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OVERSIGHT HEARING: THE PRESIDENT'S FISCAL YEAR 2016 BUDGET REQUEST FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

MARCH 4, 2015

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ONE HUNDRED FOURTEENTH CONGRESS
FIRST SESSION

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OVERSIGHT HEARING: THE PRESIDENT'S FISCAL YEAR 2016 BUDGET REQUEST FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

WEDNESDAY, MARCH 4, 2015

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee met, pursuant to notice, at 9:32 a.m. in room 406, Dirksen Senate Building, Hon. James Inhofe (chairman of the committee) presiding.

Present: Senators Inhofe, Vitter, Capito, Boozman, Sessions, Wicker, Rounds, Sullivan, Boxer, Cardin, Whitehouse, and Markey.

OPENING STATEMENT OF HON. JAMES INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator INHOFE. The meeting will come to order.

We appreciate very much, Administrator McCarthy, your being here. We will have a lot of things to talk about, agreements and disagreements.

The EPA is proposing to cut $333 million from the Clean Water State Revolving Loan Fund which provides grants and loans for wastewater treatment. This is one of the programs that back in my State, and I am sure in other States, that is very popular and one in which we are very much involved.

EPA is 3 years behind in reporting to Congress on wastewater and storm water needs. However, it doesn't stop EPA from pursing its new waters of the US rule on which we had a hearing. I have to say, in my State of Oklahoma, the Farm Bureau and the other ag groups find that to be the one that is the most offensive to them and is going to be the biggest problem.

The President's budget proposes a 66 percent cut in the Diesel Emissions Reduction Grant Program, which Senator Carper, who will be here shortly, I am sure, and I work to fund each year. Voluntary diesel engine retrofits through matching funds are a cost effective way of reducing diesel engine pollution which EPA estimates causes 15,000 premature deaths each year.

EPA consistently misses its statutory deadline for proposing and finalizing renewable volume obligations for refiners, creating significant uncertainty and volatility buying and selling Renewable Identification Numbers or RINs, which are the credits used as proof of compliance with the Renewable Fuels Standard.

The President's budget cuts Superfund, Homeland Security Preparedness and Response while he is out saying that terrorism is less of a threat to the American people than climