeable about the work of CRU scientists and the specific allegations of misconduct to evaluate the truthfulness of the information given to you by CRU scientists without seeking input from any of their critics?

A7 (e) As mentioned in my response to 7a) above, I did seek information from critics, though only one of the two responded. Moreover, the criticisms were made public at an early stage, so that in my preparation for the panel review, I became well acquainted with most of them. Therefore, yes, I feel that by the time of the panel meeting, I was sufficiently knowledgeable about at least some of the work of the CRU scientists to participate in the Panel.

Q8. Did Phil Jones tell the Oxburgh Panel (or any members of Panel) that it was "probably impossible to do the 1000-year temperature reconstructions with any accuracy"?

a. If so, why was this admission not cited in the Oxburgh Report?

A8 (a) I do not remember Phil Jones saying that.

b. If this is Jones' view, do you agree that this caveat should have been included in articles published by CRU scientists, and that the failure to include this caveat is not "compatible with a fair interpretation-of the original data"?

A8 (b) The published, peer-reviewed literature of the CRU group and their collaborators is mostly about uncertainties. As the review panels have consistently noted, there was no failure to communicate these uncertainties. Please look at Figure 1 in my response to the questions posed by Representative Hall; this is the famous "hockey stick" graph from the IPCC Third Assessment Report; the gray shading shows the range of uncertainty in the estimates. Indeed, the title of one of the original and most cited papers on the temperature reconstructions, published in 1999, is "Northern hemisphere temperatures during the past millennium: Inferences, uncertainties, and limitations".

Q9. Upon the completion of the Oxburgh Report, did you tell a colleague that there were some "real issues with TAR that needed to be investigated, but that these were beyond the purview of the committee." If so, please identify these issues.

A9. I do not remember saying that, but if I did say anything like that I must have been referring to the "hockey stick" figure in the IPCC TAR and whether that figure had been adequately documented.

Q10. On page 5 of your written testimony, you stated that CRU scientists had "omitted that part of [a particularly dubious tree-ring-based proxy] that was provably false" in a "figure for a non peer-reviewed publication" and that this was a "single lapse of judgment".

a. Are you referring to the graph prepared by Phil Jones for the cover of a 1999 World Meteorological Organization (WMO) report?

A10 (a) Yes.

b. Can you confirm that the "particularly dubious" tree ring proxy is the "Briffa" temperature reconstruction?

A10 (b) Yes.

c. Can you confirm that the part of the Briffa reconstruction that CRU scientists "omitted" in the WMO diagram was the portion of the Briffa reconstruction after 1960 when tree ring densities declined?

A10 (c) Yes.

d. You say that this was a "single lapse of judgment". At the interviews of the Oxburgh Panel that you attended, did you or any other Oxburgh Panel member ask CRU scientists asked whether they had "omitted" the declining part of the Briffa reconstruction in any peer-reviewed publication? If so, what was their answer?

A10 (d) Discussion of the "divergence problem" was a focus of our meeting.

e. Did the Oxburgh Panel perform any due diligence to determine whether CRU scientists had "omitted" the declining part of the Briffa reconstruction in their peer reviewed publications? If so, what were the results?

A10 (e) It was well known prior to the meeting that they had done this, but we reconfirmed it with them.

f. When you made your testimony that the omission in the WMO report was a "single lapse of judgment," were you aware that CRU scientists had "omitted" the declining part of the Brfffa reconstruction in figures in numerous peer reviewed publications, including P.D. Jones et al., Rev. Geophys., 37(2), 173 (1999); K.R. Briffa and TJ. Osborn, Science 295, 2227 (1999); K.R; Briffa et al., J. Geophys. Res. 106, 2929 (2001); K.R. Briffa et al., Global Planet. Change 40, 11; and S. Rutherford et aI., J. Clim. 18, 2308 (2005)?

A10 (f) Yes, certainly.

g. When you made your testimony that the omission in the WMO report was a 'single lapse of judgment", were you aware that the declining part of the Briffa reconstruction had been omitted in figures in the IPCC Third Assessment Report and the IPCC Fourth Assessment Report?

A10 (g) Yes, certainly.

h. Do you still maintain that the deletion of data was a "single lapse of judgment" and that it was only in connection with one "non peer-reviewed publication" and if so, what is your justification?

A10 (h) The error in judgment was not the omission of the data from the graph. There are many instances in the published proxy literature in which authors omitted data that in their judgment was flawed. The error in judgment was the failure, in the case of the 1999 WMO report to explain that that had been done and the basis for doing so, either explicitly in the report or paper or by virtue of the context in which the graph is presented. As far as I can tell, this failure was confined to the 1999 WMO report and possibly the IPCC TAR. My opinion is shared by the Muir Russell Commission (which I did not participate in); here is what they had to say about this in their report (emphasis theirs):

- *On the allegation that the references in a specific e-mail to a "trick" and to "hide the decline" in respect of a 1999 WMO report figure show evidence of intent to paint a misleading picture, we find that, given its subsequent iconic significance (not least the use of a similar figure in the IPCC Third Assessment Report), the figure supplied for the WMO Report was misleading.* We do not find that it is misleading to curtail reconstructions at some point per se, or to splice data, but we believe that both of these procedures should have been made plain—ideally in the figure but certainly clearly described in either the caption or the text.

i. On page 5 of your written testimony you described the editing of the Briffa tree ring record as follows: "Rather than omitting the entire record of a particularly dubious tree-ring-based proxy, the authors of the figure only omitted that part of it that was provably false." Did the Oxburgh Panel carry out any due diligence to establish that this portion of the Briffa reconstruction was "provably false"? Please provide support for your claim.

A10 (i) I do not recall whether we did or did not, but at any rate when proxy inferences and direct measurements disagree, one concludes that the proxies are in error.

j. In your testimony, you state that the Briffa tree ring data was "particularly dubious" and that it would have been a valid alternative not to show the Briffa reconstruction at all. Did the Oxburgh Panel carry out any due diligence to establish that the Briffa data was "particularly dubious," and if, what did it do?

A10 (j) Yes, we did. We spent considerable time with Keith Briffa discussing the methodology, the environment in which the trees in question were found. We even examined some tree sections under a microscope. A great deal of the meeting was spent discussing the so-called "divergence" problem, which is well known in the community and discussed extensively n the peer-reviewed literature. By no means all of the tree data show the divergence problem.

k. In light of the failure of the large Briffa proxy network to show increases in tree ring density and width in line with warming in the last half of the 20th century (the "divergence problem "), how do you rule out the possibility that proxy data

in the preinstrumental period might also fail to record historical warming intervals?

A10 (k) This is an excellent question and drives to the heart of the true scientific controversy as well as the judgments that were brought to bear in portraying this information in the IPCC report and other reports intended for a broad audience. The simple answer is that one cannot rule out the possibility that the proxy data in question in the preinstrumental period might also fail to show a warming. There is no such thing as a perfect proxy for past climates; all of the ones I am familiar with have their own drawbacks. This provides a strong motivation for looking at many different proxies based on different techniques and comparing the results; by doing this one gains some idea of the probable uncertainties in the temperature reconstructions. The last two IPCC reports presented information based on many proxies, and by showing these different proxies explicitly (in the case of the IPCC AR4) or indirectly by presenting error bars (in the case of the IPCC TAR), the uncertainty is conveyed. Please examine the two figures I provided in my responses to Representative Hall.

l. By deleting the most conspicuous modern divergences between proxies and temperatures in IPCC and WMO reports, would you agree that the CRU scientists concealed this problem from readers of the IPCC report and from policymakers?

A10 (l) I see no evidence that there was any intent to deceive, as implied by your question. We scientists are increasingly strongly encouraged to communicate with the public and policy makers and are frequently chastised for failing to simplify our points and for making our discussions too technical. In trying to simplify material for reports such as the two you quote above, intended for a broad audience, judgments must be made in how far to go to simplify the material. Had the graphs in the two reports you quote been based on information from the problematic tree proxies alone, then I think a case could be made that the graphs are deceptive. But taken in their actual entirety, they do a good job in summarizing our best estimates of the 1000-year history of northern hemisphere temperature, including the uncertainties in those estimates. I do not believe that any rational person examining these graphs could fail to appreciate the large uncertainties in the estimates, especially in the preinstrumental era.

Q11. The Oxburgh Report (page 2) states that tree ring chronologies "are subject to change when additional trees are added" and "commended" CRU for "continuously updating and reinterpreting their earlier chronologies." The Polar Urals and the regional chronology combining Yamal, Polar Urals and other chronologies were issues of controversy immediately prior to Climategate and were identified as important topics of investigation in submissions to the House of Commons Science and Technology Committee by prominent CRU critics.

a. If CRU had calculated an updated version of the Polar Urals chronology presented in K.R. Briffa et al., Nature 376, 156 (1995) that differed materially from the published version, in your opinion; would CRU scientists have an obligation under acceptable scientific practice to report the updated version?

A11 (a) Yes, if by "updated" you also mean superior.

b. If CRU had calculated a regional chronology combining the Yamal, Polar Urals and other shorter chronologies, in your opinion, did CRU scientists have an obligation under acceptable scientific practice to report this calculation either in connection with the publication of regional chronologies in K.R. Briffa et al., Phil. Trans. R. Soc. B 363,2271 (2008) or otherwise?

A11 (b) If they found errors in the original analysis then yes, they would have an obligation to publish the corrections. If they examined different data that led to differing conclusions, they should also publish that unless, in their judgment, the new data is flawed or inferior to the previously published data.

c. Did any member of Oxburgh Panel ask CRU scientists whether they had ever calculated an updated version of the Polar Urals chronology? If so, what was their answer?

A11 (c) Not that I recall.

d. Did any member of the Oxburgh Panel ask CRU scientists whether they had ever calculated regional chronology combining the Yamal, Polar Urals and other shorter chronologies? If so, what was their answer?

A11 (d) Not that I recall.

Questions submitted by Represenative David Wu

Q1. If you surveyed climate scientists in 1990 and then again in 2010, would the results indicate:

a. an increased consensus that climate change has been occurring?

A1 (a) Yes, certainly.

b. that climate change is due to an increase in greenhouse gases?

c. that the increase in greenhouse gases is primarily due to human activity?

A1 (c) Yes, certainly.
This fact was already well accepted in 1990.

Responses by Dr. W. David Montgomery, Economist

Questions submitted by Chairman Ralph Hall

Q1. In your testimony, you note that access to affordable and abundant energy, in fact, is clearly correlated with the quality of life enjoyed by a society. This appears obvious throughout our society. For example, inexpensive electricity allows refrigerators to prevent food from spoiling and energy-consuming hospitals save lives with all of their electronic equipment.

a. Can you provide some other examples of the social benefit of affordable and abundant energy?

A1 (a) The most important necessities often are the cheapest. Most people in the United States pay little for water and yet could not live without it. That is a very desirable state of affairs, as long as the use of water is not subsidised to encourage wasteful use. Thus we can say with confidence that what water is worth far exceeds what it costs. The same is true of energy. Although on the margin, there are discretionary uses of energy, most of the energy we use makes contributions to our lives far greater than what we pay for it. Coming into a warm home in winter is worth far more than the fuel bill, the flexibility and freedom of travel that we gain from readily available energy is "priceless" as the credit card advertisement puts it, and raising the price of energy means we must make do with less of these enjoyments or less of something else. With forces we cannot control driving up the price of some forms of energy, any government action that will raise those costs further needs to be scrutinized very carefully to make sure that it provides more than it takes away from the American consumer.

b. Do economic models that calculate the cost of climate-related policies adequately take into consideration the higher social cost resulting from more expensive energy?

A1 (b) Some do and some do not. Mainstream economic models like EPA's ADAGE model and the MRN–NEEM model that my colleagues and I have used in studies of climate policy do so. This class of models recognize that society's resources are limited, and that choosing to make energy more expensive will divert those resources away from producing other goods and services that consumers want. The loss of other good things—or having to make do with less comfort and convenience from using energy—is the social cost of more expensive energy. Other models do not. The kind of models used by organizations like PERI to support claims that regulations that make energy more expensive also create jobs completely ignore the social costs of more expensive energy.

Q2. Over 1.6 billion people—25 percent of the world's population—do not have access to electricity. Many of them soon will, thanks to expanded use of coal, which is forecast to increase 50 percent by 2030. The affordable electricity provided by coal will enable economic development and help alleviate poverty in places such as China, India, and Africa.

a. How will U.S. efforts to reduce greenhouse gas emissions have any impact on climate change give the expected dramatic increases globally? Should the U.S. impose higher energy costs on its citizens if the benefits are negligible?

A2. Unilateral actions by the U.S. will not have a noticeable impact on climate change worldwide, and therefore they can only provide negligible benefits to U.S. citizens. We do have a responsibility toward the poor, in the U.S. and worldwide, but policies to reduce greenhouse gas emissions will do the poor in the United States no good at all, and worldwide we would do far better to spend what climate regulations would cost us on direct aid to the neediest.

Q3. Some advocates of international action have pointed to China's commitment to reduce greenhouse gas emissions as an indication they are willing to participate in a binding international agreement. Do you agree with this hypothesis?

A3. No, nor do I see any evidence of a real commitment by China to undertake effective policy measures to reduce their emissions below levels that are already in their economic interest. What we have is a political statement in the Copenhagen Accords that is neither binding nor, in terms of its magnitude, likely to represent any sharing of real costs by China.

Q4. Should China, in response to an international treaty, commit to some sort of carbon restriction; is there reason to believe China would adhere to their commit-

ment, given their repeated disregard of other international agreements, such as enforcement of intellectual property rights?

A4. No. Indeed there is no reason to believe that any nation will adhere to the kinds of commitments that are now being discussed in negotiations to extend the Kyoto Protocol, because just about every study of how those commitments relate to national interests find that such an agreement would be unstable. Moreover, it is far from clear given the nature of the Chinese political system that the central government could enforce such a commitment even if it did believe it was in China's national interest. Regional governments in alliance with their regional industries seem to be the real power in China's economy. This alliance of government and industry has directed China's growth since market reforms in the direction of massive investments in heavy industry, which are largely responsible for the continuing growth in China's greenhouse gas emissions. They can do so despite creating massive overcapacity because of the access of local governments to loans from State banks, which they use to support uneconomic local industries. Without some way of breaking up this crony capitalism there is little chance that Beijing could greatly change the direction of emissions growth in China.

Q5. A lot of discussion relating to mandating a "clean energy" market surround the increased manufacturing base that would appear due to the newly mandated market. Yet, if energy costs increase substantially, as expected from such a mandate, is there reason to believe energy-intensive manufacturing companies wouldn't follow previous industries across the border or overseas?

A5. Absolutely not. Mandating purchases of "clean energy" through regulation is ineffective in creating an increased manufacturing base. Manufacturing will take place in the region that has the greatest comparative advantage, and raising energy costs through clean energy mandates only reduces the U.S. advantage in manufacturing. We are seeing this already, as a large share of the wind and solar equipment now being installed in the U.S. as a result of renewable energy standards is being manufactured overseas. And Europe, despite its massive subsidies to use of renewable energy, is having the same problem keeping manufacturing of the equipment at home.

Q6. President Obama recently proposed instituting a "Clean Energy Standard" of 80% energy from clean sources by 2035, presumably with the goal to reduce greenhouse gas emissions. As an expert economist, how do you anticipate such a standard would impact the economy?

A6. First, it would be exceptionally difficult to meet because getting from the current level of renewable use to 80% requires an unprecedented and premature turnover of the capital stock, the adoption of very costly or technically unproven technologies, and a level of use of intermittent and uncontrollable resources like wind and solar that would threaten the reliability of electricity supply. Moreover, being renewable does not mean that an energy source is without environmental problems of its own or that the indirect effects would be benign. The continued support for corn-based ethanol despite its making global warming worse and raising the cost of food is a case in point. Taking all this into account, the result would be a large increase in energy costs and likely massive unanticipated environmental problems and impacts on food supply.

Q7. A key assumption in the process of economic modeling is the availability of carbon offsets. Presumably, widespread availability of offsets would allow for a reduction in greenhouse gas emissions to be achieved at a cheaper cost by having another entity do so.

a. Can you outline why you believe carbon offsets will not be as widely available as assumed by many economic models?

A7. Carbon offsets can either be plentiful or valid, but it is hard to devise a system that can achieve both those goals. Any carbon offset represents the difference between what is actually happening and what would have happened otherwise, and determining that counterfactual is always to an extent arbitrary and likely to create moral hazards that lead to gaming the system. Moreover, the most prolific source of offsets is expected to be from reduced deforestation in developing countries. But the reason for that deforestation is largely the lack of adequate institutions like property rights in land and effective governance in the countries where deforestation is occurring, and without fundamental institutional change those countries will be unable to deliver credible offsets. Finally, valid offsets from forestry and prevented deforestation are likely to be competing with use of land for food production,

and therefore will be costly to the world's food supply and likely to run into severe opposition when that is realized.

b. Outside of the availability of such offsets, can you comment on the concept of "additionality" and its impact on the ability to produce tangible environmental benefits?

A7 (b) "Additionality" is the requirement that a program bring about reductions in emissions that would not be achieved in its absence. Some such requirement is necessary to make sure that there are tangible environmental benefits, but it is an area where "the best is the enemy of the good." The tighter the requirement to demonstrate "additionality," the less likely it is that useful real world measures will be credited with reducing emissions. For example, nuclear power in the U.S. is an accepted technology so that building additional nuclear powerplants might not count as "additional" emission reductions, even though significant policy aid is required. Also, in programs like the Clean Development Mechanism (CDM) a project will satisfy additionality only if it is not economically feasible without CDM credits. But if a host country adopts a broader policy, such as raising gasoline taxes, that make some projects economic, they will no longer qualify. The opposite kind of gaming has been observed in countries that use different feed-in tariffs to pay for electricity from different sources; those countries can make any project comply with the "additionality" rules by lowering the feed-in tariff until it is uneconomic without CDM credits. Thus additionality is a worthy idea that has produced great mischief in application.

Q8. In your discussion of economic impacts, you neglect to mention the often-cited "Stern Report," conducted by British economist Nicholas Stern. Can you mention some of the flaws in the process of the Stern Report?

A8. Despite the charge to the Stern Commission to review the economic issues, the Stern Report turned into an advocacy report supporting a particular set of attitudes toward climate policy. Although there is some good thinking buried in the body of the report, the overall summary and in particular its conclusion that the benefits of radically reducing emissions far exceed the cost are highly misleading. Numbers are twisted and distorted in ways that have no support in the economics profession to come up with the conclusion about benefits versus costs, largely because the report fails to mention that the benefits will accrue to future generations far richer than ourselves, while the costs fall on current generations, and that as a percentage of income we give up far more than the future generations gain. Sir Nicholas organized reviews of his draft report by leading American environmental economists, among which I was included, and the universal message to him was that the calculations in the report were absurd and would destroy its usefulness in enlightening policy. He ignored that advice.

Q9. A recent report by an English business consulting firm examined the costs and benefits of government policy to support the renewable energy industry in United Kingdom. It found that for every job created in the UK in renewable energy, 3.7 jobs are lost. [http://www.bbc.co.uk/news/uk-scotland-12597097]

The primary reasoning in support of this conclusion is that the opportunity costs associated with pushing consumers to more expensive renewable energy greatly outstrips any benefit from the creation of "green jobs."

a. What is your reaction to this conclusion that the push for "green jobs" is economically damaging?

A9. It is correct. To the extent that renewable energy makes economic sense, either because it can be produced more cheaply than fossil fuels or is a cost-effective way to comply with environmental performance standards, it will be adopted without specific support for renewable energy. For the most part, neither of these conditions hold. There are more cost-effective ways to meet environmental goals, and renewable energy costs significantly more than available alternatives to meet energy needs.

Questions submitted by Representative Randy Neugebauer

Q1. Dr. Montgomery, even President Obama has said that under his climate change policies, "electricity prices would skyrocket." Some estimates of the benefits of even the most drastic climate change initiatives find that we would abate global temperature increases by less then one degree Fahrenheit by 2100. Based on the scientific and economic information we have available to us, how would you de-

scribe the cost-benefit analysis of imposing massive subsidies and mandates on energy producers and consumers?

A1. The costs are high and the benefits are nearly non-existent. Although there are many uncertainties and disagreements about climate science, there is no dispute about two calculations: the U.S. will be contributing a declining share of global emissions over the next century no matter what we do, and President Obama's climate policies will make next to no difference in global concentrations of greenhouse gases and temperature change. No matter how costs are minimized by proponents of specific positions, including the frequent statement by EPA that "even 1% of GDP is only half of a year's growth" or Al Gore that "it's a postage stamp a day," the clear conclusion from the numbers is that the benefits to the U.S. of those actions are even smaller.

Questions submitted by Representative David Wu

Q1. If you surveyed climate scientists in 1990 and then again in 2010, would the results indicate:

a. an increased consensus that climate change has been occurring?

b. that climate change is due to an increase in greenhouse gases?

c. that the increase in greenhouse gases in primarily due to human activity?

A1. I have seen so many widely differing "surveys" purporting to state the views of "climate scientists" that I have no clear answer. Looking just at historical data, there does appear to be an increasing likelihood that recent temperatures are not just normal random fluctuations but it is by no means an unambiguous signal. That an increase in greenhouse gases in the atmosphere will lead to an increase in temperature has never been in dispute, at least since Arrhenius. Whether the increase in greenhouse gases up to now is primarily due to human activity is a question that I never thought was worth worrying about, since it is clear that there will at some point in the future be large increases that are attributable to human activity.

Questions submitted by Representative Donna F. Edwards

Q1. Have you ever received either direct or indirect compensation for any of your research, analyses, publications, testimony or a speech in any form, at any entity, by a company, trade association, institute or foundation that is represented, supported or funded by the oil, coal or energy industry?

A1. I was employed for most of the past 21 years by a consulting firm, Charles River Associates, and received all my compensation from that company. CRA had many clients from the oil, coal and energy industry, but overall its energy practice represented only a small fraction of its business.

Q2. If you answered yes to question #1 above please indicate:

a. The name of the entity that provided this compensation?

b. The year it was provided?

c. The amount of the compensation?

d. A brief description of what specifically you were compensated for doing?

A2. I cannot answer this question. All client engagements were covered by a confidentiality agreement between CRA and the client, and I am bound by my own confidentiality agreements with CRA. Even if I were not under that obligation, I no longer have access to information about CRA's revenues from any engagement because I am no longer employed by CRA.

Q3. Please indicate if you have ever appeared as an expert witness in a civil or criminal court case?

A3. I have.

Q4. If you answered yes to question #3 above please indicate:

a. The name of the court case?

b. The name of the court where the case was held?

c. The name of the plaintiff or defendant that you testified for?

d. Please indicate the amount of compensation you received either directly or indirectly for your testimony in each case mentioned above and the name of the entity that paid your compensation.

A4. All the information requested in questions a, b, and c was provided in my resume delivered to the Committee before my testimony. I am unable to answer question d. for the same reason that I am unable to answer question 2. Moreover, since I was paid a salary and bonus at the discretion of my employer, I have no knowledge of what the connection between my compensation and any of these engagements might have been. Nor would it matter, because I have always conducted my own independent research in every engagement, and stated my own conclusions objectively and honestly no matter who my client was.

Appendix II

Additional Material for the Record

ADDITIONAL MATERIAL FOR THE RECORD

Material Submitted by Chairman Ralph M. Hall

The Honorable Ralph M. Hall
Chairman, Committee on Science, Space, and Technology
U.S. House of Representatives
2123 Rayburn House Office Building
Washington, DC 20515
4/13/11

Dear Chairman Hall:

As you examine the processes used to create science and policy I wanted to provide the Committee with information relevant to such an examination. In my work on examining weather stations used for climate analysis used by NOAA and their division, the National Climatic Data Center (NCDC) I have found a number of issues that have not yet been addressed in the quantification of the climate record of the United States.

A summary of my findings is attached.

Thank you again for your time and consideration of the information. I believe it is useful for the Committee to have as it seeks to understand the complexities of the processes by which science and the policy interact and develop.

Sincerely,

Anthony Watts
IntelliWeather Inc.
3008 Cohasset Road.
Chico, CA 95973

Additional information for consideration by the committee
The Honorable Ralph M. Hall
Chairman, Committee on Science, Space, and Technology
U.S. House of Representatives
2123 Rayburn House Office Building
Washington, DC 20515

I began studying climate stations in March 2007, stemming from a curiosity about paint used on the Stevenson Screens (thermometer shelters) used since 1892, and still in use today in the Cooperative Observer climate monitoring network. Originally the specification was for lime based whitewash - the paint of the era in which the network was created. In 1979 the specification changed to modern latex paint. The question arose as to whether this made a difference. An experiment I performed showed that it did. Before conducting any further tests, I decided to visit nearby climate monitoring stations to verify that they had been repainted. I discovered they had, but also discovered a larger and troublesome problem; many NOAA climate stations seemed to be next to heat sources, heat sinks, and have been surrounded by urbanization during the decades of their operation.

The surfacestations.org project started in June 2007 as a result of a collaboration begun with Dr. Roger Pielke Senior. at the University of Colorado, who had done a small scale study (Pielke and Davies 2005) and found identical issues.

Since then, with the help of volunteers, the surfacestations.org project has surveyed over 1000 United States Historical Climatological Network (USHCN) stations, which are chosen by NOAA's National Climatic Data Center (NCDC) to be the best of the NOAA volunteer operated Cooperative Observer network (COOP). The surfacestations.org project was unfunded, using the help of volunteers nationwide, plus an extensive amount of my own volunteer time and travel. I have personally surveyed over 100 USHCN stations nationwide. Until this project started, even NOAA/NCDC had not undertaken a comprehensive survey to evaluate the quality of the measurement environment, they only looked at station records.

The work and results of the surfacestations.org project is a gift to the citizens of the United States.

There are two methods of evaluating climate station siting quality. The first is the older 100 foot rule implemented by NOAA http://www.nws.noaa.gov/om/coop/standard.htm which says:

The [temperature] sensor should be at least 100 feet from any paved or concrete surface.

A second siting quality method is for NOAA's Climate Reference Network, (CRN) a hi-tech, high quality electronic network designed to eliminate the multitude of data bias problems that Dr. Muller speaks of. In the 2002 document commissioning the project, NOAA's NCDC implemented a strict code for placement of stations, to be free of any siting or urban biases.

http://www1.ncdc.noaa.gov/pub/data/uscrn/documentation/program/X030FullDocumentD0.pdf

The analysis of metadata produced by the surfacestations.org project considered both techniques, and in my first publication on the issue, at 70% of the USHCN surveyed (Watts 2009) I found that only 1 in 10 NOAA climate stations met the siting quality criteria for either the NOAA 100 foot rule or the newer NCDC CRN rating system. Now, two years later, with over 1000 stations, 82.5% surveyed, the 1 in 10 number holds true using NOAA's own published criteria for rating station siting quality.

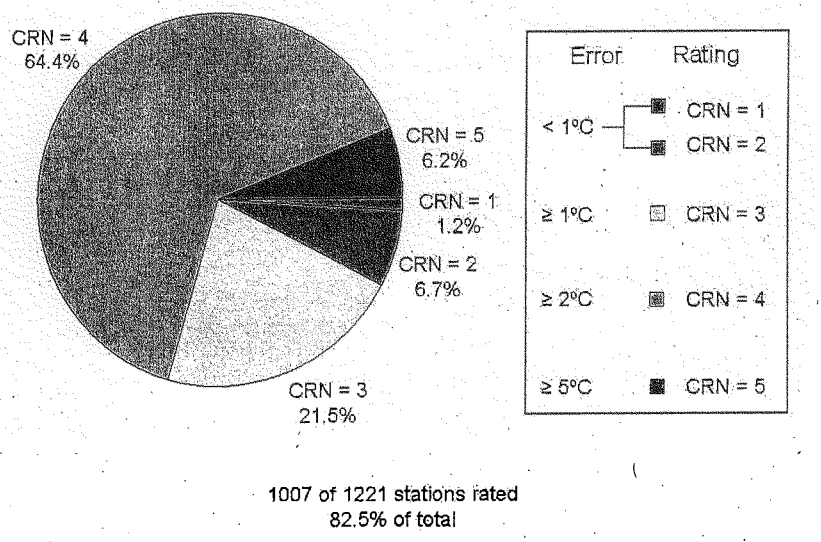


Figure 1 Findings of siting quality from the surfacestations project

During the nationwide survey, we found that many NOAA climate monitoring stations were sited in what can only be described as sub optimal locations. For example, one of the worst examples was identified in data by Steven McIntyre as having the highest decadal temperature trend in the United States before we actually surveyed it. We found it at the University of Arizona Atmospheric Sciences Department and National Weather Service Forecast Office, where it was relegated to the center of their parking lot.

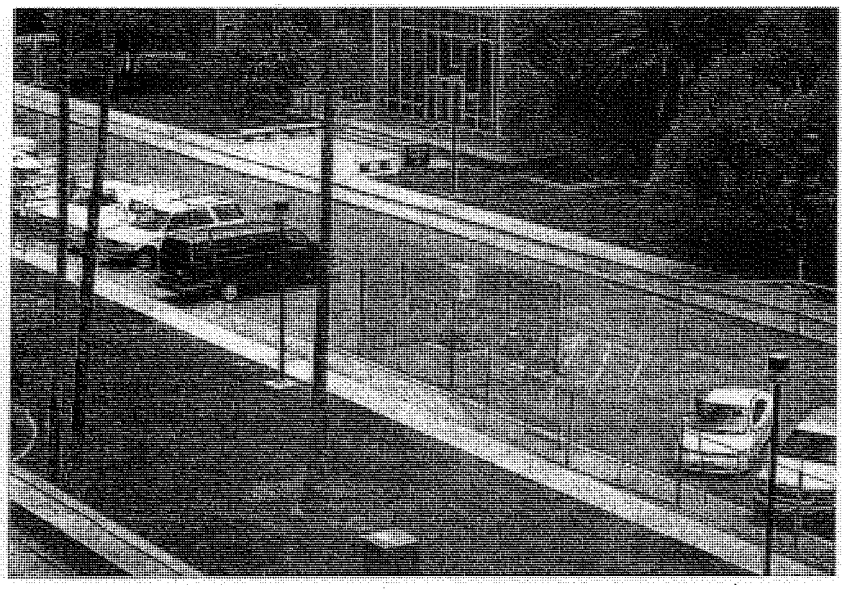


Figure2 - USHCN Station in Tucson, AZ
Photograph by surfacestations.org volunteer Warren Meyer

This USHCN station, COOP# 028815 was established in May 1867, and has had a continuous record since then. One can safely conclude that it did not start out in a parking lot. One can also safely conclude from human experience as well as peer reviewed literature (Yilmaz, 2009) that temperatures over asphalt are warmer than those measured in a field away from such modern influence.

The surfacestations.org survey found hundreds of other examples of poor siting choices like this. We also found equipment problems related to maintenance and design, as well as the fact the the majority of cooperative observers contacted had no knowledge of their stations being part of the USHCN, and were never instructed to perform an extra measure of due diligence to ensure their record keeping, and that their siting conditions should be homogenous over time.

It is evident that such siting problems do in fact cause changes in absolute temperatures, and may also contribute to new record temperatures. The critically important question is: how do these siting problems affect the trend in temperature?

Other concerns, such as the effect of concurrent trends in local absolute humidity due to irrigation, which creates a warm bias in the nighttime temperature trends, the effect of height above the ground on the temperature measurements, etc. have been ignored in past temperature assessments, as reported in, for example:

Pielke Sr., R.A., C. Davey, D. Niyogi, S. Fall, J. Steinweg-Woods, K. Hubbard, X. Lin, M. Cai, Y.-K. Lim, H. Li, J. Nielsen-Gammon, K. Gallo, R. Hale, R. Mahmood, S. Foster, R.T. McNider, and P. Blanken, 2007: **Unresolved issues with the assessment of multi-decadal global land surface temperature trends. J. Geophys. Res.,** 112, D24S08, doi:10.1029/2006JD008229

Klotzbach, P.J., R.A. Pielke Sr., R.A. Pielke Jr., J.R. Christy, and R.T. McNider, 2009: **An alternative explanation for differential temperature trends at the surface and in the lower troposphere. J. Geophys. Res.,** 114, D21102, doi:10.1029/2009JD011841.

Steeneveld, G.J., A.A.M. Holtslag, R.T. McNider, and R.A Pielke Sr, 2011: **Screen level temperature increase due to higher atmospheric carbon dioxide in calm and windy nights revisited. J. Geophys. Res.,** 116, D02122, doi:10.1029/2010JD014612.

These issues are not yet dealt with in Dr. Richard Muller's analysis, and he agrees.

The abstract of the 2007 JGR paper reads:

This paper documents various unresolved issues in using surface temperature trends as a metric for assessing global and regional climate change. A series of examples ranging from errors caused by temperature measurements at a monitoring station to the undocumented biases in the regionally and globally averaged time series are provided. The issues are poorly understood or documented and relate to micrometeorological impacts due to warm bias in nighttime minimum temperatures, poor siting of the instrumentation, effect of winds as well as surface atmospheric water vapor content on temperature trends, the quantification of uncertainties in the homogenization of surface temperature data, and the influence of land use/land cover (LULC) change on surface temperature trends. Because of the issues presented in this paper related to the analysis of multidecadal surface temperature we recommend that greater, more complete documentation and quantification of these issues be required for all observation stations that are intended to be used in such assessments. This is necessary for confidence in the actual observations of surface temperature variability and long-term trends.

While NOAA and Dr. Muller (in testimony 3/31) have analyses using our preliminary data that suggest siting has no appreciable effect, our upcoming paper reaches a different conclusion.

Our paper, Fall et al 2011 titled **"Analysis of the impacts of station exposure on the U.S. Historical Climatology Network temperatures and temperature trends"** has this abstract:

The recently concluded Surface Stations Project surveyed 82.5% of the U.S. Historical Climatology Network (USHCN) stations and provided a classification based on exposure conditions of each surveyed station, using a rating system employed by the National Oceanic and Atmospheric Administration (NOAA) to develop the U.S. Climate Reference Network (USCRN). The unique opportunity offered by this completed survey permits an examination of the relationship between

USHCN station siting characteristics and temperature trends at national and regional scales and on differences between USHCN temperatures and North American Regional Reanalysis (NARR) temperatures. This initial study examines temperature differences among different levels of siting quality without controlling for other factors such as instrument type.

Temperature trend estimates vary according to site classification, with poor siting leading to an overestimate of minimum temperature trends and an underestimate of maximum temperature trends, resulting in particular in a substantial difference in estimates of the diurnal temperature range trends. The opposite-signed differences of maximum and minimum temperature trends are similar in magnitude, so that the overall mean temperature trends are nearly identical across site classifications. Homogeneity adjustments tend to reduce trend differences, but statistically significant differences remain for all but average temperature trends. Comparison of observed temperatures with NARR shows that the most poorly-sited stations are warmer compared to NARR than are other stations, and a major portion of this bias is associated with the siting classification rather than the geographical distribution of stations. ***According to the best-sited stations, the diurnal temperature range in the lower 48 states has no century-scale trend.***

The finding that the mean temperature has no statistically significant trend difference that is dependent of siting quality, while the maximum and minimum temperature trends indicates that the lack of a difference in the mean temperatures is coincidental for the specific case of the USA sites, and may not be true globally. **At the very least, this raises a red flag on the use of the poorly sited locations for climate assessments as these locations are not spatially representative.**

Whether you believe the century of data from the NOAA COOP network we have is adequate, as Dr. Muller suggests, or if you believe the poor siting placements and data biases that have been documented with the nationwide climate monitoring network are irrelevant to long term trends, there are some very compelling and demonstrative actions by NOAA that speak directly to the issue.

1. NOAA's NCDC created a new hi-tech surface monitoring network in 2002, the Climate Reference Network, with a strict emphasis on ensuring high quality siting. If siting does not matter to the data, and the data is adequate, why have this new network at all?

2. Recently, while resurveying stations that I previously surveyed in Oklahoma, I discovered that NOAA has been quietly removing the temperature sensors from many of the USHCN stations we cited as the worst (CRN4, 5) offenders of siting quality. For example, here are before and after photographs of the USHCN temperature station in Ardmore, OK, within a few feet of the traffic intersection at City Hall:

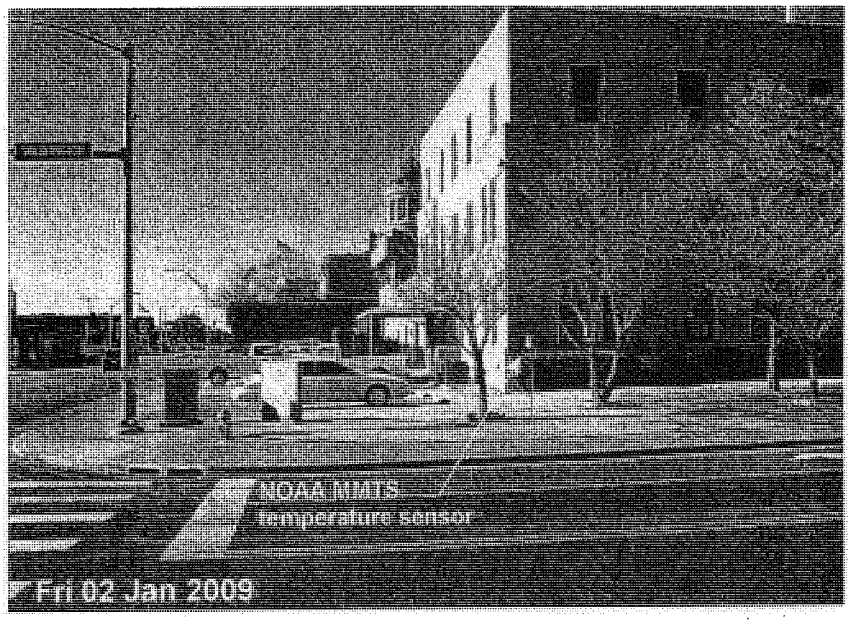
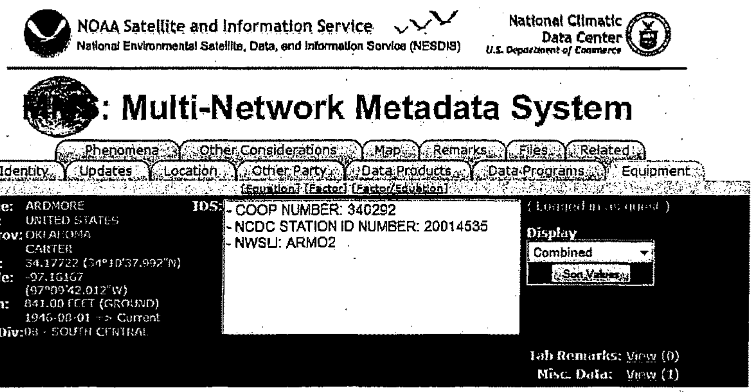


Figure 3 Ardmore USHCN station , MMTS temperature sensor, January 2009

Figure 4 Ardmore USHCN station , MMTS temperature sensor removed, March 2011

NCDC confirms in their meta database that this USHCN station has been closed, the temperature sensor removed, and the rain gauge moved to another location - the fire station west of town. It is odd that after being in operation since 1946, that NOAA would suddenly cease to provide equipment to record temperature from this station just months after being surveyed by the surfacestations.org project and its problems highlighted.

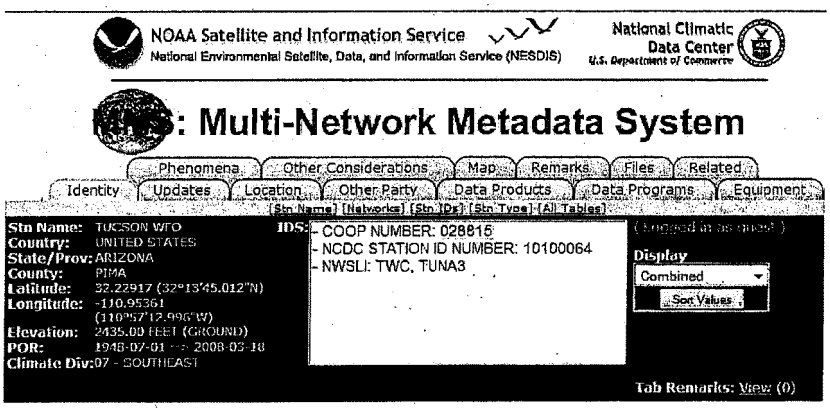


Only the rain gauge remains, temperature was removed on 3-12-2009, just months after the surfacestations survey

Begin Date	End Date	Equip Type	Equipment Model	Priority	Equipment Name	Phenomenon	Elevation	Serial Number	Data
[2009-12-03]	Current	PRCP	F&P	PRIMARY	FISCHER/PORTER RRNG	PRECIPITATION	---	6206M36	COOP HPD
			SRG		STANDARD RAIN GAGE			---	COOP SOD
[2007-04-11]	2009-12-03	PRCP	F&P	PRIMARY	FISCHER/PORTER RRNG	PRECIPITATION		6510M32	COOP HPD
			SRG		STANDARD RAIN GAGE			---	COOP SOD
		TEMP	NIMBUS		NIMBUS	TEMPERATURE		T2E8D6L02	
[2006-03-31]	2007-04-11	PRCP	F&P	PRIMARY	FISCHER/PORTER RRNG	PRECIPITATION		6510M32	COOP HPD
			SRG		STANDARD RAIN GAGE			---	COOP SOD

Figure 5 NOAA Metadata for Ardmore, OK USHCN station, showing equipment list

3. Expanding the search my team discovered many more instances nationwide, where USHCN stations with poor siting that were identified by the surfacestations.org survey have either had their temperature sensor removed, closed, or moved. This includes the Tucson USHCN station in the parking lot, as evidenced by NOAA/NCDC's own metadata online database, shown below:



Click on a Begin Date to view individual record.
Click on a Column Header to sort by that column.

Begin Date	End Date	Stn Name	Name Type	Stn Type	COOP	NCDC	NWSLI
[2002-12-18]	2008-03-18	TUCSON WFO	COOP NAME	COOP, COOPERATIVE SUB-NETWORK- C, LAND SURFACE, USHCN	028815	10100064	TWC
		TUCSON WFO	PRINCIPAL NAME				
[1998-01-01]	2002-12-18	TUCSON NWSO	COOP NAME	COOP, COOPERATIVE SUB-NETWORK- C, LAND SURFACE, USHCN	028815	10100064	TWC
		TUCSON WFO	PRINCIPAL NAME				

Figure 6 NOAA Metadata for Tucson USHCN station, showing closure in March 2008

It seems inconsistent with NOAA's claims of siting effects having no impact that they would need to close a station that has been in operation since 1867, just a few months after our team surveyed it in late 2007 and made its issues known, especially if station siting quality has no effect on the data the station produces.

It is our contention that many fully unaccounted for biases remain in the surface temperature record, that the resultant uncertainty is large, and systemic biases remain. This uncertainty and the systematic biases needs to be addressed not only nationally, but worldwide. Dr. Richard Muller and many other scientists have not yet examined these important issues which can affect the outcome of the climate record.

Thank you for the opportunity to present this to the Members.

Anthony Watts
Chico, CA

Material Submitted by Mr. Peter Glaser, Partner, Troutman Sanders, LLP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Docket No. EPA-HQ-OAR-2009-0171

Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act

74 Fed. Reg. 66496 (Dec. 15, 2009)

PETITION FOR RECONSIDERATION BY PEABODY ENERGY COMPANY

February 11, 2010

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Endangerment and Cause or Contribute	)	
Findings for Greenhouse Gases	)	Docket No.
under Section 202(a) of the Clean Air Act	)	EPA-HQ-OAR-2009-0171

PETITION FOR RECONSIDERATION OF PEABODY ENERGY COMPANY

Peabody Energy Company respectfully requests that the United States Environmental Protection Agency ("EPA" or "Agency") reconsider its *Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act* published at 74 Fed. Reg. 66,496 (Dec. 15, 2009).[1] Peabody's petition is based primarily on the release of email and other information from the University of East Anglia ("UEA") Climatic Research Unit ("CRU") in November of last year.[2] The CRU information undermines a number of the central pillars on which the Endangerment Finding rests, particularly the work of the Intergovernmental Panel on Climate Change ("IPCC").

Given the seriousness of the flaws that the CRU material reveals in the development of the IPCC reports, and given EPA's extensive reliance on those reports, the Agency has no legal option but to reexamine the Endangerment Finding in light of this new information. Indeed, the analytical process in which EPA engaged in reaching its Endangerment Finding is so tainted by the flaws now revealed in the IPCC reports that the Agency must take the unusual step of convening full evidentiary hearings in order to provide an open and fair reconsideration process.

[1] For convenience, we will refer to these findings as the Endangerment Finding.

[2] We are providing these emails and all of the information that was released from the CRU website as it was originally released. This includes the "Harry_Read_Me" files that we refer to later in this Petition. Because of the volume of the information, we are providing it to EPA on a disk. The emails are identified in this Petition using both the dates and numerical identification provided in the emails. We quote these emails exactly as they were written without correcting or indicating improper spelling. By now, there is little doubt that the emails are authentic, as none of those who wrote the emails have denied their authenticity.

TABLE OF CONTENTS

GLOSSARY OF ACRONYMS

ACUS	Administrative Conference of the United States
AGU	American Geophysical Union
ANPR	Advanced Notice of Proposed Rulemaking
AR4	Fourth Assessment Report from the IPCC
CAA	The Clean Air Act
CCSP	United States Climate Change Science Program, now USGCRP
CEI	Competitive Enterprise Institute
CO_2	Carbon dioxide
CRU	University of East Anglia's Climatic Research Unit
DOE	United States Department of Energy
ENSO	El Niño Southern Oscillation
EPA	United States Environmental Protection Agency
FAR	First Assessment Report published by the IPCC
FOIA/FOI	Freedom of Information Act, in the United States and the United Kingdom
GEF	Global Environment Facility
GISS	Goddard Institute for Space Studies
GHCN	Global Historical Climatology Network
GHG	Greenhouse gases
GRL	Geophysical Research Letters
IISD	International Institute for Sustainable Development
IJC	International Journal of Climatology
IPCC	Intergovernmental Panel on Climate Change
IQA	Information Quality Act
JGR	Journal of Geophysical Research
LIA	Little Ice Age
MBH98	Mann et al. paper *Global Scale Temperature Patterns and Climate Forcing Over the Past Six Centuries*, published in 1998.
MBH99	Mann et al. paper *Northern Hemisphere Temperatures During the Past Millennium" Inferences, Uncertainties, and Limitations,* published in 1999.
MWP	Medieval Warm Period
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Counsel
PAGES	Past Global Changes
RAOBCORE	Radiosonde Observation Correction Using Reanalyses
SAPs	Synthesis and Assessment reports produced by the CCSP
TAR	Third Assessment Report from the IPCC
TSD	Technical Support Document
UEA	University of East Anglia
UCAR	University Corporation for Atmospheric Research
UNEP	United Nations Environment Programme
USGCRP	United States Global Change Research Program
WGI	IPCC Working Group I

WGII	IPCC Working Group II
WMO	World Meteorological Organization
WWF	World Wildlife Fund

LIST OF PRINCIPAL SCIENTISTS

Dr. Caspar Ammann - Scientist II in the Climate and Global Dynamics Division of National Center for Atmospheric Research. Contributing author of Chapter 9 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. Raymond Bradley - Director of the Climate System Research Center, University of Massachusetts. Co-author of MBH98 and MBH99.

Dr. Keith Briffa - Deputy Director, Climatic Research Unit, Univeristy of East Anglia. Lead author of Chapter 6 of Working Group I Report, 2007 IPCC Fourth Assessment Report. Contributing author of Chapter 2 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. John Christy – Director ofEarth System Science Center at the University of Alabama in Huntsville. Lead author of Chapter 3 of Working Group I Report, 2007 IPCC Fourth Assessment Report. Lead author of Chapter 2 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Edward Cook - Doherty Senior Scholar and Director, Tree-Ring Laboratory, Lamont-Doherty Earth Observatory. Contributing author of Chapter 6 of Working Group I Report, 2007 IPCC Fourth Assessment Report. Contributing author of Chapter 2 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Thomas Crowley – Professor, School of GeoSciences at The University of Edinburgh.

Dr. Rosanne D'Arrigo – Senior Research Scientist at Tree-Ring Laboratory, Lamont-Doherty Earth Observatory.

Dr. Valérie Masson-Delmotte -Laboratoire des Sciences du Climat et de l'Environnement. Lead author of Chapter 6; Contributing author of Chapter 9 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. David Douglass - Professor, University of Rochester.

Dr. Jan Esper – Head of Dendro Sciences Division, Swiss Federal Research Institute WSL.

Dr. Melissa Free - Air Resources Laboratory (ARL), NOAA. Lead author of Chapter 3 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. Chris de Freitas - Associate Professor, Deputy Director of School, Associate Director (Postgraduate Affairs), School of Environment, University of Auckland.

Dr. Vincent Grey - a founder of the New Zealand Climate Science Coalition.

Dr. James Hack - Senior Scientist, CMS Section Head, CGD Deputy Director. National Center for Atmospheric Research.

Dr. Malcolm Hughes - Regents' Professor, Laboratory of Tree-Ring Research at The University of Arizona. Co-author of MBH98 and MBH99.

Dr. Eystein Jansen - Research Director of the Bjerknes Center for Climate Research, University of Bergen, Norway. Coordinating lead author of Chapter 6 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. Phil Jones - Professor, Climatic Research Unit, Univeristy of East Anglia. Coordinating lead author of Chapter 3 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. Thomas Karl - Director, National Climatic Data Center, NOAA. Review editor of Chapter 3 of Working Group I Report, 2007 IPCC Fourth Assessment Report. Coordinating lead author of Chapter 2 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Otto Kinne - President, Inter-Research Science Center.

Dr. A.T.J de Laat - The Royal Netherlands Meteorological Institute.

Dr. Murari Lal - Chairman, Climate, Energy and Sustainable Development Analysis Centre. Co-ordinating Lead Author for Asia - Chapter 10 of Intergovernmental Panel on Climate Change's Fourth Assessment Report of Working Group II (2004-2007). Contributing author of Chapter 2 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Stephen Mackwell - Director of the Lunar and Planetary Institute. Editor-in-Chief, Geophysical Research Letters, 2002–2004.

Dr. Michael Mann - Director, Earth System Science Center, Pennsylvania State University. Lead author of Chapter 2; Contributing author of Chapter 7; Contributing author of Chapter 8 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Glenn McGregor - Director of School of Environment, University of Auckland; Editor, International Journal of Climatology.

Stephen McIntyre - editor of Climate Audit.

Dr. Ross McKitrick - Professor of Economics at the University of Guelph.

Dr. Patrick Michaels - Senior Fellow at the Cato Institute and a former Professor of Environmental Sciences from the University of Virginia.

Dr. Jonathan Overpeck - Co-director of the Institute of the Environment (IoE) at The University of Arizona. Coordinating lead author of Chapter 6 of Working Group I Report, 2007 IPCC

Fourth Assessment Report. Contributing author of Chapter 2 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Tim Osborn - Academic Fellow at the Climatic Research Unit, within the School of Environmental Sciences at UEA. Contributing author of Chapter 6; Contributing author of Chapter 8 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. Roger Pielke, Jr. - Professor in the Environmental Studies Program, University of Colorado and a Fellow of the Cooperative Institute for Research in Environmental Sciences.

Dr. Benjamin Santer - Research Scientist, Program for Climate Model Diagnosis and Intercomparison at the Lawrence Livermore National Laboratory. Lead author of Chapter 8 of the 1995 IPCC report.

Dr. Gavin A. Schmidt –Climatologist and Climate Modeler at NASA Goddard Institute for Space Studies.

Dr. Stephen Schneider - Editor of the journal Climatic Change; Stanford University.

Dr. Olga Solomina - Corresponding Member, the Russian Academy of Sciences; Senior Research Scientist, Institute of Geography, Russian Academy of Sciences. Contributing author of Chapter 4, Lead author of Chapter 6 of Working Group I Report, 2007 IPCC Fourth Assessment Report.

Dr. Susan Solomon - Senior Scientist, Chemical Sciences Division (CSD)Earth System Research Laboratory (ESRL), NOAA. Co-Chair, IPCC Working Group I Report, 2007 IPCC Fourth Assessment. Contributing author of Chapter 4; Lead author of Chapter 6 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Kevin Trenberth - Senior Scientist, Head of the Climate Analysis Section at the National Center for Atmospheric Research. Contributing author of Chapter 1; Coordinating lead author of Chapter 3; Contributing author of Chapter 7 of Working Group I Report, 2007 IPCC Fourth Assessment Report. Contributing author of Chapter 8 of Working Group I Report, 2001 IPCC Third Assessment Report.

Dr. Eugene Wahl - Physical Scientist, Paleoclimatologist, Paleoecology, Climate Reconstruction, NOAA.

Dr. Edward Wegman – Professor, Department of Statistics, George Mason University.

Dr. Thomas Wigley - senior scientist in the Climate and Global Dynamics Division, University Corporation for Atmospheric Research. Contributing author of Chapter 10 of Working Group I Report, 2007 IPCC Fourth Assessment Report. Contributing author of Chapter 4; Contributing author of Chapter 9; Contributing author of Chapter 12 of Working Group I Report, 2001 IPCC Third Assessment Report.

I.

EXECUTIVE SUMMARY

"I tried hard to balance the needs of the science and the IPCC, which were not always the same."

> Dr. Keith Briffa, lead author of Chapter 6 of Working Group I Report, *The Physical Scientific Basis*, 2007 IPCC Fourth Assessment Report

"It related to several countries in this region and their water sources. We thought that if we can highlight it, it will impact policy-makers and politicians and encourage them to take some concrete action. It had importance for the region, so we thought we should put it in."

> Dr. Murari Lal, coordinating lead author of Chapter 10 of Working Group II Report, *Impacts, Adaptation and Vulnerability*, 2007 IPCC Fourth Assessment Report, referring to how misinformation about the pace of Himalayan glacier melt was included in the report, as reported in the Daily Mail, January 24, 2010

"Failure to make research data and related information accessible not only impedes science, it also breeds conflicts."

> Ralph J. Cicerone President of the National Academy of Sciences, Science, February 5, 2010, commenting on the CRU material

EPA must reconsider its Endangerment Finding based on new material that was not available during the comment period and which is central to the outcome that EPA reached in promulgating its Endangerment Finding. EPA failed to properly exercise its judgment as required by the Clean Air Act ("CAA") and acted in an arbitrary and capricious fashion by relying almost exclusively on flawed reports of the IPCC in attributing climate change to anthropogenic greenhouse gas ("GHG") emissions. As evidenced by material that became available last fall from CRU, as well as additional information that has become available since the Endangerment Finding was issued, the IPCC reports were not the product of a rigorous, transparent and neutral scientific process.

Indeed, contrary to the CAA and the Information Quality Act ("IQA"),[3] EPA largely ceded its obligation to make a "judgment" as to whether GHGs may endanger public health and welfare to the IPCC, an international body that is not subject to U.S. data quality and transparency standards and whose reports were prepared in direct disregard of those standards. As a result, EPA is set to begin regulating GHG emissions based on a scientific process that was conducted without the basic procedural safeguards *set forth in U.S. law* to ensure the reliability and accuracy of the scientific conclusions underlying the Agency's Endangerment Finding. As an agency of the United States, however, whose regulatory actions will have far-reaching consequences for U.S. citizens, EPA must abide by U.S. standards and not the standards of international bodies whose actions are governed by different norms.

Accordingly, the EPA should reconsider its Endangerment Finding in light of the recently discovered defects in the IPCC's procedures and convene full evidentiary hearings to provide an open and fair reconsideration process.

Background

On December 5, 2009, EPA released its landmark *Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act*.[4] EPA found that "[t]he scientific evidence is compelling that elevated concentrations of heat-trapping gases are the root cause of recently observed climate change."[5] According to EPA, "[m]ost of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations," with "very likely" defined

[3] The IQA was enacted as the Treasury and General Government Appropriations Act for Fiscal Year 2001 § 515, 44 U.S.C. 3504(d)(1) and 3516 (2000).

[4] The finding was subsequently published at 74 Fed. Reg. 66,496 (Dec. 15, 2009).

[5] Endangerment Finding, 74 Fed. Reg. at 66,518.

as a 90-99% probability.[6] EPA further found that this change in climate is already causing a variety of detrimental impacts to U.S. public health and safety and that these impacts are likely to worsen in the future.[7]

Just weeks before EPA issued its Endangerment Finding, a considerable body of email and other information from CRU became available on the Internet. The CRU information undermines a number of the central pillars on which the Endangerment Finding rests, particularly the work of the IPCC.[8] The CRU information reveals that many of the principal scientists who authored key chapters of the IPCC scientific assessments were driven by a policy agenda that caused them to cross the line from neutral science to advocacy. Indeed, they went far beyond even what is acceptable as advocacy, as they actively suppressed information that was contrary to the "nice, tidy story" that they wished to present, they refused to disclose underlying data concerning the studies in which they were involved to third parties who might use the information to critique those studies, they engaged in a wide variety of improper and indeed unethical tactics to manipulate the type of scientific information that appeared both in the IPCC reports and in the peer-reviewed scientific journals upon which the IPCC largely relied, and they relied on inaccurate and unverified information from secondary source material that was produced by advocacy groups, information that the authors apparently knew was unverified but

[6] ENVTL. PROT. AGENCY, TECHNICAL SUPPORT DOCUMENT FOR ENDANGERMENT AND CAUSE OR CONTRIBUTE FINDINGS FOR GREENHOUSE GASES UNDER SECTION 202(A) OF THE CLEAN AIR ACT. ("TSD") (2009) at 48, 7.

[7] Endangerment Finding, 74 Fed. Reg. at 66,523-26.

[8] The IPCC is a body that was established by the United Nations Environment Programme ("UNEP") and the World Meteorological Organization ("WMO") to "provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences." The IPCC releases Assessment Reports, and those reports contain a section entitled *Summary for Policymakers* that makes suggestions to government based on the conclusions in the Assessment Reports. The two most recent IPCC reports comprehensively assessing climate science are the 2007 Fourth Assessment Report, referred to as "AR4," and the 2001 Third Assessment Report, referred to as the "TAR." Both AR4 and the TAR included three Working Group reports. Except as specifically noted, when we cite to AR4 and the TAR below, we are referring to the Working Group I reports concerning the "scientific basis."

included anyway to advance the authors' advocacy agenda. Moreover, the Information Commissioner's Office of the United Kingdom ("U.K."), the agency that oversees and enforces the U.K.'s freedom of information laws, after investigation, recently concluded that CRU broke those laws in refusing to respond to information requests.[9]

Thus, the IPCC's recent retraction of its "poorly substantiated estimates of the rate of recession and the date for the disappearance of Himalayan glaciers" as set forth in the AR4 Working Group II Report,[10] and the numerous other recent IPCC errors that have come to light, is indicative of a process that was far less neutral and robust than EPA assumed. Moreover, since the IPCC, as an international body, is not subject to any nation's Freedom of Information Act, and since the CRU material obviously reflects only one small source of information concerning the drafting of the IPCC reports, it is not known what other flaws may have occurred in the IPCC process and are yet to be revealed.

EPA believes that it has broad discretion in making its Endangerment Finding.[11] Although the extent of EPA's discretion is debatable, what is not debatable is EPA's obligation to justify the particular choices it made in exercising that discretion.[12] EPA's determination here was not that it *might* be possible that anthropogenic GHG emissions will cause *possibly* dangerous climate change at some point in the future. Instead, EPA decided that such emissions *were almost certainly already* causing dangerous climate effects, with the danger almost

---

[9] *See Climate row unit 'broke data law,'* BBC NEWS Jan. 28, 2010 *available at* http://news.bbc.co.uk/2/hi/uk_news/8484385.stm.

[10] *IPCC statement on the melting of Himalayan glaciers,* Jan. 20, 2010 *available at* http://www.ipcc.ch/pdf/presentations /himalaya-statement-20january2010.pdf.

[11] *See* general discussion at Endangerment Finding, 74 Fed. Reg. at 66,506-09.

[12] *See Motor Vehicle Mfrs. Ass'n of the United States, Inc. v. State Farm Mutual Auto Ins. Co.*, 463 U.S. 29, 43 (1983) (agency must articulate a "rational connection between the facts found and the choice made").

certainly likely to worsen in the future. This is an important distinction because obviously the degree of endangerment that EPA finds will guide the nature and extent of regulation that EPA will now promulgate. Based on the CRU material and other information that has come to light, however, there is now reason to question the basis for EPA's endangerment finding and thus the type of regulation that this finding may lead to.

In sum, given the seriousness of the flaws that the CRU material and other information reveal in the development of the IPCC reports, the Agency must reexamine the Endangerment Finding. The Agency can no longer have confidence that those reports present a fair, unbiased and accurate assessment of climate science. Since these reports were relied on extensively in the Endangerment Finding, the Agency has no choice but to conclude that the Endangerment Finding itself is now tainted and must be reconsidered.

Peabody

Peabody is the world's largest private sector coal company. Peabody supports the deployment of next-generation green coal technologies to achieve the goal of zero or near-zero emissions from the use of coal. Peabody is involved in a variety of efforts worldwide to make this goal a reality and has made significant investments in these technologies. Last fall, for instance, Peabody became a full equity participant with Chinese companies in the 650 MW GreenGen power project, a commercial scale near-zero emissions power project that is under construction near Tianjin, China. In a joint statement issued by President Barack Obama and President Hu Jintao in Beijing at the time that Peabody's investment was announced, the two world leaders recognized the importance of GreenGen and other projects.

EPA regulation under the CAA will not be a cost-effective way of reducing GHG emissions; indeed, EPA regulation of GHGs under the CAA will likely do more harm than good.

The Agency itself has stated that congressional action is preferable to CAA regulation. Peabody believes that the best way to reduce worldwide GHG emissions from the use of coal is through congressional action to incentivize these new technologies. Peabody knows that EPA also believes in incentivizing new technologies. Although we have our differences, Peabody hopes to be able to work with EPA and the Administration in the future on an overall legislative approach. We share the same goal: reducing global GHG emissions. The question is the best way to do so.

The Risk of Reaching a Wrong Endangerment Finding

The Endangerment Finding is the foundation on which EPA will build far-reaching GHG regulation of virtually all facets of the United States economy. The regulation that will follow the Endangerment Finding will not just be limited to new motor vehicles and new motor vehicle engines under section 202(a) of the CAA, but will extend to numerous categories of stationary sources, both under the Prevention of Significant Deterioration Program and otherwise under Titles I and V, and to mobile sources under Title II.

Most affected by EPA GHG regulation will be the combustion of fossil fuels, and particularly coal, since combusting fossil fuels inevitably produces carbon dioxide ("CO_2"), the most ubiquitous of the GHGs. Eighty-five percent of all energy used in the United States is derived from fossil fuels, and approximately fifty percent of the electricity used in the United States is produced from coal. Indeed, according to EPA, "[v]irtually every sector of the U.S. economy is either directly or indirectly a source of GHG emissions."[13]

In comments on the Endangerment Finding,[14] Peabody explained that EPA's approach to assessing possible endangerment from combustion of fossil fuels was one-sided. EPA assessed

[13] Control of Emissions From New Highway Vehicles and Engines, 68 Fed. Reg. 52,922, at 52,928 (Sept. 8, 2003).
[14] EPA-HQ-OAR-2009-017-3261.

only what EPA believes are the dangers to health and welfare that are created by the emissions produced by fossil fuel combustion. EPA, however, did not assess the benefits to health and welfare that are created by the energy that results from fossil fuel combustion.

As Peabody explained, GHGs are obviously emitted for a reason; they are the inevitable byproduct of the combustion of fossil fuels for energy or the end result of some other process. For this reason, when EPA assesses whether the emission of GHGs endangers public health and welfare, EPA must assess the dangers and benefits on both sides of the point where the emissions occur: in the atmosphere where the emissions lodge and on the other side of the emitting stack or structure, in the processes that create the emissions. Otherwise, EPA will not be able to accurately assess whether society's emission of GHGs is a benefit or a detriment.

Because GHG emissions, particularly CO_2 emissions, are so closely tied with all facets of modern life, a finding that GHG emissions endanger public health and welfare is akin to saying that modern life endangers public health or welfare. But plainly just the opposite is the case. The combustion of fossil fuels has created a level of health and welfare that would have been unimaginable in pre-industrial society. Indeed, the obvious benefits of combusting fossil fuels present a paradox to EPA in making its Endangerment Finding: as the world has combusted more and more fossil fuel and therefore has emitted more and more GHGs, virtually every measurement of public health and welfare has improved.

EPA responded to Peabody's comments and similar comments of other parties by saying that these comments were legally irrelevant. According to EPA, the CAA provides for a two-step regulatory process. First, EPA decides whether there is endangerment created by the emission of air pollutants and then, at a subsequent point, EPA decides on appropriate regulation.

EPA stated that the concerns raised by Peabody and others pertained to the consequences of regulation and were therefore relevant at step two and not at step one.[15]

Peabody believes that EPA's legal analysis is faulty and will challenge it at the appropriate time and in the appropriate forum. EPA's view of the statute, however, emphasizes all the more why EPA must especially ensure that its Endangerment Finding is developed through a rigorous and transparent analytical process – and therefore why EPA should be especially concerned about the CRU material. If EPA is going to defer weighing the risk of regulating against the risk of not regulating to step two of the regulatory process, then it must make sure at step one that the scientific process has been conducted with integrity and neutrality so as to correctly identify the danger that its step two regulations will address. Otherwise, the Agency will not be able to determine what level of regulation, if any, is justified and it may end up causing large harms for little, if any, benefit.

EPA Reliance on IPCC Reports

Section 202(a) of the CAA plainly requires that the Administrator make a "judgment" as to whether the emission of air pollutants poses a danger to public health and welfare. Throughout the Endangerment Finding, however, the Administrator frankly admitted that the Agency did not itself conduct a comprehensive review of climate change science in making its judgment that anthropogenic GHG emissions create endangerment. Instead, EPA relied primarily on what it termed the "assessment literature" in reaching its scientific conclusions.[16]

Although the "assessment literature" on which the Administrator relied generally consisted of the work of both the IPCC and the U.S. Climate Change Science Program ("CCSP")

[15] Endangerment Finding, 74 Fed. Reg. at 66,515-16.

[16] EPA's reliance on the "assessment literature" is discussed at section III(A)(4) of our Petition.

science assessment reports,[17] she relied primarily on the work of the IPCC on the critical issue of whether anthropogenic GHGs are causing climate change. Most of the TSD examined observed and projected climate and the effect on public health and welfare. Only eight pages of the Endangerment Finding Technical Supporting Document ("TSD"), however, were devoted to the critical "attribution" issue: whether changes to the climate system that EPA says are occurring and will accelerate can be attributed to anthropogenic GHG emissions and not natural forces.[18] The attribution section of the TSD particularly relied on the work of the IPCC, as opposed to the other "assessment literature" or any other studies. We count 67 citations in this section, with 47 to the IPCC. All the graphics in this section were taken from the IPCC, as was the introduction. Plainly, the principal authority for EPA's central conclusion that anthropogenic GHG emissions are causing deleterious climate change was the IPCC.

EPA recognized in the Endangerment Finding that it is responsible for verifying that scientific information on which the Agency relies meets standards for quality, integrity and transparency that are set forth in U.S. law, including the CAA and the IQA.[19] EPA stated that it ensured compliance with these standards here by reviewing the IPCC's written procedures for preparation of that body's science assessment reports.[20] Based on that review, EPA determined that the IPCC had procedures in place to ensure "a basic standard of quality, including objectivity, utility and integrity."[21] Accordingly, EPA concluded that it had "no reason to

---

[17] The CCSP has now been subsumed into the U.S. Global Change Research Program ("USGCRP"). CCSP issued a series of synthesis and assessment reports ("SAPs"), and these reports, along with the IPCC reports, became the principal basis for the June 2009 USGCRP report GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES. available at http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[18] TSD at 47-54.

[19] TSD at 4.

[20] EPA Response to Public Comments ("Resp. to Comm.") Vol. 1 at 9-23.

[21] *Id.* at 57.

believe" that the "assessment reports do not represent the best source material to determine the state of the science and the "consensus" view of the world's scientific experts on the issues central to making an endangerment decision with respect to greenhouse gases."[22]

The CRU material and other recently released information, however, reveals that EPA's trust in the IPCC's written procedures was misplaced. Based on this material, EPA now does have reason to conclude that the IPCC reports were not the product of a rigorous, transparent and neutral scientific process. The effect of EPA's reliance on the IPCC is that the Agency delegated its obligation to make a judgment as to whether GHGs may endanger public health and welfare to an international body that acted in direct contravention of basic U.S. information standards. EPA cannot, consistent with law, regulate based on that foundation.

This concern is particularly acute given that EPA asserts authority to protect the public health against an "air pollutant" that EPA concedes does not create a direct public health concern from inhalation or exposure as is the case for traditional air pollutants. In fact, CO_2 is a naturally-occurring substance that is necessary for life on Earth. As shown in Peabody's Endangerment Finding comments, a large body of peer-reviewed studies shows the benefits of increased CO_2 on plant productivity in general, including agricultural crops. It is thus not a "pollutant" that endangers public health or welfare.

Of course, too much of any substance can lead to damaging consequences – for instance, too much water can lead to flooding. EPA's view is that, because of human activities, there is too much CO_2 and other GHGs in the atmosphere and that, as a result, climate will change leading to indirect effects on health. But these indirect health impacts are asserted to be caused by, at best, a highly uncertain chain of cause and effect. Even if EPA has authority to expand its

[22] Endangerment Finding, 74 Fed. Reg. at 66,511.

regulatory mandate to regulate asserted indirect health effects, which Peabody disputes, such expansion could be justified only if this chain of cause and effect could be proven with a high level of confidence. Just the opposite occurred here, however; EPA's regulatory expansion was based on IPCC reports prepared in a manner that demonstrably did not ensure data quality, integrity and transparency and which therefore cannot be found to produce reliable results.

In sum, EPA must reconsider its Endangerment Finding.

CRU Materials Implicate Key IPCC Actors on the Critical Attribution Issue

A temptation may exist to dismiss the abuses revealed in CRU material as the product of a few scientists at a single English institution. But, the CRU is responsible for the development of critical datasets central to climate change studies and is acknowledged as a "primary data source by climate scientists around the world."[23] Furthermore, the main scientists implicated in these emails were not just minor research scientists at CRU. Those implicated include both leading CRU scientists and senior scientists at leading American climate science institutions who were in close contact with the CRU scientists. They are the leaders in the fields of climate observations and paleoclimate, two of the key areas from which the IPCC (and therefore EPA) drew in determining that anthropogenic GHGs are affecting climate. These scientists include:

- Dr. Phil Jones, Director of the Climatic Research Unit and one of two coordinating lead authors of Chapter 3 of AR4 addressing observed climate.
- Dr. Kevin E. Trenberth, head of the Climate Analysis Section at the National Center for Atmospheric Research ("NCAR") and the other coordinating lead author of Chapter 3 of AR4.
- Dr. Keith R. Briffa of CRU, a lead author of Chapter 6 of AR4.
- Dr. Jonathan Overpeck of the University of Arizona, one of two coordinating lead authors of Chapter 6 of AR4 addressing paleoclimate.

[23] History of the Climate Research Unit *available at* http://www.cru.uea.ac.uk/cru/about/history/.

- Dr. Eystein Jansen of the University of Bergen, Norway, the other coordinating lead author of Chapter 6.
- Dr. Michael Mann, a lead author of Chapter 2 of the TAR, one of the leading figures in the field of paleoclimatology, and the scientist whose "hockey stick" graph became the single most important piece of information in the TAR.
- Dr. Benjamin D. Santer of the Lawrence Livermore National Laboratory and lead author of Chapter 8 of the 1995 IPCC report.
- Dr. Thomas Wigley, former head of the CRU, PhD advisor to Drs. Santer and Jones, senior scientist at the University Corporation for Atmospheric Research and a 1995 IPCC report lead author, a TAR contributing author, and an AR4 contributing author.
- A number of other scientists who worked for and with these scientists.

Moreover, the information revealed in the disclosures is significant enough that investigations have been launched of the actions of the involved scientists by the UEA[24] and The Pennsylvania State University[25] and now by the Science and Technology Committee of the United Kingdom Parliament.[26] As stated, the U.K. government agency responsible for overseeing and enforcing U.K. freedom of information laws has concluded that those laws were broken. Although it has concluded that prosecutions cannot be brought because of the applicable statute of limitations, it says it will seek to change the laws to lengthen the limitations period.[27]

---

[24] Press Release, CRU Update 3, *Professor Phil Jones has today announced that he will stand aside as Director of the Climatic Research Unit until the completion of an independent Review resulting from allegations following the hacking and publication of emails from the Unit* (Dec. 1, 2009), *available at* http://www.uea.ac.uk/mac/comm/media/press/2009/dec/CRUphiljones.

[25] Public Statement, Penn State University, University Reviewing Recent Reports on Climate Information, *available at* http://www.ems.psu.edu/sites/default/files/u5/Mann_Public_Statement.pdf.

[26] http://www.parliament.uk/parliamentary_committees/science_technology/s_t_pn14_100122.cfm.

[27] *See Climate row unit 'broke data law,'* Jan. 28, 2010 *available at* http://news.bbc.co.uk/2/hi/uk_news/8484385.stm.

Attribution: The Key Findings

In concluding that the "scientific evidence is compelling" that anthropogenic GHG emissions – as opposed to natural forces – are causing dangerous climate change, EPA relied on what it terms "three lines of evidence." The first is based on the "physical" understanding of the climate. The second is the determination that the temperatures of the last "several decades" are unusual and even unprecedented during the current interglacial period known as the Holocene, when the world's climate system has been similar to that of today, and particularly during the last 1000-2000 years when more is known about climate. The third is based on computer model simulations.[28]

All three of these lines of evidence are undermined by the CRU emails, although the second line of evidence as to whether temperatures of the last several decades are unprecedented during the Holocene is the area in which the abuses are most notable.

The Attempt to Present a "Nice Tidy Story" of Unprecedented 20th Century Warmth

Placing current climate in context within the paleoclimate has always been considered to be of exceptional importance in determining whether an anthropogenic GHG influence can be detected in the current climate. After all, if temperature conditions during the paleoclimate were as high or higher than today, it becomes difficult to conclude that anthropogenic GHG emissions are the cause of current temperatures. As the IPCC itself stated, "To determine whether 20th century warming is unusual, it is essential to place it in the context of longer-term climate variability."[29]

---

[28] TSD at 47.

[29] TAR at § 2.3.1.

In particular, temperature during the Holocene has fluctuated over multi-century periods, and during the last 1000 years, there was a period of warming known as the Medieval Warm Period ("MWP"), followed by a Little Ice Age ("LIA") that lasted through about 1850, followed by two periods in which temperatures rose, 1910-1945 and 1977-1998, and now followed by an eleven-year period of no warming. The magnitudes and duration of the two periods of 20th century warming are statistically similar, with EPA admitting that the first period did not result from the combustion of fossil fuels as there was little increase during this time of atmospheric carbon dioxide.[30] It has also long been recognized that early in the Holocene there were multi-century periods (known as the "Holocene Thermal Maximum") when temperatures were warmer than today.[31]

Recognizing the importance of the paleoclimate issue and driven by an agenda, those involved with writing the paleoclimate sections of both the 2001 TAR and the 2007 AR4 appear to have set out to create a picture of unprecedented 20th century warmth during the Holocene, with particular attention to the last 1000 years.[32] The key way they did this was through unjustified reliance on highly uncertain proxy temperature reconstructions of climate over the last millennium using tree rings and other information as indicators of temperatures. Based on these reconstructions, the TAR and AR4 concluded that any warming of the MWP was localized and not a global phenomenon. This enabled the conclusion that the warming in the 20th century was so unprecedented in the last 1000 years that it was most likely caused by anthropogenic GHG emissions.

---

[30] TSD at 45.

[31] *See, e.g.*, IPCC First Assessment Report, CLIMATE CHANGE: THE IPCC SCIENTIFIC ASSESSMENT 202 (Cambridge University Press 1990) ("FAR").

[32] The attempts in the TAR and AR4 to create a clean picture of unprecedented 20th century warmth are discussed more fully in our Petition at section IV(C).

The CRU emails, however, reveal that the authors of this material did not present a neutral view of the science. In particular, they downplayed the considerable uncertainty inherent in trying to approximate temperatures from proxy data over a 1000-year period, they suppressed contrary information, and they suppressed dissenting views in ways that made even their own colleagues uncomfortable. Thus, in one representative email written during the preparation of the TAR, Keith Briffa stated that "***I know there is pressure to present a nice tidy story as regards 'apparent unprecedented warming in a thousand years or more in the proxy data' but in reality the situation is not quite so simple.***"[33] He went on to say that "I believe that the recent warmth was probably matched about 1000 years ago."[34] Similarly, another key researcher, Ed Cook, in a lengthy email bristling at the effort to eliminate the MWP, wrote that "***I do find the dismissal of the Medieval Warm Period as a meaningful global event to be grossly premature and probably wrong.***"[35]

These concerns, however, were brushed aside in the final TAR. The TAR's version of the temperature record of the last 1000 years was based on the now infamous "hockey stick" study of Mann et al., a study that purported to show 1000 years of slightly declining global temperatures followed by a sharp increase in the 20th century. The hockey stick paper concluded that the 1990s were the warmest decade and 1998 was the warmest year in a millennium. The hockey stick graph was the single most important piece of information in the TAR. It was Figure 1 of the Summary For Policymakers of the TAR appearing on page 3, and it was widely relied on by advocates.[36]

---

[33] CRU email 938018124.txt (Sep. 22, 1999) (emphasis added).

[34] *Id.*

[35] CRU email 988831541.txt (May 2, 2001) (emphasis added).

[36] *See* discussion in our Petition of this matter at section IV(C)(3).

Despite its prominence in the TAR, the hockey stick has now largely been discredited, with both the National Research Council ("NRC")[37] and the independent Wegman Report[38] rejecting confidence in the conclusion that the 1990s were the warmest decade and 1998 was the warmest year in a millennium. Although the hockey stick paper was cited in AR4, its significance was downplayed, and EPA did not cite the paper in the Endangerment Finding or TSD.

However, the same people who gave that paper such prominence in the TAR – despite the misgivings expressed internally within the group – continued to dominate paleoclimate research and were again the leading authors of the AR4 paleoclimate material. Indeed, perhaps stung by criticisms of the hockey stick and by the appearance of so-called "skeptics" who questioned the central conclusions of the TAR, the drafting of at least the paleoclimate chapter of AR4 became more of a political than a scientific process.[39]

Thus, the two coordinating lead authors of Chapter 6 of AR4, Jonathan Overpeck of the University of Arizona and Eystein Jansen of the University of Bergen in Norway, openly coached contributors to produce materials that would serve a public policy agenda. As just a few examples, the CRU emails show that Overpeck instructed his colleagues to make sure that text was "***FOCUSED on only that science which is policy relevant***" and that would support pre-conceived summary bullet points.[40] The pair also advised authors to include graphics that would be "compelling" and that the "sign of ultimate success" of a graphic would be that it was so

---

[37] National Research Council, SURFACE TEMPERATURE RECONSTRUCTIONS FOR THE LAST 2,000 YEARS (National Academy Press 2006) ("NRC Report").

[38] Edward Wegman et al. AD HOC REPORT ON THE "HOCKEY STICK" GLOBAL CLIMATE RECONSTRUCTION. ("Wegman Report") (July 27, 2006) *available at* http://republicans.energycommerce.house.gov/108/home /07142006_ Wegman_Report.pdf.

[39] This matter is discussed more fully in our Petition at section IV(C)(1)(c).

[40] CRU email 1121392136.txt (Jul. 14, 2005) (capitals in original) (emphasis added).

compelling that it would be selected for use in the policymaker's summary.[41] They told authors to "pls DO please try hard to follow up on my advice" to only refer to the MWP and the Holocene Thermal Maximum in a "dismissive" way.[42] They expressed satisfaction with a graphic that described the MWP as heterogeneous – meaning that warming was not uniform on a planetary scale – not because it was accurate but because it read "much like a big hammer," driving home the point they wished to make.[43] Moreover, although the hockey stick could no longer be relied on as a principal source of authority, authors were instructed that "[w]e're hoping you guys can generate something compelling enough" for the summary material for policymakers, "something that will replace the hockey-stick with something even more compelling."[44] Yet new research that reexamined the data on which the IPCC relied has challenged the IPCC's dismissal of the MWP as non-heterogeneous, concluding that the IPCC's conclusion in this regard was, at least, "premature" and based on limited data.[45]

A representative case in point as to how these scientists treated conflicting information is revealed in emails concerning two studies addressing the Holocene Thermal Maximum. Coordinating lead author Jansen's view was that the extended warm temperatures of that period were caused by orbital wobbles, with the evidence being (in his view) that the warmth was not globally synchronous and was instead dominated by high-latitude summer warming – consistent with the projections of climate models run with the orbital parameters characteristic of that period. That was the explanation that appeared in AR4, and that is the explanation that EPA

---

[41] *Id.*

[42] CRU email 1105670738.txt (Jan. 13, 2005).

[43] CRU email 1105978592.txt (Jan. 17, 2005).

[44] CRU email 1116902771.txt (May 23, 2005).

[45] Jan Esper and David Frank, *The IPCC on a heterogeneous Medieval Warm Period,* 94 CLIM. CHNG. 267-272 (2009).

adopted in reliance on AR4.[46] Jansen had a problem, however, in that his co-authors brought to his attention two papers published in peer-reviewed literature showing that the warmth of this period was not restricted to the high latitudes. Jansen's solution? He dismissed the papers as wrong and did not allow them even to be referred to in text.[47]

The examples of this type of behavior abound. Jones told Mann in a 2004 "HIGHLY CONFIDENTIAL" email that he "can't see" either of two papers that they didn't like "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!"***[48] These scientists also acted inappropriately as both contributors and reviewers despite the obvious conflict of interest.[49] They enlisted the aid of their colleagues in the drafting process without disclosing that fact.[50] They manipulated publication deadlines so that papers supporting their views could be included.[51] And they acted as peer reviewers of scientific papers in order to influence the literature on which they intended to rely as IPCC authors.[52]

These actions are not those of neutral scientists trying to present an accurate summary of the findings of paleoscience. They are the actions of advocates building a case. But science is not supposed to be developed on the basis of whether or not it is "policy relevant" – it is supposed to be honest, accurate and neutral – and scientific discussion should not be circumscribed for the purpose of supporting a simple bullet point or presented in ways that are

---

[46] TSD at 49.

[47] This matter is discussed in more detail in our Petition at section IV(D).

[48] CRU email 1089318616.txt (Jul 8, 2004) (all capitals in original). Although both of these papers were eventually cited in the text, they were referred to dismissively without substantive reason.

[49] *See* our Petition at section VII (B).

[50] *See Id.* at section VII (C).

[51] *See Id.* at section VII (D).

[52] *See Id.* at section VII (E).

considered to be "compelling." Nor should supposedly neutral scientific summaries omit studies containing data that contradict model predictions and undermine the case that the authors wish to present. And, most obvious of all, science reports should not contain demonstrably incorrect information supplied by agenda-driven advocacy groups. The AR4 material, thus, does not comport with good science and should not be treated as such by EPA.

The "Trick" to "Hide the Warming"

Much attention has been placed on Jones' now-famous email in which he stated that "I've just completed Mike's Nature trick of adding in the real temps to each series for the last 20 years (ie from 1981 onwards) amd from 1961 for Keith's to hide the decline."[53] The trick he and Mann performed was to hide a decline in temperatures appearing in tree ring data in the latter part of the 20th century. Unless this trick were used, their multi-century proxy temperature reconstructions would show an embarrassing decline in temperatures at the end of the reconstruction, a decline that was not paralleled in the record of directly measured temperatures, which showed an increase. To hide the decline in the proxy data, Mann and then Jones grafted on actual temperature data to the end of their proxy reconstructions rather than using the same proxy data as had been used throughout the reconstruction.

This trick makes the graphic presentations of the proxy reconstructions misleading, since the effect is to make it seem as if the proxy data shows rising 20th century warming when it doesn't. But the real deception in the trick was in hiding what became known as the "divergence" problem. The accuracy of tree ring data as proxies for temperatures can only be confirmed by comparing the proxy temperatures yielded by the tree rings with temperatures directly measured during the period when direct temperature measurements could be made. If

[53] CRU email 942777075.txt (Nov. 16, 1999).

the proxy data are contradicted by actual data, as they are for a significant period of the time when direct temperature measurements exist, the accuracy of the proxy data over the entire period of the proxy reconstruction is called into question. Thus, the divergence problem undermined faith in the ability of the proxy reconstructions to provide conclusive or even meaningful information about paleoclimate temperature conditions, even as the IPCC was relying on these reconstructions to conclude that temperatures in the 20th century had reached unprecedented levels in the last 1000 years. As one email candidly said, "[t]he issue of why we dont show the proxy data for the last few decades (they dont show continued warming) but assume that they are valid for early warm periods needs to be explained."[54] These concerns, however, were given short shrift. Although divergence was discussed in AR4, the conclusion was reached that the results of the proxy temperature reconstructions remained valid and showed that 20th century warmth was likely unprecedented in 1000 years. If divergence was not a significant issue, however, one wonders why it was necessary to perform "tricks" to hide the problem.[55]

More importantly, after AR4 was issued, at least three studies have been published reanalyzing the data used in the proxy reconstructions cited in AR4, including two by authors whose reconstructions were used in AR4. These studies concluded that, in fact, the divergence problem makes the reconstructions unreliable.[56] According to one study, the divergence problem "serve(s) to impede a robust comparison of recent warming during the anthropogenic period with

[54] CRU email 1150923423.txt (Jun. 21, 2006).

[55] The "trick" and the divergence issue is discussed more fully in our Petition at section IV (C)(2).

[56] These studies are discussed in our Petition at section IV (C)(2)(d).

past natural climate episodes such as the Medieval Warm Period or MWP."[57] Another study found that the divergence problem makes it "impossible to make any statements about how warm recent decades are compared to historical periods."[58] Another concluded that the divergence problem "is of importance, as it limits the suitability of tree-ring data to reconstruct long-term climate fluctuations, particularly during periods that might have been as warm or even warmer than the late twentieth century."[59]

It would seem, therefore, that the IPCC should have been more cautious in dismissing the divergence problem. It would also seem that the IPCC may have understood that there was something to hide after all.

How Do These Flaws in the IPCC Findings on Paleoclimate Affect the Endangerment Finding?

The Endangerment Finding recognizes that there is "significant uncertainty" as to temperatures prior to about 1600, citing both the IPCC and the NRC report *Surface Temperature Reconstructions for the Last 2,000 Years* (2006). Although the IPCC's AR4 did in fact recognize uncertainty in attempts to determine temperatures prior to 1600, it nevertheless found it "likely," which it defined as a 66-90% probability, that the second half of the 20th century was warmer than any comparable period in the Northern Hemisphere over the last 1300 years and that this warmth was more widespread globally than during any other comparable period over the

[57] Rosanne D'Arrigo, et al., *On the 'divergence problem' in northern forests: a review of the tree-ring evidence and possible causes,* 60 GLOB. PLANET. CHNG. 289 (2008).

[58] Craig Loehle, *A mathematical analysis of the divergence problem in dendroclimatology,* 94 CLIM. CHNG. 233 (2009).

[59] Jan Esper and David Frank, *Divergence pitfalls in tree-ring research,* 94 CLIM. CHNG. 261, 262 (2009).

last 1300 years.[60] The CRU emails show that the AR4's statement as to the "likely" unprecedented warming of the 20th century cannot be credited.

More to the point is EPA's reference to the NRC report as to the uncertainty of temperature reconstructions prior to 1600. In fact, the NRC's discussion of uncertainty concluded with the statement that, because of the uncertainty, it is no more than "plausible" that the Northern Hemisphere was warmer during the last few decades of the 20th century than during any comparable period over the preceding millennium.[61]

EPA's reliance on the NRC Report on the issue of uncertainty creates a dilemma for the Agency in defending the Endangerment Finding. As stated above, EPA determined that "compelling" scientific evidence supports the conclusion that anthropogenic GHG emissions are the "root cause of recently observed climate change." According to EPA, one of three lines of such "compelling" scientific evidence is that the temperatures of the last several decades are so unusual in the last 1000-2000 years that anthropogenic GHG emissions are very likely the cause. However, the significant uncertainty that the NRC identified as to temperatures during the MWP, and which is reflected in the CRU emails and subsequent scientific studies, directly undercuts this line of evidence. Evidence that it is no more than "plausible" that temperatures of the last several decades are the highest in 1000 years can hardly be deemed to be "compelling" evidence that anthropogenic GHGs must be the "root cause" of those recent temperatures.

[60] AR4 Ch. 6 at Executive Summary.

[61] NRC Report at 20-21.

What to Make of the Current 11-Year Trend of No Warming?

According to temperature data on which both EPA and the IPCC rely, the earth has experienced no warming over an 11-year period.[62] This lack of warming undermines EPA's other two proffered lines of evidence – in addition to evidence that the current warming is likely unprecedented in the last 1000 years – for its conclusion that anthropogenic GHG emissions are primarily responsible for changes in the climate.

One of these lines of evidence is EPA's "physical understanding" of the climate system. According to that understanding, GHGs trap heat and, therefore, as GHGs accumulate in the atmosphere, the planet should warm. In fact, according to EPA, in reliance on the IPCC, the planet should warm beyond the level that would be produced as a direct response to the radiative effect of the GHGs themselves, as the IPCC believes that the direct radiative effect should produce indirect positive feedbacks in the atmosphere magnifying the warming significantly.[63]

The other line of evidence is the results of computer simulation models, which of course are based on the modelers' physical understanding of the climate. In conformance with that understanding, the models show that increasing concentrations of GHGs produce warming.[64]

What then to make of the current period of no warming? According to EPA, that lack of warming is produced by natural variability. EPA stated that warming caused by anthropogenic GHG emissions will not necessarily be uniform but instead could be muted by natural forces for a period of a decade or two. In particular, EPA cited two recent studies that attempted to show

[62] Resp. to Comm. Vol. 3 at 3.

[63] TSD at 23-26.

[64] *Id.* at § 6(b).

that the GHG models on which the IPCC, and therefore EPA, relied show sufficient natural variability to accommodate periods of no warming.[65]

Each of these studies has flaws discussed in the body of the Petition that result in an overstating of the likelihood that the models can account for the lack of warming. But even taken at face value, these studies should provide little comfort to EPA. One of the studies found that during the first half of the 21st century, there is a 1 in 10 chance of a zero (or negative) trend in temperatures through 10 years of data. The other study found that for the entire 21st century there is a five percent chance of a zero (or negative) trend through 11 years of data. Given these very low odds, and given that this trend occurred in the first decade of the 21st century and we have already experienced an 11-year trend of no warming, these studies hardly provide reassuring support for the underlying accuracy of the models' long-term predictive capacity.[66]

Adding to the questions about the accuracy of climate models are new results that show water vapor variations in the lower stratosphere play a large role in the variability global temperature trends over scales of several decades—influencing recent trends by some 25% to 30%. The physics governing lower stratospheric water vapor content are quite limited in current climate models, and the observed trends are poorly simulated.[67]

In fact, the CRU emails reveal that the lack of warming has caused leading IPCC scientists to question the assumed physical understanding of the climate system on which the models are based. Just last fall, even after the studies that EPA relied on had been produced, Trenberth conceded that the lack of warming exposes science's basic lack of understanding of

---

[65] Resp. to Comm. Vol. 4 at 23-24.

[66] These studies are discussed more fully in our Petition at section V(B).

[67] Susan Solomon et al., 2010. *Contribution of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming.* SCI (forthcoming 2010) published online at http://www.sciencemag.org/cgi/rapidpdf/science.1182488v1.pdf

the climate system: "***Saying it is natural variability is not an explanation. What are the physical processes? Where did the heat go***?"[68] Trenberth concluded that either the understanding of the climate system reflected in the climate models is wrong:

> ***How come you do not agree with a statement that says we are no where close to knowing where energy is going or whether clouds are changing to make the planet brighter. We are not close to balancing the energy budget. The fact that we can not account for what is happening in the climate system makes any consideration of geoengineering quite hopeless as we will never be able to tell if it is successful or not! It is a travesty***![69]

Or else the data is wrong:

> ***The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't.*** The CERES data published in the August BAMS 09 supplement on 2008 shows there should be even more warming: but the data are surely wrong. Our observing system is inadequate.[70]

Or perhaps both. It is, moreover, particularly relevant that Trenberth stated that "[t]he fact that we can not account for what is happening in the climate system makes any consideration of geoengineering quite hopeless as we will never be able to tell if it is successful or not!" Trenberth's reference to "geoengineering" here includes reducing GHG emissions.[71] In other words, Trenberth stated that the flaws in the climate community's understanding of climatic forces that are exposed by the lack of warming is so fundamental – and the extent of natural variability must be so great – that it cannot be demonstrated that reducing GHG emissions will reduce warming.

---

[68] CRU email 1255523796.txt (Oct. 14, 2009) (emphasis added).

[69] *Id.* (emphasis added).

[70] *Id.* (emphasis added).

[71] Trenberth has publicly (and recently) referred to attempts to "reduce emissions... or reduce the amount of carbon dioxide in the atmosphere" as "geoengineering." *See* Physics Today letter 2/09, at http://www.cgd.ucar.edu/cas/Trenberth/trenberth.papers/GeoengineeringPhsToday.pdf.

Trenberth's statement would seem to eviscerate the grounds for EPA's Endangerment Finding. The purpose and effect of that finding is to trigger regulation mandating GHG reductions to eliminate or at least mitigate the danger. But if, as Trenberth says, the science is too uncertain to determine whether GHG reductions will produce a measurable climate response, there is no basis to regulate and no basis to express confidence that anthropogenic GHG emissions are almost certainly the dominant cause of the warming of the last several decades.

Abject Lack of Transparency

The CRU materials also show a determined effort to stonewall attempts by third parties to obtain basic information underlying the scientific studies that were used in the IPCC reports. A considerable volume of transatlantic email traffic between the CRU scientists and their American counterparts was devoted to figuring out strategies to avoid producing information that could be used to critique their work, even when the information was requested under the American or United Kingdom Freedom of Information Acts ("FOIA").[72]

The emails reveal that these scientists refused to disclose information that would allow their studies to be replicated and critiqued because they saw themselves in a battle with "skeptics" who they considered to be "bozos" and "morons" and perpetrators of fraud.[73] They appeared to be particularly concerned that putting their information in the public domain would expose their work to criticism. As Jones said in one now-famous email, "We have 25 years or so invested in the work. ***Why should I make the data available to you, when your aim is to try and find something wrong with it?***"[74] Jones' view was echoed by Mann. As Jones reported, "Mike

[72] This issue is discussed more fully in our Petition at section VI (C).

[73] CRU email 1146062963.txt (Apr. 26, 2006); CRU email 1147435800.txt (May 12, 2006); CRU email 1107899057.txt. (Feb. 8, 2005).

[74] Email provided by Warwick Hughes to whom the email was sent.

Mann refuses to talk to these people and I can understand why. ***They are just trying to find if we've done anything wrong***."[75]

Indeed, "these people" were trying to find something wrong, and well they should. That's how science should work.

The emails reflecting the stonewalling of attempts to obtain underlying data as discussed in the Petition are not taken out of context and reflect a steady course of conduct over a decade-long period by the same network of scientists who were principally responsible for authoring Chapters 3 and 6 of AR4. The stonewalling was comprehensive – anyone considered to be associated with the "skeptical" camp was refused as much underlying information as possible. Most troubling from the point of view of the transparency of the IPCC process, the stonewalling extended to any information concerning the drafting of AR4, with the scientists taking the position that no country's FOIA governs the work of the IPCC, an international body.[76]

Indeed, concern over communications these scientists had had concerning the drafting of AR4 was so great that they mutually agreed to destroy those communications in order to avoid disclosure under FOIA. Thus, on May 29, 2008, Jones sent an email to Mann under the subject line "IPCC & FOI," asking that Mann delete his emails with Briffa and advising that he would make the same request to Eugene Wahl and Caspar Amman. Wahl and Amman co-authored a paper that attempted to rehabilitate the hockey stick. As shown in the Petition, publication deadlines were improperly manipulated in order to include the paper in AR4.[77] Jones wrote:

> ***Can you delete any emails you may have had with Keith re AR4?*** Keith will do likewise. He's not in at the moment — minor family crisis. ***Can you also email Gene and get him to do the same?*** I

[75] CRU email 1091798809.txt (Aug. 6, 2004) (emphasis added).

[76] *See* the Petition at section VI (D).

[77] *See* the Petition at section VII (D).

> don't have his new email address. We will be getting Caspar to do likewise.[78]

Later in the same thread, Mann responded to Jones that he would "contact Gene about this ASAP."[79] Several months later Jones reported that he had in fact "***deleted loads of emails***."[80] One is forced to wonder what damaging admissions were made in these now-deleted emails concerning how AR4, in fact, was prepared.

After the efforts of these scientists to stonewall data requests were exposed to public scrutiny through FOIA and now through release of the CRU material, many of them were forced to admit that their actions were not in the best interests of science. Wigley told Briffa that "***many *good* scientists appear to be unsympathetic***" to the reasons advanced for the stonewalling.[81] Overpeck wrote in relation to one information request that "***it would be nice if he could have access to all the data that we used—that's the way science is supposed to work.***"[82] And now John Beddington, the British government chief scientific adviser, has recently said, "I think, wherever possible, we should try to ensure there is openness and that source material is available for the whole scientific community."[83]

---

[78] CRU email 1212073451.txt (May 29, 2008) (emphasis added).

[79] CRU email 1212063122.txt (May 29, 2008).

[80] CRU email 1228412429.txt (Dec. 3, 2008) (emphasis added).

[81] CRU email 1254756944.txt (October 5, 2009).

[82] CRU email 1252164302.txt (Sept. 5, 2009) (emphasis added).

[83] *As quoted* in Ben Webster, *Britain's chief scientist John Beddington calls for engagement with climate skeptics,* THE TIMES, Jan. 27, 2010, *available at* http://www.theaustralian.com.au/news/britains-chief-scientist-john-beddington-calls-for-engagement-with-climate-sceptics/story-e6frg6xf-1225823874671.

When the Administrator took office, she properly committed to science that would be "transparent" and conducted "in a fishbowl."[84] This commitment cannot be squared with reliance on IPCC reports that were prepared in such flagrant disregard of those principles.

Improper Editorial and Peer Review Practices in Drafting IPCC Reports

The CRU material reveals a series of improper practices in the drafting of the IPCC reports that confirms that the reports were agenda-driven and not a neutral presentation of science. The report authors rejected inclusion of or dismissed peer-reviewed papers that disagreed with their views, authors simultaneously acted as reviewers, contributing authors were not disclosed, publication deadlines were manipulated to included supporting papers, reviewer comments were rejected based on fabrications of the views of the authors of the relevant literature, and data sources used in unpublished papers that were included in the reports were not made available to reviewers. Perhaps worst of all, scientific conclusions were reached based on secondary material supplied by advocacy groups for the purpose of advancing the policy agendas of the IPCC's authors, conclusions that, perhaps not surprisingly, have now been forced to be retracted.

Publication Abuses

The CRU scientists and their American colleagues engaged in a variety of practices to manipulate the peer-reviewed literature to favor publication of papers that supported their views and to discourage publication of papers that contradicted their views. As Mann told a New York Times reporter, "[a] necessary though not in general sufficient condition for taking a scientific criticism seriously is that it has passed through the legitimate scientific peer review process."[85]

---

[84] January 23, 2009 memorandum to EPA employees.

[85] CRU email 1254259645.txt (Sep. 29, 2009) (emphasis added).

That being the case, these scientists took steps to ensure that "skeptics" did not have access to peer-reviewed literature.[86]

For instance, enraged that the journal Climate Research had published a paper presenting evidence that the MWP was global and as warm as today, these scientists discussed organizing a boycott to strong-arm the journal board into firing the offending editor. Jones wrote that the journal needed to "rid themselves of this troublesome editor."[87] Wholesale changes ensued at the journal.[88] Similar action was taken at Geophysical Research Letters after publication of an offending letter. Mann reported back to his colleagues that the problem had been solved: "[t]he GRL leak has been plugged up with new editorial leadership there,"[89] as if the appearance of a paper that did not support their view of the science was a "leak" in the peer-reviewed journalistic community that had to be "plugged."[90]

One of the most egregious abuses of the peer-reviewed literature occurred after these scientists found out that the International Journal of Climatology intended on publishing a paper by Douglass et al. demonstrating that data do not show the model-projected "fingerprint" of warming in the tropical troposphere.[91] This is a key issue in the Endangerment Finding, and EPA relied on the response of Santer et al. to the Douglass et al paper.[92] But the way in which the Santer et al. paper was produced was a direct violation of the norms that apply to peer-reviewed scientific literature. Santer and his group and others interfered with the editorial

[86] This issue is discussed more fully in our Petition at section VIII(A).

[87] CRU email 1047388489.txt (Mar. 11, 2003).

[88] The threats to boycott the Journal of Climate Research are discussed in our Petition at section VIII(A).

[89] CRU email 1132094873.txt (Nov. 15, 2005).

[90] The Geophysical Research Letters matter is discussed more fully in our Petition at VIII(A).

[91] This issue is discussed more fully in our Petition at section VIII (A)(2).

[92] EPA relied on Karl et al. (2009) (the USGCRP report), and that report in turn relied on the Santer et al. paper on this point.

process for publishing the Douglass et al. paper in order to slow down its publication and to advance the time when Santer et al. could publish a rejoinder. The purpose of this scheme was to ensure that the Santer et al. response was filed at the same time as the Douglass et al paper so that Santer et al. could have the last word, an outcome that these scientists knew was contrary to normal practice. To ensure quick publication of the Santer et al paper, peer reviewers were selected who were Santer's close associates so that the paper would receive a favorable review, again in complete contradiction of normal editorial practice (they discuss "achieving the quick turn-around time by identifying in advance reviewers who are both suitable and available").[93] This scheme was carried out without the knowledge of Douglass et al, and with the emails of the group expressing the need for extreme confidentiality and a concern about leaks, as if in recognition of their total disregard of normal peer-review journal ethics.

Conclusion

Dr. Briffa had it exactly right when he reported to his colleagues that "the needs of the science and the IPCC" "were not always the same." In fact, the IPCC process has been revealed to be as much about advocacy as about science. And the CRU material is only one thin slice of information concerning the drafting of the TAR and AR4. It seems that every day new revelations appear about flaws in the accuracy of the IPCC's conclusions and in the process that was used to select information that would, and would not, be included in the reports.

Given EPA's extensive reliance on the IPCC, particularly on the critical attribution issue, that taint now extends to the Endangerment Finding. EPA has effectively delegated its judgment under section 202(a) of the CAA to an international body that acted contrary to basic U.S. standards of information quality, integrity and transparency. In the interests of good science and

[93] *Id.* (emphasis added).

policy, and as required by law, EPA must now reconsider its Endangerment Finding in light of the CRU revelations. The importance of low-cost, reliable energy to the economy is too high for EPA to begin regulation based on such an uncertain foundation.

Material Submitted by Representative Dana Rohrabacher

House of Commons

Science and Technology Committee

The disclosure of climate data from the Climatic Research Unit at the University of East Anglia

Eighth Report of Session 2009–10

Report, together with formal minutes

Ordered by the House of Commons
to be printed 24 March 2010

HC 387-I
Published on 31 March 2010
by authority of the House of Commons
London: The Stationery Office Limited
£0.00

The Science and Technology Committee

The Science and Technology Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Government Office for Science. Under arrangements agreed by the House on 25 June 2009 the Science and Technology Committee was established on 1 October 2009 with the same membership and Chairman as the former Innovation, Universities, Science and Skills Committee and its proceedings were deemed to have been in respect of the Science and Technology Committee.

Current membership

Mr Phil Willis *(Liberal Democrat, Harrogate and Knaresborough)(Chair)*
Dr Roberta Blackman-Woods *(Labour, City of Durham)*
Mr Tim Boswell *(Conservative, Daventry)*
Mr Ian Cawsey *(Labour, Brigg & Goole)*
Mrs Nadine Dorries *(Conservative, Mid Bedfordshire)*
Dr Evan Harris *(Liberal Democrat, Oxford West & Abingdon)*
Dr Brian Iddon *(Labour, Bolton South East)*
Mr Gordon Marsden *(Labour, Blackpool South)*
Dr Doug Naysmith *(Labour, Bristol North West)*
Dr Bob Spink *(Independent, Castle Point)*
Ian Stewart *(Labour, Eccles)*
Graham Stringer *(Labour, Manchester, Blackley)*
Dr Desmond Turner *(Labour, Brighton Kemptown)*
Mr Rob Wilson *(Conservative, Reading East)*

Powers

The Committee is one of the departmental Select Committees, the powers of which are set out in House of Commons Standing Orders, principally in SO No.152. These are available on the Internet via www.parliament.uk.

Publications

The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at http://www.parliament.uk/science. A list of reports from the Committee in this Parliament is included at the back of this volume.

Committee staff

The current staff of the Committee are: Glenn McKee (Clerk); Richard Ward (Second Clerk); Dr Christopher Tyler (Committee Specialist); Xameerah Malik (Committee Specialist); Andy Boyd (Senior Committee Assistant); Camilla Brace (Committee Assistant); Dilys Tonge (Committee Assistant); Melanie Lee (Committee Assistant); Jim Hudson (Committee Support Assistant); and Becky Jones (Media Officer).

Contacts

All correspondence should be addressed to the Clerk of the Science and Technology Committee, Committee Office, 7 Millbank, London SW1P 3JA. The telephone number for general inquiries is: 020 7219 2793; the Committee's e-mail address is: scitechcom@parliament.uk.

Contents

Report

Summary

The disclosure of climate data from the Climatic Research Unit (CRU) at the University of East Anglia (UEA) in November 2009 had the potential to damage the reputation of the climate science and the scientists involved.

We believe that the focus on CRU and Professor Phil Jones, Director of CRU, in particular, has largely been misplaced. Whilst we are concerned that the disclosed e-mails suggest a blunt refusal to share scientific data and methodologies with others, we can sympathise with Professor Jones, who must have found it frustrating to handle requests for data that he knew—or perceived—were motivated by a desire simply to undermine his work.

In the context of the sharing of data and methodologies, we consider that Professor Jones's actions were in line with common practice in the climate science community. It is not standard practice in climate science to publish the raw data and the computer code in academic papers. However, climate science is a matter of great importance and the quality of the science should be irreproachable. We therefore consider that climate scientists should take steps to make available all the data that support their work (including raw data) and full methodological workings (including the computer codes). Had both been available, many of the problems at UEA could have been avoided.

We are content that the phrases such as "trick" or "hiding the decline" were colloquial terms used in private e-mails and the balance of evidence is that they were not part of a systematic attempt to mislead. Likewise the evidence that we have seen does not suggest that Professor Jones was trying to subvert the peer review process. Academics should not be criticised for making informal comments on academic papers.

In the context of Freedom of Information (FOIA), much of the responsibility should lie with UEA. The disclosed e-mails appear to show a culture of non-disclosure at CRU and instances where information may have been deleted, to avoid disclosure. We found *prima facie* evidence to suggest that the UEA found ways to support the culture at CRU of resisting disclosure of information to climate change sceptics. The failure of UEA to grasp fully the potential damage to CRU and UEA by the non-disclosure of FOIA requests was regrettable. UEA needs to review its policy towards FOIA and re-assess how it can support academics whose expertise in this area is limited.

The Deputy Information Commissioner has given a clear indication that a breach of the Freedom of Information Act 2000 may have occurred but that a prosecution was time-barred; however no investigation has been carried out. In our view it is unsatisfactory to leave the matter unresolved. We conclude that the matter needs to be resolved conclusively—either by the Independent Climate Change Email Review or by the Information Commissioner.

We accept the independence of the Climate Change E-mail Review and recommend that the Review be open and transparent, taking oral evidence and conducting interviews in public wherever possible.

On 22 March UEA announced the Scientific Appraisal Panel to be chaired by Lord

Oxburgh. This Panel should determine whether the work of CRU has been soundly built and it would be premature for us to pre-judge its work.

1 Introduction

1. On Friday 20 November 2009 it was reported across the world that hackers had targeted a "leading climate research unit"[1] and that e-mails from the University of East Anglia's (UEA) Climatic Research Unit (CRU), one of the world's foremost centres of climate science, had been published in the internet.[2] The story of the substantial file of private e-mails, documents and data that had been leaked helped ignite the global warming debate in the run up to the Copenhagen climate change conference in December 2009. As reported by the press, exchanges on the internet alleged that data had been manipulated or deleted, in order to support evidence on global warming.

The Climatic Research Unit at UEA

2. UEA was founded in 1963 and in 1972 UEA established CRU.[3] CRU's website describes the Unit as being "widely recognised as one of the world's leading institutions concerned with the study of natural and anthropogenic [human caused] climate change".[4] CRU has a staff of around thirty research scientists and students.[5] But as we heard in oral evidence, it is in fact "a very small Unit [with only] three full-time members of academic staff".[6]

3. CRU has developed a number of the datasets widely used in climate research, including the global temperature record used to monitor the state of the climate system, as well as statistical software packages and climate models. In its written submission to the inquiry UEA outlined CRU's "pioneering role" in the science of understanding the world's changing climate. CRU's contributions included the compilation of a global land temperature record and the development of increasingly sophisticated methods by which to represent the average temperature of the globe and changes in that average over time.[7] Professor Edward Acton, the Vice-Chancellor of UEA, indicated that he was "immensely proud of what they have done; [as] without them humanity would be vastly less able to understand climate change."[8]

The disclosure of climate data

4. In mid November 2009 it appeared that a server used by CRU had been accessed with 160 MB of data containing more than 1,000 e-mails and 3,000 other documents being

1 "Hackers target leading climate research unit", *BBC News website*, 20 November 2009 news.bbc.co.uk/1/hi/sci/tech/8370282.stm

2 For example: "Hacked E-Mail Is New Fodder for Climate Dispute", *New York Times website*, 21 November 2009 www.nytimes.com/2009/11/21/science/earth/21climate.html?_r=4 and "Hackers leak emails, stoking climate debate", *Sydney Morning Herald website*, 23 November 2009, www.smh.com.au/technology/technology-news/hackers-leak-emails-stoking-climate-debate-20091123-iu6u.html

3 Ev 17, paras 1.2 and 1.5

4 "About the Climatic Research Unit", CRU website, www.cru.uea.ac.uk/cru/about/

5 *As above*

6 Q 92

7 Ev 17, paras 1.5-1.6

8 Q 152

copied.[9] A UEA spokeswoman confirmed that the information was not available on a server that could be easily accessed and could not have been inadvertently released.[10] It is not known exactly when the breach occurred; the RealClimate website, "a commentary site on climate science by working climate scientists for the interested public and journalists",[11] indicated that UEA had been notified of the possible security breach on 17 November.[12] The following was posted anonymously on the climate-sceptic blog, *The Air Vent*:

> November 17, 2009 at 9:57 pm
>
> We feel that climate science is, in the current situation, too important to be kept under wraps.
>
> We hereby release a random selection of correspondence, code, and documents. Hopefully it will give some insight into the science and the people behind it.[13]

From here the debate was "blown wide open".[14] *The Guardian* ran the story on 20 November with the headline: "Climate sceptics claim leaked e-mails are evidence of collusion among scientists".[15]

5. UEA issued a statement on 20 November: "This information has been obtained and published without our permission and we took immediate action to remove the server in question from operation. We are undertaking a thorough internal investigation and we have involved the police in this inquiry."[16] The e-mails contained technical and routine aspects of climate research, including data analysis and details of scientific conferences. The controversy has focused on a small number of e-mails, particularly those sent to, or written by, climatologist Professor Phil Jones, the Director of CRU.

The aftermath

6. Condemnation of alleged malpractices found within the leaked CRU e-mails was quickly disseminated on the internet. Contributors to climate change debate websites and written submissions to us claimed that these e-mails showed a deliberate and systematic attempt by leading climate scientists to manipulate climate data, arbitrarily adjusting and "cherry-picking" data that supported their global warming claims and deleting adverse data that questioned their theories.[17] It was alleged that UEA may not have complied with the requirements of the Freedom of Information Act 2000, that inappropriate statistical methods and defective computer programmes may have been used to analyse data and that

---

9 RealClimate website archive, November 2009, www.realclimate.org/index.php/archives/2009/11/the-cru-hack

10 "Scotland Yard call in to probe climate data leak from UEA in Norwich", *Norwich Evening News*, 1 December 2009

11 RealClimate website 'about' page, www.realclimate.org

12 RealClimate website archive, November 2009, www.realclimate.org/index.php/archives/2009/11/the-cru-hack; the data may have been downloaded on to the RealClimate—see paragraph 12.

13 The Air Vent website, November 2009 archive, noconsensus.wordpress.com/2009/11/page/3/

14 *As above*

15 "Climate sceptics claim leaked emails are evidence of collusion among scientists", *The Guardian*, 20 November 2009

16 "Sceptics publish climate e-mails 'stolen from East Anglia University'", *The Times*, 21 November 2009

17 For examples see Ev 85 [Roger Helmer MEP], Ev 92 [Godfrey Bloom MEP], and Ev 144 [Stephen McIntyre]

CRU may have attempted to abuse the process of peer review to prevent the publication of research papers with conflicting opinions about climate change.[18]

7. In a statement released on 24 November, Professor Trevor Davies, UEA pro-Vice-Chancellor with responsibility for research, rejected calls for Professor Jones's resignation: "We see no reason for Professor Jones to resign and, indeed, we would not accept his resignation. He is a valued and important scientist."[19] He also contested several of the claims of malpractice: "It is well known within the scientific community and particularly those who are sceptical of climate change that over 95% of the raw station data has been accessible through the Global Historical Climatology Network for several years. We are quite clearly not hiding information which seems to be the speculation on some blogs and by some media commentators". He added:

> There is nothing in the stolen material which indicates that peer-reviewed publications by CRU, and others, on the nature of global warming and related climate change are not of the highest-quality of scientific investigation and interpretation. CRU's peer-reviewed publications are consistent with, and have contributed to, the overwhelming scientific consensus that the climate is being strongly influenced by human activity.[20]

8. On 1 December, Professor Jones announced that he would step aside from the Director's role during the course of the independent review.[21]

The independent inquiries set up by UEA

9. On 3 December UEA announced that an independent review—the Independent Climate Change Email Review—into the allegations made against CRU would be carried out by Sir Muir Russell.[22] Professor Acton explained in a letter to us why Sir Muir was chosen to head the review:

> Sir Muir is extremely experienced in public life, has an understanding of the conduct of universities and research, and is entirely independent of any association with this University and with the climate change debate.[23]

10. Alongside the Independent Climate Change E-Mails Review, UEA decided on a separate scientific assessment of CRU's key scientific publications; an external reappraisal of the science itself. The Royal Society agreed to assist UEA in identifying assessors with the requisite experience, standing and independence.[24] UEA announced on 22 March that Lord Oxburgh FRS would "chair an independent Scientific Assessment Panel to examine

---

18 For examples see Ev 90 [Phillip Bratby]; Ev 115 [David Holland], para 2; Ev 144 [Stephen McIntyre]; Ev 194 [Peabody Energy Company], para 24.

19 "Climate scientist at centre of leaked email row dismisses conspiracy claims", *The Guardian*, 24 November 2009

20 UEA, "CRU update 2", 24 November 2009, www.uea.ac.uk/mac/comm/media/press/2009/nov/CRUupdate

21 UEA, "CRU update 3", 1 December 2009, www.uea.ac.uk/mac/comm/media/press/2009/nov/CRUupdate

22 "Sir Muir Russell to head the Independent Review into the allegations against the Climatic Research Unit (CRU)", UEA Press Release, 3 December 2009, www.uea.ac.uk/mac/comm/media/press/2009/dec/CRUreview

23 Ev 16

24 Ev 18, para 2.3

important elements of the published science of the Climatic Research Unit (CRU) at the University of East Anglia".[25]

Our inquiry

11. We were concerned by the press reports and on 1 December 2009 the Chair of the Committee wrote to the Vice-Chancellor of UEA. The letter explained that we took a close interest in academic integrity and the systems in place to ensure the quality of evidence from research and evidence-based policy making. The letter requested a note on the recent events setting out:

a) what had taken place;

b) the steps that had been taken to investigate the allegations and to test the integrity of the data held and used by CRU;

c) how CRU justified its commitment to academic transparency; and

d) how the Vice-Chancellor proposed to restore confidence in CRU and its handling of data.

We also asked for an assurance that none of the data referred to in the e-mails that had been publicised had been destroyed.[26]

12. UEA replied on 10 December 2009. It explained that "a significant amount of material including emails and documents appears to have been accessed illegally from a back-up server in CRU and downloaded in whole, or possibly in part, on to the RealClimate website."[27] This incident was the subject of a police enquiry and the Norfolk Constabulary investigation was expected to take some time. UEA was keen to stress that this "episode is being treated very seriously" and announced that it had set up the independent inquiry, headed by Sir Muir Russell, to investigate the allegations against CRU. UEA said that "none of the adjusted station data referred to in the emails that have been published has been destroyed."[28]

13. In the light of the gravity of the allegations against CRU, the growing weight of damaging press coverage, on-going concerns about the deletion of data and the serious implications for UK science we decided to hold an inquiry into the disclosure of the data at CRU. On 22 January 2010 we therefore announced the inquiry inviting submissions on three key issues:

- What were the implications of the disclosures for the integrity of scientific research?
- Were the terms of reference and scope of the Independent Review announced on 3 December 2009 by UEA adequate?

---

25 "CRU Scientific Assessment Panel announced", UEA Press Release, 22 March 2010, www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAPannounce

26 House of Commons Science and Technology Committee Press Notice 04, 7 December 2009, Session 2009–10

27 Ev 16

28 Ev 17

- How independent were the other two international data sets (see paragraph 23)?

14. If there had been more time available before the end of this Parliament we would have preferred to carry out a wider inquiry into the science of global warming itself. In response to enquiries we issued a statement on 1 February making it clear that the inquiry would focus on the terms of reference announced on 22 January and that this was not an inquiry into global warming.[29]

15. We set a deadline of 10 February for the submission of memoranda and we have received 58 submissions, not including supplementary memoranda. We held one oral evidence session on 1 March, when we took evidence from five panels:

a) Rt Hon Lord Lawson of Blaby, Chairman, and Dr Benny Peiser, Director, Global Warming Policy Foundation;

b) Richard Thomas CBE, former Information Commissioner;

c) Professor Edward Acton, Vice-Chancellor, UEA and Professor Phil Jones, Director of CRU;

d) Sir Muir Russell, Head of the Independent Climate Change E-Mails Review; and

e) Professor John Beddington, Government Chief Scientific Adviser, Professor Julia Slingo OBE, Chief Scientist, Met Office, and Professor Bob Watson, Chief Scientist, Department for Environment, Food and Rural Affairs.

16. We would like to thank everyone who contributed to the inquiry through written submissions or oral evidence. We also received unsolicited copies of a number of books challenging anthropogenic global warming and reviewing events at CRU and the disclosed e-mails.[30]

Our Report

17. In the time left before the end of this Parliament we will not be able to cover all the issues raised by the events at UEA, nor cover all the ground that would be covered by the Independent Climate Change Email Review and the Scientific Appraisal Panel. We have therefore concentrated on what we believe to be key issues. Of central concern is the accuracy and availability of CRU's data, datasets and computer programming, which we address in Chapter 2 of this Report; and related to the data and methodology is the question of access, or the withholding of access, under the Freedom of Information Act 2000 which we cover in Chapter 3. Finally, in Chapter 4 we comment on the independent reviews that UEA has announced.

---

29 House of Commons Science and Technology Committee Press Notice 11, 1 February 2010, Session 2009–10

30 The Committee received the following books:
Christopher Booker, *The Real Global Warming Disaster*, Continuum, 2009
A.W. Montford, *The Hockey Stick Illusion*, Stacey International, 2010
Steven Mosher and Tom Fuller, *Climategate*, St Matthew Publishing, 2010
Ian Plimer, *Heaven and Earth*, Quartet Books Limited, 2009

2 Datasets

Climate science

18. *Climate* is distinct from *weather*: it is the average of weather conditions over a number of years. Climatologists study climates in different parts of the world and for the Earth as a whole. CRU, according to its website: "has developed a number of the data sets widely used in climate research, including the global temperature record used to monitor the state of the climate system, as well as statistical software packages and climate models".[31]

19. The process of calculating the Earth's average global temperatures (past, present and future) is complicated and lengthy. Data from thousands of weather stations all around the world, on land and at sea, must he collected, checked for quality, adjusted for inconsistencies and error margins, and then mapped onto a series of grids on the Earth's surface. The methods, results and conclusions are then presented to the academic world, first by passing the peer review process prior to publication, and second, after presentation, the scrutiny of the wider academic community.

20. Climate science, like any other science, uses the scientific method to make its assessments of past and present climate and predictions about the future climate. The key characteristics of the scientific method can be described as: characterisations, hypotheses, predictions, and experiments.

- Characterisations: consideration of a problem, and examination of whether or not an explanation exists for it.
- Hypotheses: if no such explanation exists, a new explanation is stated.
- Predictions: what consequences follow from a new explanation?
- Experiments: is the outcome consistent with the predicted consequences?

Each of these is subject to peer review prior to the formal sharing of knowledge through publication. Through peer review scientists allow their views and methods to be critically appraised expertly and externally.

- Replication and verification

To have the results and conclusions survive criticism or scepticism and be part of the accepted canon of scientific knowledge, most experiments will have to be demonstrably replicable (by the same group) to pass peer review and will often need to be verified by other independent researchers taking similar approaches.

21. Therefore climatologists are, like other scientists, required to test their theories—such as global warming and the causes of warming—against observational data. They must also replicate and verify their experiments, by holding independent datasets and conducting independent analyses of these datasets, and by publishing their full methods and results for

31 www.cru.uea.ac.uk/cru/about

scrutiny. Ultimately, these ideas are put up to the threat of falsification by other scientists working in the field.

22. In this Chapter we discuss some aspects of this process.

Context

23. There are three main international climate datasets, which have been built up from direct temperature measurements on land and sea at weather stations all around the world:

a) the National Climatic Data Center (NCDC) of the National Oceanographic and Atmospheric Administration (NOAA) in Asheville, North Carolina, USA;

b) the Goddard Institute of Space Studies (GISS), part of the National Aeronautic and Space Administration (NASA) in New York, USA; and

c) CRUTEM3, at CRU, UEA.[32]

24. In addition, there are two others, one in Russia and one in Japan, that use similar methods.[33] There are also two that use satellite observations, by the University of Alabama at Huntsville and by Remote Sensing Systems, California.[34]

25. Professor Jones, commenting on the different climate research groups around the world in the UK, US, Russia and Japan,[35] told us that:

> we are all working independently so we may be using a lot of common data but the way of going from the raw data to a derived product of gridded temperatures and then the average for the hemisphere and the globe is totally independent between the different groups.[36]

26. What sets the CRU dataset apart is its comprehensiveness:

> The CRU dataset, which forms the land surface component of the HadCRUT global temperature record, was compiled with the aim of comprehensiveness. The majority of the data in it are derived from the same freely-available raw data sets used by NOAA and NASA. However, it also includes data derived from station data that were obtained directly from countries, institutions and scientists on the understanding that they would not be passed on.[37]

Complaints and accusations

27. The complaints and accusations made against CRU in relation to the scientific process come under two broad headings. The first is transparency: that CRU failed to abide by best

32 Ev 21, para 4.2

33 Q 78

34 Ev 104 [D.R. Keiller], para 2

35 Q 79

36 Q 80

37 Ev 64 [John Beddington and Julia Slingo]

scientific practice by refusing to share its raw data and detailed methods. The second is honesty: that CRU has deliberately misrepresented the data, in order to produce results that fit its preconceived views about the anthropogenic warming of the climate. We take each of these complaints and accusations in turn.

Transparency

Raw data

28. Warwick Hughes, a "freelance earth scientist from Australia",[38] had asked Professor Jones for CRU's raw data. He received the following reply:

> I should warn you that some data we have we are not supposed [to] pass on to others. We can pass on the gridded data—which we do. Even if WMO [World Meteorological Organization] agrees, I will still not pass on the data. We have 25 or so years invested in the work. Why should I make the data available to you, when your aim is to try and find something wrong with it.[39]

29. On the face of it, this looks like an unreasonable response to a reasonable request. As Lord Lawson put it: "Ask any decent scientist and they will say the keystone for integrity in scientific research is full and transparent disclosure of data and methods".[40] However, Professor Jones, while confessing that he has sent some "awful" e-mails,[41] defended his position.

30. First, in answer to the question of whether the raw data are accessible and verifiable, Professor Jones told us that:

> The simple answer is yes, most of the same basic data are available in the United States in something called the Global Historical Climatology Network. They have been downloadable there for a number of years so people have been able to take the data, do whatever method of assessment of the quality of the data and derive their own gridded product and compare that with other workers.[42]

31. In addition, of course, there are the sources of the data, the weather stations, to which any individual is free to go and collect the data in the same way that CRU did. This is feasible because the list of stations that CRU used was published in 2008.[43]

32. Even if CRU had wanted to, it would have been unable to publish all of these data because, as Professor Acton explained, some of the data are bound by commercial agreements with different national meteorological organisations:

---

38 www.warwickhughes.com

39 Ev 158, Appendix 1

40 Q 9

41 Q 103

42 Q 78

43 Q 98

> Unfortunately, several of these countries impose conditions and say you are not allowed to pass [on the data]. Seven countries have said "No, you cannot", half the countries have not yet answered, Canada and Poland are amongst those who have said, "No you cannot publish it" and also Sweden. Russia is very hesitant. We are under a commercial promise, as it were, not to; we are longing to publish it because what science needs is the most openness.[44]

(The issue with Sweden has since been resolved. The Swedish Meteorological and Hydrological Institute gave permission for CRU to publish its Swedish data on the UEA website on 8 March 2010.[45])

33. Second, as UEA explained in its submission, it is:

> sometimes necessary to adjust temperature data because changes in station location, instrument or observation time, or in the methods used to calculate monthly average temperatures can introduce false trends. These have to be removed or adjusted, or else the overall series of values will be incorrect. In the early 1980s, CRU painstakingly examined the long-term homogeneity of each station temperature series which it acquired. As a result, data were adjusted for about 11% of the sites, that is approximately 314 sites out of a then-total of some 3,276. This was in complete accordance with standard practice, and all adjustments were documented.[46]

34. Professor Jones added, when he gave oral evidence:

> It is all documented [...] what [adjustments we made to the data] in the 1980s and since then we have obviously added more station data as more has become available, as countries have digitised more data; we have added that in and we have reported on that in our peer review publications in 2003 and 2006.[47]

35. These kinds of adjustments to raw data take a lot of time. That is why, in the words of Professor Jones, "Most scientists do not want to deal with the raw station data, they would rather deal with a derived product".[48]

36. A third point was made by Professor Acton that CRU should not be under any obligation to provide raw data:

> May I also point out that it is not a national archive, it is not a library, it is a research unit. It has no special duty to conserve and its data is the copy of data provided by over 150 countries, whose national meteorological stations turn the data into the average for a month.[49]

---

44 Q 94

45 Ev 39, para 8

46 Ev 18, para 3.4

47 Q 81

48 Q 107

49 Q 92

37. CRU's refusal to release the raw data gave some the impression that it was deliberately keeping its work private so that its studies could not "be replicated and critiqued".[50] The Peabody Energy Company said of CRU that "they appeared to be particularly concerned that putting their information in the public domain would expose their work to criticism".[51] Even an effort to conduct a simple quality check was said to be thwarted by CRU's unwillingness to share the data it had used.[52] In contrast, NASA has been able to make all its raw data available as well as its programmes.[53]

38. **We recognise that some of the e-mails suggest a blunt refusal to share data, even unrestricted data, with others. We acknowledge that Professor Jones must have found it frustrating to handle requests for data that he knew—or perceived—were motivated by a desire simply to seek to undermine his work. But Professor Jones's failure to handle helpfully requests for data in a field as important and controversial as climate science was bound to be viewed with suspicion. He was obviously frustrated by other workers in the field trying to "undermine" his work, but his actions were inevitably counterproductive. Professor Jones told us that the published e-mails represented only "one tenth of 1%" of his output, which amounts to one million e-mails, and that we were only seeing the end of a protracted series of e-mail exchanges. We consider that further suspicion could have been allayed by releasing all the e-mails. In addition, we consider that had the available raw data been available online from an early stage, these kinds of unfortunate e-mail exchanges would not have occurred. In our view, CRU should have been more open with its raw data and followed the more open approach of NASA to making data available.**

39. **We are not in a position to set out any further the extent, if any, to which CRU should have made the data available in the interests of transparency, and we hope that the Independent Climate Change Email Review will reach specific conclusions on this point. However, transparency and accountability are of are increasing importance to the public, so we recommend that the Government reviews the rules for the accessibility of data sets collected and analysed with UK public money.**

Methods

40. The Royal Society of Chemistry in its submission made it clear that:

> It is essential that the public and all non-specialists remain truly confident in the scientific method to provide a sound scientific evidence-base on which strong decisions can be made.[54]

There have been criticisms that Professor Jones and colleagues have not shared their methodologies. Andrew Montford, author of *The Hockey Stick Illusion*,[55] pointed out in his memorandum that:

---

50 Ev 194 [Peabody Energy Company], para 20

51 *As above*

52 Ev 152 [Steven Mosher], para 8

53 Q 150 [Professor Jones]

54 Ev 170, summary

> The scientific method demands that findings be subject to testing and verification by others. The refusal of CRU scientists to release information to those who they felt might question or threaten their findings have led many to conclude that the CRU's work is not trustworthy.[56]

41. Professor Jones contested these claims. According to him, "The methods are published in the scientific papers; they are relatively simple and there is nothing that is rocket science in them".[57] He also noted: "We have made all the adjustments we have made to the data available in these reports[58]; they are 25 years old now".[59] He added that the programme that produced the global temperature average had been available from the Met Office since December 2009.[60]

42. On this basis, he argued, it was unnecessary to provide the exact codes that he used to produce the CRUTEM3 chart. The Met Office had released its code and it produced exactly the same result.[61]

43. In answer to the charge that the computer codes that were stolen from CRU's computer network were defective,[62] Professor Jones pointed out that:

> Those codes are from a much earlier time, they are from the period about 2000 to 2004. [They] do not relate to the production of the global and hemispheric temperature series. They are nothing to do with that, they are to do with a different project [...] that was funded by the British Atmospheric Data Centre, which is run by NERC, and that was to produce more gridded temperature data and precipitation data and other variables. A lot of that has been released on a Dutch website and also the BADC website.[63]

44. CRU's alleged refusal to disclose its assumptions and methodologies gave credence to the view that exposure to "independent scrutiny would have undermined the AGW [anthropogenic global warming] hypothesis".[64] However, the failure to publish the computer code for CRUTEM3 left CRU vulnerable when concerns emerged that other codes it used had faults. John Graham-Cumming, a professional computer programmer, told us that:

---

55 Andrew Montford, *The Hockey Stick Illusion: Climategate and the corruption of science*, Stacey International, 2010

56 Ev 159, para 4

57 Q 92

58 Raymond Bradley, Mick Kelly, Phil Jones and others, *A Climatic Data Bank for Northern Hemisphere Land Areas, 1851-1980*, US DoE, Technical Report TRO17, 1985, p 335; Phil Jones, Sarah Raper, Ben Santer, and others, *A Grid Point Surface Air Temperature Data Set for the Northern Hemisphere*, DoE Technical Report No. TR022, US Department of Energy, 1985, p 251; Phil Jones, Sarah Raper, Claire Goodess, and others, *A Grid Point Surface Air Temperature Data Set for the Southern Hemisphere, 1851-1984*, DoE Technical Report No. TR027, US Department of Energy, 1986, 73

59 Q 97

60 *As above*

61 Qq 139-42

62 Ev 32, Q 137; Ev 196 [John Graham-Cumming]

63 Qq 137-38

64 Ev 94 [Clive Menzies], para 1.5

> the organization writing the [other] code did not adhere to standards one might find in professional software engineering. The code had easily identified bugs, no visible test mechanism, was not apparently under version control and was poorly documented. It would not be surprising to find that other code written at the same organization was of similar quality. And given that I subsequently found a bug in the actual CRUTEM3 code only reinforces my opinion.[65]

45. The conspiracy claims were fuelled by CRU's refusal to share the most detailed aspects of its methodologies, for example, the computer codes for producing global temperature averages. **We note that the research passed the peer review process of some highly reputable journals. However, we note that CRU could have been more open at that time in providing the detailed methodological working on its website. We recommend that all publicly funded research groups consider whether they are being as open as they can be, and ought to be, with the details of their methodologies.**

Repeatability and verification

46. These complaints and concerns surrounding transparency cut to the heart of the scientific process. It has been argued that without access to the raw data and detailed methodology it is not possible to check the results of CRU's work. The Institute of Physics pointed out that:

> Published reconstructions may represent only a part of the raw data available and may be sensitive to the choices made and the statistical techniques used. Different choices, omissions or statistical processes may lead to different conclusions. This possibility was evidently the reason behind some of the (rejected) requests for further information.[66]

47. This has substance if one considers CRU's work in isolation. But science is more than individual researchers or research groups. One should put research in context and ask the question: what would one hope to find by double checking the processing of the raw data? If this were the only dataset in existence, and Professor Jones's team had been the only team in the world to analyse it, then it might make sense to double check independently the processing of the raw data and the methods. But there are other datasets and other analyses that have been carried out as Professor Jones explained:

> There are two groups in America that we [CRU] compare with and there are also two additional groups, one in Russia and one in Japan, that also produce similar records to ourselves and they all show pretty much the same sort of course of instrumental temperature change since the nineteenth century compared to today.[67]
>
> [...] we are all working independently so we may be using a lot of common data but the way of going from the raw data to a derived product of gridded temperatures and

65 Ev 196

66 Ev 167, para 4

67 Q 78

> then the average for the hemisphere and the globe is totally independent between the different groups.[68]

48. In its memorandum UEA explained the differences between the methodologies used by three basic datasets for land areas of the world, NOAA, NASA and CRU/UEA:

> All these datasets rely on primary observations recorded by NMSs [National Meteorological Services] across the globe.[69]
>
> GISS[70] and NCDC[71] each use at least 7,200 stations. CRUTEM3 uses fewer. In CRUTEM3, each monthly temperature value is expressed as a departure from the average for the base period 1961–90. This "anomaly method" of expressing temperature records demands an adequate amount of data for the base period; this limitation reduces the number of stations used by CRUTEM3 to 4,348 (from the dataset total of 5,121). The latest NCDC analysis [...] has now moved to the "anomaly method" though with different refinements from those of CRU.[72]
>
> NCDC and GISS use different approaches to the problem of "absolute temperature" from those of CRUTEM3. The homogeneity procedures undertaken by GISS and NCDC are completely different from those adopted for CRUTEM3. NCDC has an automated adjustment procedure [...], whilst GISS additionally makes allowances for urbanization effects at some stations.[73]

49. In our call for evidence we asked for submissions on the question of how independent the other international data sets are. We have established to the extent that a limited inquiry of this nature can, that the NCDC/NOAA and GISS/NASA data sets measuring temperature changes on land and at sea have arrived at similar conclusions using similar data to that used by CRU, but using independently devised methodologies. We have further identified that there are two other data sets (University of Alabama and Remote Sensing Systems), using satellite observations that use entirely different data than that used by CRU. These also confirm the findings of the CRU work. **We therefore conclude that there is independent verification, through the use of other methodologies and other sources of data, of the results and conclusions of the Climate Research Unit at the University of East Anglia.**

50. The fact that all the datasets show broadly the same sort of course of instrumental temperature change since the nineteenth century compared to today was why Professor John Beddington, the Government Chief Scientific Adviser, had the confidence to say that

---

68 Q 80

69 Ev 21, para 4.3

70 Dataset held by the Goddard Institute for Space Studies (GISS, USA) part of the National Aeronautic and Space Administration (NASA)

71 Global Historical Climatology Network (GHCN) dataset held by National Climatic Data Center (NCDC), the National Oceanographic and Atmospheric Administration (NOAA, USA)

72 Ev 21, para 4.4

73 Ev 21, para 4.5

human induced global warming was, in terms of the evidence to support that hypothesis, "unchallengeable":[74]

> I think in terms of datasets, of the way in which data is analysed, there will always be some degree of uncertainty but when you get a series of fundamentally different analyses on the basic data and they come up with similar conclusions, you get a [...] great deal of certainty coming out of it.[75]

51. **Even if the data that CRU used were not publicly available—which they mostly are—or the methods not published—which they have been—its published results would still be credible: the results from CRU agree with those drawn from other international data sets; in other words, the analyses have been repeated and the conclusions have been verified.**

52. That is probably part of why it has not been practice in the climate science community to publish all the data and computer codes with the academic papers. We got to the crux of the issue during an interesting exchange with Professor Jones:

> **Graham Stringer:** You are saying that every paper that you have produced, the computer programmes, the weather stations, all the information, the codes, have been available to scientists so that they could test out how good your work was. Is that the case on all the papers you have produced?
>
> ***Professor Jones:*** That is not the case.
>
> **Graham Stringer:** Why is it not?
>
> ***Professor Jones:*** Because it has not been standard practice to do that.
>
> **Graham Stringer:** That takes me back to the original point, that if it is not standard practice how can the science progress?
>
> ***Professor Jones:*** Maybe it should be standard practice but it is not standard practice across the subject.[76]

53. Another reason why data and the codes were not published may be that norms for publication evolved in a period when the journals were only published in hard copy. In such circumstances it is understandable why an editor would not want to publish raw climate data (extremely long lists of numbers) and code for the computer programmes that analyse the data (which run to hundreds of thousands of lines of code). However, in the age of the internet, these kinds of products can be made available more easily, and we are minded to agree with Professor Jones observation on this point that: "Maybe it should be standard practice".[77]

---

74 Q 191

75 Qq 191–92

76 Qq 100-02

77 Q 102

54. **It is not standard practice in climate science and many other fields to publish the raw data and the computer code in academic papers. We think that this is problematic because climate science is a matter of global importance and of public interest, and therefore the quality and transparency of the science should be irreproachable. We therefore consider that climate scientists should take steps to make available all the data used to generate their published work, including raw data; and it should also be made clear and referenced where data has been used but, because of commercial or national security reasons is not available. Scientists are also, under Freedom of Information laws and under the rules of normal scientific conduct, entitled to withhold data which is due to be published under the peer-review process.[78] In addition, scientists should take steps to make available in full their methodological workings, including the computer codes. Data and methodological workings should be provided via the internet. There should be enough information published to allow verification.**

Dishonesty

55. Of all the e-mails released, one dated 16 November 1999 has caused particular concern:

> I've just completed Mike's Nature trick of adding in the real temps to each series for the last 20 years (ie from 1981 onwards) amd [*sic*] from 1961 for Keith's to hide the decline.[79]

56. The word "trick" and the phrase "hide the decline" have been taken by some to demonstrate intent on the part of Professor Jones to "falsify data" and to "exaggerate warming".[80]

"Trick"

57. In his submission, Peter Taylor, author of *Chill*,[81] states that:

> The tree ring data did not match the model expectation (ie the 'hockey stick' pattern of a sudden rise at the end of the period). Rather than admit this, the team-workers discuss using Michael Mann's 'trick' of replacing the offending tree-ring data and using instrumental data in its place in a spliced graph.[82]

58. UEA interpreted the use of the word "trick" differently:

> as for the (now notorious) word 'trick', so deeply appealing to the media, this has been richly misinterpreted and quoted out of context. It was used in an informal email, discussing the difficulties of statistical presentation. It does not mean a 'ruse' or method of deception. In context it is obvious that it is used in the informal sense

---

78 See paragraph 78 and following; section 22 of the FOIA provides an exemption from disclosure where the requested information is intended for future (but imminent) publication.

79 E-mail from Phil Jones to Ray Bradley, 16 November 1999

80 Ev 93 [Godfrey Bloom MEP], para 4

81 Peter Taylor, *Chill, A Reassessment of Global Warming Theory: Does Climate Change Mean the World is Cooling, and If So What Should We Do About It?*, Clairview Books, 2009

82 Ev 188, para 22

> of 'the best way of doing something'. In this case it was 'the trick or knack' of constructing a statistical illustration which would combine the most reliable proxy and instrumental evidence of temperature trends.[83]

59. These interpretations of the colloquial meaning of "trick" have been accepted by even the staunchest of critics:

> ***Lord Lawson of Blaby:*** The sinister thing is not the word 'trick'. In their [UEA's] own evidence they say that what they mean by 'trick' is the best way of doing something.
>
> **Chairman:** You accept that?
>
> ***Lord Lawson of Blaby:*** I accept that.[84]

60. **Critics of CRU have suggested that Professor Jones's use of the word "trick" is evidence that he was part of a conspiracy to hide evidence that did not fit his view that recent global warming is predominately caused by human activity. The balance of evidence patently fails to support this view. It appears to be a colloquialism for a "neat" method of handling data.**

"Hide the decline"

61. Lord Lawson did, however, describe CRU's treatment of the data as "reprehensible",[85] because, in his view, Professor Jones deliberately hid data that demonstrated a decline in temperatures.[86]

62. The data that he believed to be "hidden" are a set of tree ring data that disagree with other data sources regarding temperature trends. Lord Lawson said: "when the proxy series [...] departed from the measured temperature series, a normal person will say maybe that means the proxy series is not all that reliable".[87] In that context he made two specific claims:

- that the tree ring data were flawed because "for a long period before 1421 they relied on one single pine tree";[88] and
- that the divergence problem was not just for data after the 1960s, "it is not a good fit in the latter half of the nineteenth century either".[89]

63. It is outside the remit of the terms of reference of this inquiry to make a detailed assessment of the science, but it is worth noting that Professor Jones had a very different perspective. On the first point, he commented:

---

83 Ev 19, para 3.5.6

84 Qq 25–26

85 Q 26

86 Qq 26–28

87 Q 26

88 *As above*

89 Q 28

> That particular reconstruction went back to 1400, or just after 1400, and that is because there are insufficient trees to go back before that, there are more than just one. We have criteria to determine how far you can go back in terms of the number of trees you have at a certain number of sites.[90]

64. On the second point, he told us:

> One of the curves was based on tree ring data which showed a very good relationship between the tree rings and the temperature from the latter part of the nineteenth century through to 1960, and after that there was a divergence where the trees did not go up as much as the real temperatures had.[91]

65. Professor Jones has published on this issue on several occasions, including a 1998 *Nature* paper[92] and subsequent papers.[93] He contested the view that he was trying to hide the decline in the sense that he was trying to pretend that these data did not exist and thereby exaggerate global warming: "We do not accept it was hidden because it was discussed in a paper[94] the year before and we have discussed it in every paper we have written on tree rings and climate".[95] Rather, what was meant by "hide the decline" was remove the effects of data known to be problematic in the sense that the data were known to be misleading. UEA made it clear in its written submission that:

> CRU never sought to disguise this specific type of tree-ring "decline or divergence". On the contrary, CRU has published a number of pioneering articles that illustrate, suggest reasons for, and discuss the implications of this interesting phenomenon.[96]

66. **Critics of CRU have suggested that Professor Jones's use of the words "hide the decline" is evidence that he was part of a conspiracy to hide evidence that did not fit his view that recent global warming is predominantly caused by human activity. That he has published papers—including a paper in *Nature*—dealing with this aspect of the science clearly refutes this allegation. In our view, it was shorthand for the practice of discarding data known to be erroneous. We expect that this is a matter the Scientific Appraisal Panel will address.**

Perverting the peer review process

67. The main allegations on the suppression or distortion of others' findings concern the role of CRU in the operation of the peer review process. It has been alleged that scientists at CRU abused the peer review process to prevent those with dissenting views on climate change the opportunity in getting papers published. There are three key accusations. First,

---

90 Q 125

91 Q 122

92 Q 122; Keith Briffa and others, "Reduced sensitivity of recent tree-growth to temperature at high northern latitudes", *Nature*, vol 391 (1998), pp 678-82

93 For example: Edward Cook, Paul Krusic and Phil Jones, "Dendroclimatic signals in long tree-ring chronologies from the Himalayas of Nepal", *International Journal of Climatology*, Vol 23 (2003), pp 707-32

94 Keith Briffa and others, "Trees tell of past climates: but are they speaking less clearly today?", *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences*, vol 353 (1998), pp 65-73

95 Q 124

96 Ev 19, para 3.5.5

David Holland, an author of several FOIA requests that were mentioned in the leaked e-mails, claimed that climate scientists at CRU corrupted the IPCC process:

> The emails show that a group of influential climate scientists colluded to subvert the peer-review process of the IPCC and science journals, and thereby delay or prevent the publication and assessment of research by scientists who disagreed with the group's conclusions about global warming. They manufactured pre-determined conclusions through the corruption of the IPCC process and deleted procedural and other information hoping to avoid its disclosure under freedom-of-information requests.[97]

68. In one e-mail, Professor Jones appeared to suggest that he and another scientist would deliberately try to "keep out" two papers from the IPCC's Fourth Assessment Report.[98]

> From: Phil Jones <p.jones@xxxxxxxxx.xxx>
> To: "Michael E. Mann" <mann@xxxxxxxxx.xxx>
> Subject: HIGHLY CONFIDENTIAL
> Date: Thu Jul 8 16:30:16 2004
>
> Mike,
>
> Only have it in the pdf form. FYI ONLY - don't pass on. Relevant paras are the last
>
> 2 in section 4 on p13. As I said it is worded carefully due to Adrian knowing Eugenia for years. He knows the're wrong, but he succumbed to her almost pleading with him to tone it down as it might affect her proposals in the future !
>
> I didn't say any of this, so be careful how you use it - if at all. Keep quiet also that you have the pdf. The attachment is a very good paper - I've been pushing Adrian over the last weeks to get it submitted to JGR or J. Climate. The main results are great for CRU and also for ERA-40. The basic message is clear - you have to put enough surface and sonde obs into a model to produce Reanalyses. The jumps when the data input change stand out so clearly. NCEP does many odd things also around sea ice and over snow and ice. The other paper by MM is just garbage - as you knew. De Freitas 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 !

69. The second is that climate scientists tried to suppress a paper on research fraud. As Dr Benny Peiser, Director of the Global Warming Policy Foundation, put it:

> The CRU e-mails under investigation suggest that climate scientists (not only at CRU but also elsewhere) have actively sought to prevent a paper on alleged research fraud from being published in violation of principles of academic integrity.[99]

70. The third allegation is made by Dr Sonja Boehmer-Christiansen, a former peer reviewer for the IPCC, editor of the journal, *Energy & Environment*, and Reader Emeritus

97 Ev 115, para 2

98 www.eastangliaemails.com

99 Ev 164, para 2

at Hull University, who stated in her memorandum that her journal became the focus of attacks from CRU scientists:

> As editor of a journal which remained open to scientists who challenged the orthodoxy, I became the target of a number of CRU manoeuvres. The hacked emails revealed attempts to manipulate peer review to E&E's disadvantage, and showed that libel threats were considered against its editorial team. Dr Jones even tried to put pressure on my university department. The emailers expressed anger over my publication of several papers that questioned the 'hockey stick' graph and the reliability of CRU temperature data. The desire to control the peer review process in their favour is expressed several times. [...] CRU clearly disliked my journal and believed that "good" climate scientists do not read it.[100]

71. When we asked Professor Jones about these accusations, he contested each of them.

- On the claim that he tried to keep two papers out of the IPCC report, he explained that the papers were already published and that "I was just commenting that I did not think those papers were very good".[101]
- On the claim by he tried to suppress papers that alleged research fraud, he told us:

> Dr Benny Peiser [...] was editing a series of papers in *Energy & Environment*. He asked me to comment on a particular paper and I sent him some views back that I did not think the paper was very good. It was not a formal review, he was just asking me for my views.[102]

- On the claims made by Dr Boehmer-Christiansen, he noted: "I was sending an email to the head of department about a complaint that she had made about me to the UK Climate Impacts Programme, so I was just responding there".[103]

72. In summary, Professor Jones argued:

> I do not think there is anything in those emails that really supports any view that I or CRU have been trying to pervert the peer review process in any way. I have just been giving my views on specific papers.[104]

73. **The evidence that we have seen does not suggest that Professor Jones was trying to subvert the peer review process. Academics should not be criticised for making informal comments on academic papers. The Independent Climate Change Email Review should look in detail at all of these claims.**

---

100 Ev 125, paras 4.1–4.3

101 Q 154

102 Q 157

103 *As above*

104 Q 159

3 Freedom of information issues

74. We are not a tribunal reviewing whether breaches of the Freedom of Information Act 2000 (FOIA) have taken place but see as our role in this inquiry as considering whether:

(a) the arrangements for examining whether CRU breached FOIA are adequate;

(b) whether the six-month time limit on the initiation of a prosecution where a public authority acts so as to prevent intentionally the disclosure of requested information needs to be revised; and

(c) whether UEA ensured that CRU was able to meet the requirements of the legislation when it received FOIA requests.

Freedom of Information legislation

75. The FOIA creating new rights of access to information came into operation on 1 January 2005. CRU, as part of UEA, is classed as a "public authority" for the purposes of the FOIA. In his submission Richard Thomas, who was Information Commissioner from 2002 until June 2009, explained the application of the FOIA to scientific data held by UK universities:

> the public must be satisfied that publicly-funded universities, as with any other public authority in receipt of public funding, are properly accountable, adopt systems of good governance and can inspire public trust and confidence in their work and operations [...] The fact that the FOIA requests relate to complex scientific data does not detract from this proposition or excuse non-compliance.[105]

76. When he gave oral evidence, we asked Mr Thomas if the legislation drew a distinction between, on the one hand, scientific data and modelling and, on the other hand, administrative records. He replied:

> the broad answer [...] is no [...] First of all, the legislation applies to information held by the public authority, and information is not elaborated in that sense. [...] It is not ownership. The legislation uses the word "held", and in the Environmental Information Regulations [EIR] that phrase "held" is slightly elaborated. If I can quote the regulation for you there, "It is held by a public authority if the information: (a) is in the authority's possession and has been produced or received by the authority, or (b) is held by another person on behalf of the authority." So that is an elaboration of the concept of "held". It is not ownership.[106]

77. Mr Thomas considered that the issues in this case which were most relevant to the information law appeared to be:

(a) the relevance and impact of the information laws on scientific and academic research conducted within universities;

105 Ev 8, para 3.2

106 Qq 59–60

(b) the adequacy of section 77 of FOIA to deal with suggestions that CRU researchers deleted information, not in the course of normal work, but to frustrate FOIA/EIR[107] requests;

(c) the handling of a large number of FOIA/EIR requests by UEA relating especially to climate change research which (within CRU) it "held"; and

(d) whether this case illustrates that there is scope to extend the "proactive" disclosure provisions of FOIA as they relate to universities.[108]

78. Parliament has created a presumption in favour of disclosure but there are exclusions.[109] Mr Thomas explained:

> There are over 20 exemptions to the fundamental duty to disclose requested information in FOIA.[...] Eight of the main exemptions are absolute and 16 are qualified. Qualified means that there is a "public interest override," which means that, even where the exemption applies, the public interest considerations must be considered. In formal terms, there must still be disclosure—even though the qualified exemption applies—unless the public interest in the exemption outweighs the public interest in disclosure.

Mr Thomas added that:

> The exemptions are similar to those found in other Freedom of Information laws in force in the world. I am not aware which exemptions were considered by the University as potentially applicable to some or all of the requests to CRU. I can speculate that some or all of the following [...] might have been considered:
>
> (a) Section 22—where the requested information is intended for future (but imminent) publication;
>
> (b) Section 40—where disclosure of personal data would breach any of the data protection principles;
>
> (c) Section 41—where the information had been obtained from elsewhere in such circumstances that its disclosure would constitute an actionable breach of confidence under common law;
>
> (d) Section 43 (qualified)—where disclosure would, or would be likely to, prejudice the commercial interests of any person, including the public authority;
>
> (e) Section 44—where disclosure is prohibited by another enactment or inconsistent with an EU obligation (which may include some intellectual property restrictions); and

---

107 EIR: Environmental Information Regulations 2004. Deriving from European Directive 2003/4/EC these give rights of public access to environmental information held by public authorities.

108 Ev 8, para 2.2

109 Ev 9, para 3.6

(f) Section 14 (not an exemption, strictly speaking)—where the request is vexatious.[110]

79. We were grateful to Mr Thomas for explaining the operation of the FOIA and EIR. He did, however, point out that he did not have detailed knowledge of events at UEA since leaving the Information Commissioner's Office:

> I have no idea at all what has happened inside my former office. I cannot say because this is a serious matter. It depends a great deal on the circumstances of the particular case, the evidence. I have had no direct contact with the office as to how this case is being handled.[111]

Alleged breaches of the Freedom of Information Act 2000

The e-mails

80. Some of the hacked e-mails appear to reveal scientists encouraging their colleagues to resist disclosure and to delete e-mails, apparently to prevent them from being revealed to people making FOIA requests. Below are examples, in chronological order, of e-mails sent by Professor Jones which address FOIA and requests for information.

E-mail: 1107454306 [Extract]
At 09:41 AM 2/2/2005, Phil Jones wrote:
Mike,[...]Just sent loads of station data to Scott. Make sure he documents everything better this time! And don't leave stuff lying around on ftp sites - you never know who is trawling them. The two MMs have been after the CRU station data for years. If they ever hear there is a Freedom of Information Act now in the UK, I think I'll delete the file rather than send to anyone. Does your similar act in the US force you to respond to enquiries within 20 days? - our does ! The UK works on precedents, so the first request will test it. We also have a data protection act, which I will hide behind. Tom Wigley has sent me a worried email when he heard about it - thought people could ask him for his model code. He has retired officially from UEA so he can hide behind that. IPR should be relevant here, but I can see me getting into an argument with someone at UEA who'll say we must adhere to it !. [...]

E-mail: 1219239172 [Extract]
From: Phil Jones <p.jones@xxxxxxxxx.xxx>
To: Gavin Schmidt <gschmidt@xxxxxxxxx.xxx>
Subject: Re: Revised version the Wengen paper
Date: Wed Aug 20 09:32:52 2008

[...] Keith/Tim still getting FOI requests as well as MOHC and Reading. All our FOI officers have been in discussions and are now using the same exceptions not to respond - advice they got from the Information Commissioner. As an aside and just between us, it seems that Brian Hoskins has withdrawn himself from the WG1 Lead nominations. It seems he doesn't want to have to deal with

110 Ev 9, para 3.7

111 Q 58

this hassle.

The FOI line we're all using is this. IPCC is exempt from any countries FOI – the Sceptics have been told this. Even though we (MOHC, CRU/UEA) possibly hold relevant info the IPCC is not part our remit (mission statement, aims etc) therefore we don't have an obligation to pass it on.
Cheers
Phil

E-mail: 1228330629
From: Phil Jones <p.jones@xxxxxxxxx.xxx>
To: santer1@xxxxxxxxx.xxx, Tom Wigley <wigley@xxxxxxxxx.xxx>
Subject: Re: Schles suggestion
Date: Wed Dec 3 13:57:09 2008
Cc: mann <mann@xxxxxxxxx.xxx>, Gavin Schmidt <gschmidt@xxxxxxxxx.xxx>, Karl Taylor <taylor13@xxxxxxxxx.xxx>, peter gleckler gleckler1@xxxxxxxxx.xxx

Ben,
When the FOI requests began here, the FOI person said we had to abide by the requests. It took a couple of half hour sessions - one at a screen, to convince them otherwise showing them what CA was all about. Once they became aware of the types of people we were dealing with, everyone at UEA (in the registry and in the Environmental Sciences school - the head of school and a few others) became very supportive. I've got to know the FOI person quite well and the Chief Librarian - who deals with appeals. The VC is also aware of what is going on - at least for one of the requests, but probably doesn't know the number we're dealing with. We are in double figures.

One issue is that these requests aren't that widely known within the School. So I don't know who else at UEA may be getting them. CRU is moving up the ladder of requests at UEA though - we're way behind computing though. We're away of requests going to others in the UK - MOHC, Reading, DEFRA and Imperial College. So spelling out all the detail to the LLNL management should be the first thing you do. I hope that Dave is being supportive at PCMDI. The inadvertent email I sent last month has led to a Data Protection Act request sent by a certain Canadian, saying that the email maligned his scientific credibility with his peers!

If he pays 10 pounds (which he hasn't yet) I am supposed to go through my emails and he can get anything I've written about him. About 2 months ago I deleted loads of emails, so have very little - if anything at all. This legislation is different from the FOI - it is supposed to be used to find put why you might have a poor credit rating ! In response to FOI and EIR requests, we've put up some data - mainly paleo data. Each request generally leads to more - to explain what we've put up. Every time, so far, that hasn't led to anything being added - instead just statements saying read what is in the papers and what is on the web site! Tim Osborn sent one such response (via the FOI person) earlier this week. We've never sent programs, any codes and manuals.

In the UK, the Research Assessment Exercise results will be out in 2 weeks time.
These are expensive to produce and take too much time, so from next year we'll be moving onto a metric based system. The metrics will be # and amounts of grants, papers and citations etc. I did flippantly suggest that the # of FOI requests you get should be another.

When you look at CA, they only look papers from a handful of people. They will start on another coming out in The Holocene early next year. Gavin and Mike are on this with loads of others. I've told both exactly what will appear on CA once they get access to it!
Cheers

Phil
E-mail: 1237496573 [Extract] From: Phil Jones <p.jones@xxxxxxxxx.xxx> To: santer1@xxxxxxxxx.xxx Subject: Re: See the link below Date: Thu Mar 19 17:02:53 2009 [...] CRU has had numerous FOI requests since the beginning of 2007. The Met Office, Reading, NCDC and GISS have had as well - many related to IPCC involvement. I know the world changes and the way we do things changes, but these requests and the sorts of simple mistakes, should not have an influence on the way things have been adequately dealt with for over a century. Cheers Phil

81. In his submission Andrew Montford stated that:

> Research materials should be made available to outsiders as a requirement of the scientific method. That scientists have failed to do so is reprehensible, but the fact that they have apparently also resorted to breaches of the Freedom of Information Act in order to do so requires urgent attention from policymakers.[112]

82. As we explained in the previous chapter, David Holland was the author of several FOIA requests that were mentioned in the leaked e-mails. In his submission he pointed out that on 9 May [2008] in e-mail 1210367056, Professor Jones sent "my formal information request to 'team' members Mann, Hughes and Ammann" writing:

> You can delete this attachment if you want. Keep this quiet also, but this is the person who is putting in FOI requests for all emails Keith and Tim have written and received re Ch 6 of AR4.[113] We think we've found a way around this.[114]

83. Mr Holland also drew attention to e-mail 1212063122 dated 29 May 2008 in which Professor Jones asked Professor Mann:

> Can you delete any emails you may have had with Keith re AR4? Keith will do likewise. Can you also email [Eu]Gene [Wahl] and get him to do the same? I don't have his new email address. We will be getting Caspar [Ammann] to do likewise.[115]

Correspondence with the Deputy Information Commissioner

84. On 22 January 2010, when the Deputy Information Commissioner, Graham Smith, issued a statement which suggested that at l east some of the requested information should

112 Ev 159, para 6

113 Intergovernmental Panel on Climate Change: Fourth Assessment Report

114 Ev 117, para 23

115 Ev 118, para 32

have been disclosed in the absence of applicable exemptions, it gave support to the criticisms of CRU's handling of FOIA requests. Mr Smith said:

> The FOI Act makes it an offence for public authorities to act so as to prevent intentionally the disclosure of requested information. Mr Holland's FOI requests were submitted in 2007/8, but it has only recently come to light that they were not dealt with in accordance with the Act. The legislation requires action within six months of the offence taking place, so by the time the action came to light the opportunity to consider a prosecution was long gone.[116]

85. Mr Thomas commented that this was "clearly a reference to section 77 of the Act and/or the near-identical Regulation 19 of EIR".[117] Section 77 of the FOIA provides:

> 1. Where:
>
> (a) a request for information has been made to a public authority,
>
> (b) under section 1 of this Act or section 7 of the Data Protection Act 1998, the applicant would have been entitled (subject to payment of any fee) to communication of any information in accordance with that section,
>
> any person to whom this subsection applies is guilty of an offence if he alters, defaces, blocks, erases, destroys or conceals any record held by the public authority, with the intention of preventing the disclosure by that authority of all, or any part, of the information to the communication of which the applicant would have been entitled.
>
> 2. Subsection (1) applies to the public authority and to any person who is employed by, is an officer of, or is subject to the direction of, the public authority.
>
> 3. A person guilty of an offence under this section is liable on summary conviction to a fine not exceeding level 5 on the standard scale.[118]

86. Mr Thomas added that the Deputy Commissioner also appeared "to have in mind" section 127(1) of the Magistrates Court Act 1980, which provides that

> a magistrates' court shall not try an information or hear a complaint unless the information was laid, or the complaint made, within 6 months from the time when the offence was committed, or the matter of complaint arose.[119]

Mr Thomas confirmed in oral evidence that

> because of the interaction with the Magistrates Court Act, any prosecution must be brought within six months of the offence being committed.[120]

87. In its memorandum to our inquiry, UEA defended its actions:

---

116 Ev 9, para 4.1

117 Ev 10

118 Ev 10, para 4.1

119 Ev 10, para 4.2

120 Q 56

> CRU has been accused of refusing to release data requested under the FOIA. There are many obstacles outside CRU's control surrounding the release of data provided by NMSs [National Meteorological Services]. Many FOIA requests made to CRU related to primary data provided by the NMSs. Some of these data are subject to formal non-publication agreements between the NMS and CRU. Other primary data had been provided to CRU on an individual-to-individual basis, with accompanying verbal agreements that they may be used within the gridded dataset, but should not be passed on to others. CRU responded to the FOIA requests for primary data by pointing out that approximately 90% of the stations in the CRU dataset are available from other sources, particularly GHCN.[121]

88. On 29 January there was an exchange between UEA and Mr Smith, the Deputy Commissioner. Brian Summers, the Registrar and Secretary of UEA responded forcibly to Mr Smith's 22 January press statement, which asserted that UEA had not dealt with FOIA requests "as they should have been under the legislation".[122] He did not consider it was "acceptable that such a statement which has led to an extremely damaging commentary on the University [was] first communicated to the University by a journalist".[123] His letter goes on to defend UEA's actions in detail and to ask that, if the Information Commissioner's Office (ICO) cannot retract the 22 January statement, it issue a clarification regarding the alleged breaches of the FOIA. A response from the ICO was issued the same day. It did not retract the original statement but offered clarification:

> 1. [No] decision notice has yet been issued and no alleged breaches have yet been put to the University for comment. That matter has yet to be addressed, but it will be over coming months.
>
> 2. The fact that the elements of a section 77 offence may have been found here, but cannot be acted on because of the elapsed time, is a very serious matter. The ICO is not resiling from its position on this.
>
> 3. The ICO's position is as stated in point 2 above. The statement may be read to indicate that.[124] Under section 77, an offence may be committed by an individual, not necessarily the public authority itself.
>
> 4. Errors like this are frequently made in press reports and the ICO cannot be expected to correct them, particularly when the ICO has not itself referred to penalties or sanctions in its own statement.[125]

---

121 Ev 20, para 3.7.2

122 "Scientists in stolen e-mail scandal hid climate data", *The Times*, 28 January 2010

123 Registrar and Secretary to Deputy Information Commissioner - 29 January 2010, UEA website, Correspondence between University of East Anglia and the Information Commissioner's Office, www.uea.ac.uk/mac/comm/media/press/CRUstatements/ICOcorrespondence

124 UEA had asked the Deputy Commissioner to confirm that "your statement cannot be taken to mean that there has been a demonstrable breach of Section 77, which is a breach of the FOI which can result in prosecution"; Registrar and Secretary to Deputy Information Commissioner, 29 January 2010, UEA website, Correspondence between University of East Anglia and the Information Commissioner's Office, www.uea.ac.uk/mac/comm/media/press/CRUstatements/ICOcorrespondence

125 Deputy Information Commissioner to Registrar and Secretary - 29 January 2010, UEA website, Correspondence between University of East Anglia and the Information Commissioner's Office, www.uea.ac.uk/mac/comm/media/press/CRUstatements/ICOcorrespondence

89. UEA responded on 1 February thanking the ICO for the clarification but setting out its concerns relating to the press coverage of the ICO's original statement:

> Your clarification that the press cannot infer from your statement to the Sunday Times that it has been established that the University (or indeed any individual associated with the University) has breached the terms of the Freedom of Information Act is welcome. [UEA's] reputation which has been subjected to these damaging and incorrect assertions claiming to be based on your statement and we must take some steps to put this right. We will be writing to the media which carried reports based on your statement, pointing out the inaccuracies and asking them to rectify the position.[126]

90. In his oral evidence Professor Acton questioned the ICO statement of 22 January:

> our principle is that *prima facie* evidence is evidence which on the face of it and without investigation suggests that there is a case to answer. To my mind if there is *prima facie* evidence; why did I set up the Muir Russell independent review? Prima facie evidence is not the same as, you have been found to breach. [...] If it is sub judice, if, as we had in the letter ten days ago from the ICO, the investigation has not even begun, I am puzzled how we could have been found to breach if there has been no investigation.[127]

91. The ICO's most recent letter, dated 3 March, in UEA's view, "makes plain that there is no assumption by the ICO, prior to investigation, that UEA has breached the Act; and that no investigation has yet been completed."[128] The ICO's letter confirmed that the "ICO is not pursuing any investigation under section 77 of the Act. That matter is closed as far as the ICO is concerned, given the statutory time limits for action". It added that:

> The ICO acknowledges your concern about the statement made and the subsequent media and blog reports. Given that the Deputy Commissioner has already been publicly associated with the matter, any Decision Notice will be reviewed and signed off by another authorised signatory.[129]

We regret that the ICO made a statement to the press that went beyond that which it could substantiate and that it took over a month for the ICO properly to put the record straight. We recommend that the ICO develop procedures to ensure that its public comments are checked and that mechanisms exist to swiftly correct any mis-statements or misinterpretations of such statements.

92. The disclosed e-mails appear to show a culture of non-disclosure at CRU and instances where information (disclosable or otherwise) may have been deleted, to avoid disclosure. The Deputy Information Commissioner's letter of 29 January gives a clear indication that a

---

126 Registrar and Secretary to Deputy Information Commissioner - 1 February 2010, UEA website, Correspondence between University of East Anglia and the Information Commissioner's Office, www.uea.ac.uk/mac/comm/media/press/CRUstatements/ICOcorrespondence

127 Q130

128 Ev 39, para A

129 Ev 39, annex

breach of the FOIA may have occurred but that a prosecution was time-barred.[130] As, however, UEA pointed out, no investigation has been carried out.

93. It seems to us that both sides have a point. **There is *prima facie* evidence that CRU has breached the Freedom of Information Act 2000. It would, however, be premature, without a thorough investigation affording each party the opportunity to make representations, to conclude that UEA was in breach of the Act. In our view, it is unsatisfactory to leave the matter unresolved simply because of the operation of the six-month time limit on the initiation of prosecutions. Much of the reputation of CRU hangs on the issue. We conclude that the matter needs to be resolved conclusively—either by the Independent Climate Change Email Review or by the Information Commissioner.**

94. On the question of the six-month time limit on the initiation of prosecutions, Mr Thomas pressed for a revision of the law. He pointed out that apart from in the most blatant cases "it will usually be impossible for the ICO to detect an offence within 6 months of its occurrence" and thus to be able to initiate a prosecution.[131] He drew attention to a recent debate in the House of Lords on a proposal to amend the time limit. In reply, in the debate the Parliamentary Under-Secretary of State at the Ministry of Justice said that:

> The Freedom of Information Act 2000 came into force only in 2005, and [...] we have no evidence at present that the current six-month time limit presents a systemic problem for the Information Commissioner or any other prosecutor in taking action under Section 77. [...] We will listen to the views of the Information Commissioner and other interested parties on this point, and if there is evidence that the current legislation is causing systemic difficulties, we will look for ways to address the matter, if necessary by means of an alternative legislative vehicle in the future. However, I cannot go further than that today on behalf of the Government.[132]

No change was made to the legislation.

95. We consider that events at CRU throw light on the operation of the Freedom of Information Act 2000 and, in particular, whether there is a need to amend the time limit on prosecutions from six months from the time the alleged offence was committed. **If the Minister was correct to assert in July 2009 that the Government had no evidence that the current six-month time limit presents a systemic problem, then it is now clear that such evidence exists. Irrespective of whether or not CRU breached the Freedom of Information Act 2000, we recommend that the Government review the operation of section 77 of the 2000 Act and the six month limit on the initiation of prosecutions provided by section 127(1) of the Magistrates Court Act 1980.**

---

130 UEA website, Correspondence between University of East Anglia and the Information Commissioner's Office, www.uea.ac.uk/mac/comm/media/press/CRUstatements/ICOcorrespondence

131 Ev 10, para 4.3

132 HL Deb, 21 July 2009, col 1571

Volume of requests

96. In the face of allegations of poor handling of FOIA requests, one of the explanations offered by UEA was that in:

> July 2009 UEA received an unprecedented, and frankly administratively overwhelming, deluge of FOIA requests related to CRU. These amounted to 61 requests out of a 2009 total of 107 related to CRU, compared to annual totals of 2 in 2008 and 4 in 2007 (University totals for those years were 204, 72 and 44 respectively).[133]

97. At the oral evidence session Lord Lawson commented on the increase in the volume of FOIA requests:

> what had happened was there had been a very, very small number of FOI Act requests to begin with and it was in response to those that there was all the evasion, the lack of disclosure and all the other things which we have seen in the emails: discussions about possibly destroying evidence and so on. All that came well before the 2009 flood of stuff. The 2009 flood, if you look at the sequence of events, was a response to the refusal to give disclosure of various things before. That was what came first.[134]

98. There are two issues here: the adequacy of CRU's handling of the FOIA requests and whether the increase in the number of requests in July 2009 was a deluge. On the latter, Mr Thomas said that, whilst agreeing that UEA had faced a significant rise in FOIA requests in July 2009, he did not consider that a total of 61 was a "huge number".[135]

99. On handling, CRU claimed that it could not cope with the significant rise in FOIA requests because it only had three full-time academic staff.[136] We therefore wrote to UEA on 2 March 2010 to ask what extra resources were provided to assist CRU cope with these requests. UEA responded that:

> additional support was provided to the University's Information Policy Compliance Manager (IPCM) who handles FOI requests. This included rescheduling workloads to allow him to concentrate on the CRU FOI requests and diverting secretarial support to provide additional resource. Given the high volume of requests received, the Director of Information Services (DoIS) also took an active role in the first stage of a number of requests, thus providing additional support to the IPCM. (Should any cases where the DoIS was directly involved in the first stage be appealed then we have arranged for the PVC Academic to adjudicate to ensure impartiality). ISD also fast-tracked the merging of the Security Policy and Compliance team to ensure that a fully trained back-up to the IPCM was available.[137]

---

133 Ev 20, para 3.7.4

134 Q 9

135 Q 68

136 Q 92 [Professor Acton], Ev 20, para 3.7.4; Ev 37, Q 1

137 Ev 37, para 1

100. The Science Faculty also provided additional administrative support, including that of the Director of Faculty Administration, the most senior member of the Faculty's administrative staff. UEA pointed out that many of the requests were of a very technical nature and:

> required scientific knowledge and understanding of the subject area in order to provide the details. Despite the additional administrative resources provided, the requirement to respond to the 61 requests received in July 2009 impacted considerably upon the work of CRU.[138]

101. We also asked UEA to outline what legal advice and guidance on handling had been offered to CRU in handling these FOIA requests. UEA confirmed that the:

> IPCM provided advice to CRU on the requirements of the Act both generally, and in relation to any applicable sections, exemptions or exceptions pertaining to the specific request. In this latter role, the IPCM set out the requirements of any possible exemption or exception, inclusive of the public interest test, and elicited from CRU staff whether the public interest test had been met. Additional advanced training was provided to the 'FOI Contact' for the Faculty of Science, the Director of Faculty Administration. In this role, the FOI contact acted as a support to CRU in the location and retrieval of information and provided assistance to the IPCM in exploring the application of the Act to the specific requests.[139]

102. On the evidence we took we have concerns about the handling of FOIA requests by CRU. First, the disclosed e-mails betray an attitude to freedom of information that was antipathetic to the spirit of disclosure in the legislation. Mr Thomas pointed out that:

> the simplest approach, particularly where requests tend to generate either a defensive attitude or place a great burden on the public authority, is proactive disclosure in the first place.[...] Public authorities ought to decide what really has to be kept away from the public. If it is particularly sensitive or there is a good reason for withholding it, fair enough, but where there is no good reason for withholding information, then why not proactively disclose it and avoid the hassle of large numbers of requests?[140]

103. Whether or not CRU liked it, those making FOIA requests were entitled to have their requests dealt with in accordance with the legislation and, if the information sought did not fall within one of the exclusions provided by the FOIA, it should have been disclosed. **We have already recommended in paragraph 54 above that in future information, including data and methodology, should be published proactively on the internet wherever possible. However, a culture of withholding information—from those perceived by CRU to be hostile to global warming—appears to have pervaded CRU's approach to FOIA requests from the outset. We consider this to be unacceptable.**

104. In the face of such an unhelpful approach we are not surprised that FOIA requests multiplied. When the surge in FOIA requests hit CRU in July 2009 UEA provided extra

138 Ev 37, para 1

139 Ev 37, para 2

140 Q 70

resources but because of their technical nature the same small group of staff at CRU had a pivotal role in handling the requests. We are not clear that the culture changed. **We cannot reach a firm conclusion on the basis of the evidence we took but we must put on record our concern about the manner in which UEA allowed CRU to handle FOIA requests. Further, we found *prima facie* evidence to suggest that the UEA found ways to support the culture at CRU of resisting disclosure of information to climate change sceptics. The failure of UEA to grasp fully the potential damage to CRU and UEA by the non-disclosure of FOIA requests was regrettable. UEA needs to review its policy towards FOIA and re-assess how it can support academics whose expertise in this area is limited.**

4 Independent inquiries

105. There are two reviews underway: the Independent Climate Change Email Review led by Sir Muir Russell; and a scientific assessment panel reviewing CRU's key scientific publications. The Vice-Chancellor explained to us in oral evidence on 1 March 2010 that the reviews would focus on different matters:

> Muir Russell's independent review is not looking at the science, it is looking at allegations about malpractice. As for the science itself, I have not actually seen any evidence of any flaw in the science but I am hoping, later this week, to announce the chair of a panel to reassess the science and make sure there is nothing wrong.[141]

In the event the announcement was not made until 22 March.

The Independent Climate Change Email Review

106. The Independent Climate Change Email Review is being conducted by a team, led by Sir Muir Russell. According to the Review's website the team has more than 100 years' collective expertise of scientific research methodology and a wide range of scientific backgrounds. None have any links to the Climatic Research Unit, or the United Nations' Intergovernmental Panel on Climate Change (IPCC).[142]

Terms of reference

107. The Review's terms of reference are as follows:

> The Independent Review will investigate the key allegations that arose from a series of hacked e-mails from the University of East Anglia's Climatic Research Unit (CRU). The review will:
>
> 1.1. Examine the hacked e-mail exchanges, other relevant e-mail exchanges and any other information held at CRU to determine whether there is any evidence of the manipulation or suppression of data which is at odds with acceptable scientific practice and may therefore call into question any of the research outcomes.
>
> 1.2. Review CRU's policies and practices for acquiring, assembling, subjecting to peer review and disseminating data and research findings, and their compliance or otherwise with best scientific practice.
>
> 1.3. Review CRU's compliance or otherwise with the University's policies and practices regarding requests under the Freedom of Information Act ('the FOIA') and the Environmental Information Regulations ('the EIR') for the release of data.

141 Q 129

142 www.cce-review.org/About.php

> 1.4. Review and make recommendations as to the appropriate management, governance and security structures for CRU and the security, integrity and release of the data it holds.[143]

108. Sir Muir has discretion to amend or add to the terms of reference if he feels necessary, devise his own methods of working, and call on appropriate expertise, in order to investigate the allegations fully. UEA has asked for the Review to be completed by Spring 2010 and this will be made public along with UEA's response.[144]

109. Lord Lawson, in both his written submission and his oral evidence, considered that the terms of reference "may be a bit too CRU-centric"[145] and "needed to be extended to include more fully the issue of the dissenting scientists".[146] These points were echoed in written submissions to us. Andrew Montford suggested that:

> The independence of the review is not assured. Sir Muir Russell was appointed to head the review by the vice-chancellor of the University of East Anglia, [...] Edward Acton. However, the emails disclosed implicate [his] predecessor in an apparent breach of the Freedom of Information Act and there is therefore a prime-facie case that the review is not sufficiently independent. [...] The review must take evidence from sceptics. At time of writing it appears that no prominent sceptic has been contacted by Sir Muir with a view to providing evidence. Without complainants being able to make their case to the review, it is unlikely that the findings will be sound or accepted by the sceptic community.[147]

Mike Haseler, creator of the Number 10 Petition regarding the CRU, was also critical of the Review saying that it "seems to serve no real purpose except the PR of the University to appear to be doing something."[148]

110. Others offered amendments to the terms of reference. Professor Ross McKitrick, a professor of environmental economics, recommended that the terms of reference "should consider whether CRU scientists whose responsibilities include providing climate data to the IPCC should not serve as IPCC Lead Authors (or Coordinating Lead Authors) on any Report or Chapter that assesses evidence for or against its quality for climatic research purposes."[149]

111. The Royal Society of Chemistry considered the terms of reference "adequate"[150] and Professor John Beddington suggested that they "give sufficient scope for the issue to be investigated in full".[151] Professor Peter Cox, a former lead author on the last IPCC Working

---

143 Ev 39

144 "Sir Muir Russell to head the Independent Review into the allegations against the Climatic Research Unit (CRU)" UEA Press Release, 3 December 2009, www.uea.ac.uk/mac/comm/media/press/2009/dec/CRUreview

145 Q 5, Ev 1, annex containing letter dated 26 January 2010 from the Foundation to Sir Muir Russell (*not printed*)

146 Q 3

147 Ev 161, paras 22 and 24

148 Ev 139, para 27

149 Ev 140, para 3.2

150 Ev 172, para 12

151 Ev 45, para 7

Group, suggested that the "Inquiry should hear evidence on the reviewing of scientific papers and the exclusion of papers from the IPCC report. It will be critical to determine whether these decisions were carried out on the basis of scientific merit alone".[152]

112. In response to criticisms Sir Muir pointed out that the review "is not actually about the big science of global warming and making forecasts for the next hundred years".[153] He said that "it will not be window dressing", and UEA had "not interfered at all".[154]

113. **We accept the assurances that Sir Muir Russell has given about the independence of the Independent Climate Change Email Review and we expect him to be scrupulous in preserving its impartiality. We see no reason why the Review's conclusions and UEA's response have to be published together. Indeed, it could give the impression that UEA was being given an advantage when it comes to responding. We consider that the Review's conclusions and recommendations should not be conveyed to UEA in advance of publication.**

114. **With regards to the terms of reference of the Review, we consider that as well as measuring CRU against current acceptable scientific practice, the Review should also make recommendations on best practice to be followed by CRU in the future. We invite Sir Muir Russell to respond formally to our Report to the extent that he sets out whether, on the basis of its contents, he finds the Terms of Reference of his inquiry need to be changed.**

The Review team

115. The Review Team membership, as announced, consisted of:

> Sir Muir Russell
> Professor Geoffrey Boulton
> Dr Philip Campbell [*subsequently resigned*]
> Professor Peter Clarke
> Mr David Eyton
> Professor Jim Norton.[155]

116. Sir Muir and the Review team held a press briefing at the Science Media Centre in London on 11 February 2010 to announce its membership, publish its workplan and issue a call for submissions from interested parties. Almost immediately it was beset by claims of partiality. On the same day as the launch Sir Muir Russell accepted the resignation of Dr Philip Campbell, Editor of Chief of *Nature*, after a recording of an interview given by Dr Campbell to China Radio International in December 2009 was alleged to raise doubts over his impartiality. Dr Campbell said:

> I made the remarks in good faith on the basis of media reports of the leaks. As I have made clear subsequently, I support the need for a full review of the facts behind the

152 Ev 132, para 2

153 Q 163

154 Q 166

155 Ev 40

> leaked e-mails. There must be nothing that calls into question the ability of the independent Review to complete this task, and therefore I have decided to withdraw from the team.[156]

117. Sir Muir said "I have spoken to Philip Campbell, and I understand why he has withdrawn. I regret the loss of his expertise, but I respect his decision."[157] Further allegations arose on 12 February that Professor Geoffrey Boulton's background and views affected his ability to be a member of the Review.[158] These have been rejected by Sir Muir Russell and by Professor Boulton. Professor Boulton said:

> At the Review press conference (on February 11), I pointed out that I had worked full-time in the School of Environmental Sciences at UEA from its inception in 1968 to 1980, and that I had a part-time appointment between 1980 and 1986, whilst working primarily in the University of Amsterdam. Since then, I have had no professional contact with the University of East Anglia or the Climatic Research Unit. I was equally clear that although my research is not in the field of modern or recent climate change, I am familiar with its scientific basis and uncertainties surrounding it. I declared my current view of the balance of evidence: that the earth is warming and that human activity is implicated. These remain the views of the vast majority of scientists who research on climate change in its different aspects. They are based on extensive work worldwide, not that of a single institution. As a sceptical scientist, I am prepared to change those views if the evidence merits it. They certainly do not prevent me from being heavily biased against poor scientific practice, wherever it arises.[159]

Sir Muir Russell said:

> This Review must determine if there is evidence of poor scientific practice, as well as investigate allegations around the manipulation and suppression of data. As others have pointed out, it would be impossible to find somebody with the qualifications and experience we need who has not formed an opinion on climate change. I am completely confident that each member of the Review team has the integrity, the expertise, and the experience to complete our work impartially.[160]

118. In his oral evidence Sir Muir outlined his approach in choosing the team:

---

156 "Dr Philip Campbell withdraws from the Review", *Independent Climate Change Email Review News release*, 12 February 2010, www.cce-review.org/News.php

157 *As above*

158 There has been pressure on Professor Boulton to step down. *The Scotsman* reported: "Dr Benny Peizer, [*sic*] director of the Global Warming Policy Foundation, a think tank which claims the debate on climate change has become distorted, called for Prof Boulton to step down, too. He said: 'Prof Boulton obviously is a very distinguished geologist. The problem is, he is a very outspoken campaigner on this issue and he's given talks calling for galvanising public opinion. He also worked at the very institution that he is now going to be investigating. That, we think, is a conflict of interest.'" ("Senior Scots scientist in climate probe row", *The Scotsman*, 13 February 2010) Sir Muir has rejected the call. ("Allegations of bias against Review member rejected", *Independent Climate Change Email Review News release*, 15 February 2010)

159 "Allegations of bias against Review member rejected", *Independent Climate Change Email Review News release*, 15 February 2010,www.cce-review.org/News.php

160 *As above*

> You can see as you look at the composition of the team that I needed to be looking at climate science in general but not somebody who was associated with this particular stream of work but would understand what was going on. There were going to be huge data handling issues, there was a lot of work on computing and data security and so on and that the work was going to have a resonance out there in the real world and around the world. Really on that basis I came up with this set of names that you can see. In relation to Dr Campbell, the others that I had got together thought that it would be extremely important to have somebody who knew about peer review and that was really the qualification that brought him in.[161]

119. **It is unfortunate that the Independent Review got off to a bad start with the necessary resignation of Dr Campbell. The question of the operation of peer review is going to be a critical issue in the inquiry and the Review Team needs to take steps to ensure the insight and experience he would have brought are replaced.**

Transparency

120. Contributors to our inquiry have suggested the importance that the Independent Review is open and transparent. Lord Lawson, in his oral evidence, said that he was:

> concerned about the openness and transparency, [...] there should be public hearings, like you are having here—I think that is very, very important—and I regret the fact that it appears that they do not intend to do this.[162]

Andrew Montford commented:

> The review must be held in public. Sir Muir Russell has stated that he wants to retain the confidence of global warming sceptics. However, in his letter to Mr Willis of 10 December 2009, [...] the vice-chancellor of UEA, states that Sir Muir will present his findings to [him], who will in turn present a report to the council of the university. We are asked to believe that Sir Muir will properly investigate [the Vice-Chancellor's] role in the alleged FoI breaches, and that [he] will pass on the findings that Sir Muir makes on this subject to the university council.[163]

121. When answering our question on transparency Sir Muir indicated that the Review team "plans to put on its website the evidence that we receive".[164] When pressed on the question of holding public evidence sessions Sir Muir responded that:

> all my predispositions and those of the fellow team members are to do it that way [via written evidence] rather than to do it in a hearing of perhaps this kind or in a series of one-to-one interviews or whatever. Where we have interviews with people in CRU or elsewhere, those will be written up and they will be part of the record but at the moment I am not really sure that getting to the stage of putting people in a

---

161 Q 160

162 Q 3

163 Ev 161, para 23

164 Q 172

> hearing context is going to be a particularly effective way of adding value to the objective evidence that we want to get our hands on.[165]

122. We agree that the Review must be open and transparent. **We conclude that, when the Independent Review holds oral hearings or interviews, they should be carried out in public wherever possible and that it should publish all the written evidence it receives on its website as soon as possible.**

Scientific Appraisal Panel

123. In its evidence to us the Independent Climate Change Email Review stated that its remit does not invite it to re-appraise the scientific work of CRU. That re-appraisal is being separately commissioned by UEA, with the assistance of the Royal Society.[166] In a statement released on 11 February UEA said that:

> The Royal Society will assist the University in identifying assessors with the requisite expertise, standing and independence. "Published papers from CRU have gone through the rigorous and intensive peer review process which is the keystone for maintaining the integrity of scientific research," said Professor Trevor Davies, the University's Pro-Vice-Chancellor for Research, Enterprise and Engagement. "That process and the findings of our researchers have been the subject of significant debate in recent months. Colleagues in CRU have strenuously defended their conduct and the published work and we believe it is in the interests of all concerned that there should be an additional assessment considering the science itself."
>
> The independent reassessment will complement Sir Muir Russell's Review of the key allegations about the handling of data arising from the publication of a series of e-mails hacked from CRU. Sir Muir's Review is expected to announce its finding in Spring 2010.
>
> The reassessment of CRU's key publications will be completed at the earliest date the assessors can manage. The findings will be made public.[167]

124. Details of the panel were announced on 22 March. It will be headed by Lord Oxburgh. His appointment was made on the recommendation of the Royal Society, which was also consulted on the choice of the six scientists on the panel: Professor Huw Davies, Professor of Physics at the Institute for Atmospheric and Climate Science at ETH Zürich; Professor Kerry Emanuel, Professor of Meteorology at Massachusetts Institute of Technology; Professor Lisa Graumlich, Director of the School of Natural Resources and the Environment at The University of Arizona; Professor David Hand, Professor of Statistics in the Department of Mathematics at Imperial College; Professor Herbert Huppert, Professor of Theoretical Geophysics at the University of Cambridge; and Professor Michael Kelly, Prince Philip Professor of Technology at the University of Cambridge. The panel will have

---

165 Q 176

166 Ev 40, para 4

167 UEA, 11 February 2010, www.uea.ac.uk/mac/comm/media/press/CRUstatements/New+scientific+assessment+of+climatic+research+publications+announced

access to any publications or materials it requests, and all information considered will be listed in the Report. UEA, in consultation with the Royal Society, has suggested that the panel looks in particular at key publications, from the body of CRU's research referred to in the UEA submission to our inquiry. According to the announcement on 22 March, the panel will meet in Norwich in April and will have the opportunity to see original data and speak to those who did the work and it comprises of scientists who use techniques similar to those used in CRU but who largely apply them to other areas of research, as well as those with experience in climate or related research.[168]

125. Announcing the Panel, Professor Trevor Davies, UEA's Pro-Vice-Chancellor for Research, said that:

> Our concern has been to bring together a distinguished group of independent scientists who understand the difference between assertion and evidence, and are familiar with using the latter to judge the validity of conclusions arising from science research. The panel members have the right mix of skills to understand the complex nature of climate research and the discipline-based expertise to scrutinise CRU's research. How they do this will be entirely down to the panel.
>
> The choice of scientists is sure to be the subject of discussion, and experience would suggest that it is impossible to find a group of eminent scientists to look at this issue who are acceptable to every interest group which has expressed a view in the last few months. Similarly it is unlikely that a group of people who have the necessary experience to assess the science, but have formed no view of their own on global warming, could be found.[169]

Public view of the climate science

126. There is no doubt that the e-mail disclosure from CRU in November 2009, and especially the extensive media coverage that has followed it ever since, has affected the general public view of climate science, both in the UK and further afield. Professor Bob Watson, Defra's Chief Scientific Adviser, told us that "the media has certainly portrayed the UEA issue as a crisis, so I think to the public it has been portrayed as a crisis".[170] Professor Peter Cox, a climate scientist and a lead-author on the last IPCC[171] Working Group, in his written submission to us, said as much: "I am concerned that public confidence in the science of climate change has been undermined by the email leak".[172] In its submission the Royal Society of Chemistry said that the:

> true nature of science dictates that research is transparent and robust enough to survive scrutiny. A lack of willingness to disseminate scientific information may infer that the scientific results or methods used are not robust enough to face scrutiny, even if this conjecture is not well-founded. This has far-reaching consequences for

168 "CRU Scientific Assessment Panel announced", UEA Press Release, 22 March 2010, www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAPannounce

169 *As above*

170 Q 198

171 Intergovernmental Panel on Climate Change

172 Ev 132, para 1

> the reputation of science as a whole, with the ability to undermine the public's confidence in science.[173]

127. The majority of submissions submitted to our inquiry has been from those who stated that the disclosed e-mails confirmed their worries that the climate change orthodoxy has serious flaws and the actions of CRU seriously impugned the integrity of climate change research.[174] A representative example was the memorandum from Dr Phillip Bratby, "a semi-retired energy consultant", who said that having examined the disclosures:

> It is concluded that over at least a period of 20 years, climate science has been seriously compromised by the actions of a small group of scientists who have attempted to control the debate about climate change. The effects of this are potentially profound. For example a generation of work may have been corrupted and may be unreliable. A generation of students may have been corrupted and their work may be unreliable.[175]

128. Others offered a different perspective. Dr Timothy Osborn, a full-time member of staff at CRU, defended CRU:

> It is impossible to draw firm conclusions from the hacked documents and emails. They do not represent the complete record, and they are not a random selection from the complete record. They are clearly selected with a purpose in mind and it is easy for people to fall into the traps set by those who did the selection.[176]

129. Beyond CRU, Professor Hans von Storch and Dr Myles Allen, professional statistical climatologists, agreed that the publication of the hacked e-mails had initiated an intense debate about the credibility of climate science and that "unfortunately, this debate sometimes goes so far as to question a key result of climate science",[177] and the

> language used in some of these e-mails has created concern, among both scientists and the public, about the openness and integrity of the scientific process. But at the same time it is critical to point out that no grounds have arisen to doubt the validity of the thermometer-based temperature record since 1850, nor any results based upon it.[178]

130. We put the concerns about the threat to the reputation of science to the fifth panel who gave oral evidence: Professor John Beddington, Government Chief Scientific Adviser, Professor Julia Slingo, Chief Scientist, Met Office, and Professor Bob Watson, Chief Scientist, Department for Environment, Food and Rural Affairs. Professor Beddington did

---

173 Ev 171, para 4

174 For examples, see Ev 68 [Richard S Courtney]; Ev 77 [Walter Radtke]; Ev 78 [Geoffrey Sherrington]; and Ev 93 [Clive Menzies]

175 Ev 92, para 21

176 Ev 130, para 3

177 Ev 172, para 1

178 *As above*

not consider that "UK science has been damaged".[179] The Met Office, in its written submission stated that

> the UK enjoys a reputation for strong and robust science on the international stage. In the field of climate research the Met Office is widely acknowledged as world leading.[180]

Professor Slingo confirmed in oral evidence that she has "absolute confidence in the science that we produce at the Met Office",[181] and Professor Watson, looking at the wider situation, attested that "there is absolutely no adverse effect on any of the conclusions of the IPCC."[182]

131. **In our view, reputation has to be built on the solid foundation of excellent, peer-reviewed science. The review of the science to be carried out by the Scientific Appraisal Panel, which UEA announced on 22 March, should determine whether the work of CRU has been soundly built and it would be premature for us to pre-judge that review.**

132. **Reputation does not, however, rest solely on the quality of work as it should. It also depends on perception. It is self-evident that the disclosure of CRU e-mails has damaged the reputation of UK climate science and, as views on global warming have become polarised, any deviation from the highest scientific standards will be pounced on. As we explained in chapter 2, the practices and methods of climate science are a key issue. If the practices of CRU are found to be in line with the rest of climate science, the question would arise whether climate science methods of operation need to change. In this event we would recommend that the scientific community should consider changing those practices to ensure greater transparency.**

Need for a single review

133. The final issue is whether the best interests of science are served by having two reviews or inquiries. We found this difficult to evaluate as details of the Scientific Appraisal Panel were released in a late stage in our inquiry. When we asked Sir Muir whether it would be better to have a single inquiry, he responded:

> It would have been possible, obviously, to have constructed an inquiry that looked at both aspects of that, and that was not what I was asked to do. Whether I would have been the right person to be asked to do it I do not know but certainly it obviously became clear to the Vice Chancellor that there was this different issue about the confidence that one should have not in all the methodological and handling issues but in the higher level set of conclusions about what was actually happening.[183]

134. The process of two reviews or inquiries is underway. In our view there is the potential for overlap between the two inquiries—for example, the question of the operation of peer

---

179 Q 194

180 Ev 46, para 1

181 Q 197

182 Q 198

183 Q 181

review needs to examine both methodology and quality of the science subject to review. **The two reviews or inquiries need to map their activities to ensure that there are no unmanaged overlaps or gaps. If there are, the whole process could be undermined.**

5 Conclusions

135. Consideration of the complaints and accusations made against CRU has led us to three broad conclusions.

136. Conclusion 1 **The focus on Professor Jones and CRU has been largely misplaced. On the accusations relating to Professor Jones's refusal to share raw data and computer codes, we consider that his actions were in line with common practice in the climate science community. We have suggested that the community consider becoming more transparent by publishing raw data and detailed methodologies. On accusations relating to Freedom of Information, we consider that much of the responsibility should lie with UEA, not CRU.**

137. Conclusion 2 **In addition, insofar as we have been able to consider accusations of dishonesty—for example, Professor Jones's alleged attempt to "hide the decline"—we consider that there is no case to answer. Within our limited inquiry and the evidence we took, the scientific reputation of Professor Jones and CRU remains intact. We have found no reason in this unfortunate episode to challenge the scientific consensus as expressed by Professor Beddington, that "global warming is happening [and] that it is induced by human activity".[184] It was not our purpose to examine, nor did we seek evidence on, the science produced by CRU. It will be for the Scientific Appraisal Panel to look in detail into all the evidence to determine whether or not the consensus view remains valid.**

138. Conclusion 3 **A great responsibility rests on the shoulders of climate science: to provide the planet's decision makers with the knowledge they need to secure our future. The challenge that this poses is extensive and some of these decisions risk our standard of living. When the prices to pay are so large, the knowledge on which these kinds of decisions are taken had better be right. The science must be irreproachable.**

184 Q 191

Conclusions and recommendations

Datasets

1. We recognise that some of the e-mails suggest a blunt refusal to share data, even unrestricted data, with others. We acknowledge that Professor Jones must have found it frustrating to handle requests for data that he knew—or perceived—were motivated by a desire simply to seek to undermine his work. But Professor Jones's failure to handle helpfully requests for data in a field as important and controversial as climate science was bound to be viewed with suspicion. He was obviously frustrated by other workers in the field trying to "undermine" his work, but his actions were inevitably counterproductive. Professor Jones told us that the published e-mails represented only "one tenth of 1%" of his output, which amounts to one million e-mails, and that we were only seeing the end of a protracted series of e-mail exchanges. We consider that further suspicion could have been allayed by releasing all the e-mails. In addition, we consider that had the available raw data been available online from an early stage, these kinds of unfortunate e-mail exchanges would not have occurred. In our view, CRU should have been more open with its raw data and followed the more open approach of NASA to making data available. (Paragraph 38)

2. We are not in a position to set out any further the extent, if any, to which CRU should have made the data available in the interests of transparency, and we hope that the Independent Climate Change Email Review will reach specific conclusions on this point. However, transparency and accountability are of are increasing importance to the public, so we recommend that the Government reviews the rules for the accessibility of data sets collected and analysed with UK public money. (Paragraph 39)

3. We note that the research passed the peer review process of some highly reputable journals. However, we note that CRU could have been more open at that time in providing the detailed methodological working on its website. We recommend that all publicly funded research groups consider whether they are being as open as they can be, and ought to be, with the details of their methodologies. (Paragraph 45)

4. We therefore conclude that there is independent verification, through the use of other methodologies and other sources of data, of the results and conclusions of the Climate Research Unit at the University of East Anglia. (Paragraph 49)

5. Even if the data that CRU used were not publicly available—which they mostly are—or the methods not published—which they have been—its published results would still be credible: the results from CRU agree with those drawn from other international data sets; in other words, the analyses have been repeated and the conclusions have been verified. (Paragraph 51)

6. It is not standard practice in climate science and many other fields to publish the raw data and the computer code in academic papers. We think that this is problematic because climate science is a matter of global importance and of public interest, and therefore the quality and transparency of the science should be irreproachable. We

therefore consider that climate scientists should take steps to make available all the data used to generate their published work, including raw data; and it should also be made clear and referenced where data has been used but, because of commercial or national security reasons is not available. Scientists are also, under Freedom of Information laws and under the rules of normal scientific conduct, entitled to withhold data which is due to be published under the peer-review process. In addition, scientists should take steps to make available in full their methodological workings, including the computer codes. Data and methodological workings should be provided via the internet. There should be enough information published to allow verification. (Paragraph 54)

7. Critics of CRU have suggested that Professor Jones's use of the word "trick" is evidence that he was part of a conspiracy to hide evidence that did not fit his view that recent global warming is predominately caused by human activity. The balance of evidence patently fails to support this view. It appears to be a colloquialism for a "neat" method of handling data. (Paragraph 60)

8. Critics of CRU have suggested that Professor Jones's use of the words "hide the decline" is evidence that he was part of a conspiracy to hide evidence that did not fit his view that recent global warming is predominantly caused by human activity. That he has published papers—including a paper in *Nature*—dealing with this aspect of the science clearly refutes this allegation. In our view, it was shorthand for the practice of discarding data known to be erroneous. We expect that this is a matter the Scientific Appraisal Panel will address. (Paragraph 66)

9. The evidence that we have seen does not suggest that Professor Jones was trying to subvert the peer review process. Academics should not be criticised for making informal comments on academic papers. The Independent Climate Change Email Review should look in detail at all of these claims. (Paragraph 73)

Freedom of Information issues

10. We regret that the ICO made a statement to the press that went beyond that which it could substantiate and that it took over a month for the ICO properly to put the record straight. We recommend that the ICO develop procedures to ensure that its public comments are checked and that mechanisms exist to swiftly correct any mis-statements or misinterpretations of such statements. (Paragraph 91)

11. There is *prima facie* evidence that CRU has breached the Freedom of Information Act 2000. It would, however, be premature, without a thorough investigation affording each party the opportunity to make representations, to conclude that UEA was in breach of the Act. In our view, it is unsatisfactory to leave the matter unresolved simply because of the operation of the six-month time limit on the initiation of prosecutions. Much of the reputation of CRU hangs on the issue. We conclude that the matter needs to be resolved conclusively—either by the Independent Climate Change Email Review or by the Information Commissioner. (Paragraph 93)

12. If the Minister was correct to assert in July 2009 that the Government had no evidence that the current six-month time limit presents a systemic problem, then it is now clear that such evidence exists. Irrespective of whether or not CRU breached the Freedom of Information Act 2000, we recommend that the Government review the operation of section 77 of the 2000 Act and the six month limit on the initiation of prosecutions provided by section 127(1) of the Magistrates Court Act 1980. (Paragraph 95)

13. We have already recommended in paragraph 54 above that in future information, including data and methodology, should be published proactively on the internet wherever possible. However, a culture of withholding information—from those perceived by CRU to be hostile to global warming—appears to have pervaded CRU's approach to FOIA requests from the outset. We consider this to be unacceptable. (Paragraph 103)

14. We cannot reach a firm conclusion on the basis of the evidence we took but we must put on record our concern about the manner in which UEA allowed CRU to handle FOIA requests. Further, we found *prima facie* evidence to suggest that the UEA found ways to support the culture at CRU of resisting disclosure of information to climate change sceptics. The failure of UEA to grasp fully the potential damage to CRU and UEA by the non-disclosure of FOIA requests was regrettable. UEA needs to review its policy towards FOIA and re-assess how it can support academics whose expertise in this area is limited. (Paragraph 104)

The Independent Climate Change Email Review

15. We accept the assurances that Sir Muir Russell has given about the independence of the Independent Climate Change Email Review and we expect him to be scrupulous in preserving its impartiality. We see no reason why the Review's conclusions and UEA's response have to be published together. Indeed, it could give the impression that UEA was being given an advantage when it comes to responding. We consider that the Review's conclusions and recommendations should not be conveyed to UEA in advance of publication. (Paragraph 113)

16. With regards to the terms of reference of the Review, we consider that as well as measuring CRU against current acceptable scientific practice, the Review should also make recommendations on best practice to be followed by CRU in the future. We invite Sir Muir Russell to respond formally to our Report to the extent that he sets out whether, on the basis of its contents, he finds the Terms of Reference of his inquiry need to be changed. (Paragraph 114)

17. It is unfortunate that the Independent Review got off to a bad start with the necessary resignation of Dr Campbell. The question of the operation of peer review is going to be a critical issue in the inquiry and the Review Team needs to take steps to ensure the insight and experience he would have brought are replaced. (Paragraph 119)

18. We conclude that, when the Independent Review holds oral hearings or interviews, they should be carried out in public wherever possible and that it should publish all the written evidence it receives on its website as soon as possible. (Paragraph 122)

The Scientific Appraisal Panel

19. In our view, reputation has to be built on the solid foundation of excellent, peer-reviewed science. The review of the science to be carried out by the Scientific Appraisal Panel, which UEA announced on 22 March, should determine whether the work of CRU has been soundly built and it would be premature for us to pre-judge that review. (Paragraph 131)

20. Reputation does not, however, rest solely on the quality of work as it should. It also depends on perception. It is self-evident that the disclosure of the CRU e-mails has damaged the reputation of UK climate science and, as views on global warming have become polarised, any deviation from the highest scientific standards will be pounced on. As we explained in chapter 2, the practices and methods of climate science are a key issue. If the practices of CRU are found to be in line with the rest of climate science, the question would arise whether climate science methods of operation need to change. In this event we would recommend that the scientific community should consider changing those practices to ensure greater transparency. (Paragraph 132)

The two inquiries

21. The two reviews or inquiries need to map their activities to ensure that there are no unmanaged overlaps or gaps. If there are, the whole process could be undermined. (Paragraph 134)

Conclusions

22. The focus on Professor Jones and CRU has been largely misplaced. On the accusations relating to Professor Jones's refusal to share raw data and computer codes, we consider that his actions were in line with common practice in the climate science community. We have suggested that the community consider becoming more transparent by publishing raw data and detailed methodologies. On accusations relating to Freedom of Information, we consider that much of the responsibility should lie with UEA, not CRU. (Paragraph 136)

23. In addition, insofar as we have been able to consider accusations of dishonesty—for example, Professor Jones's alleged attempt to "hide the decline"—we consider that there is no case to answer. Within our limited inquiry and the evidence we took, the scientific reputation of Professor Jones and CRU remains intact. We have found no reason in this unfortunate episode to challenge the scientific consensus as expressed by Professor Beddington, that "global warming is happening [and] that it is induced by human activity". It was not our purpose to examine, nor did we seek evidence on, the science produced by CRU. It will be for the Scientific Appraisal Panel to look in detail into all the evidence to determine whether or not the consensus view remains valid. (Paragraph 137)

24. A great responsibility rests on the shoulders of climate science: to provide the planet's decision makers with the knowledge they need to secure our future. The challenge that this poses is extensive and some of these decisions risk our standard of

living. When the prices to pay are so large, the knowledge on which these kinds of decisions are taken had better be right. The science must be irreproachable. (Paragraph 138)

○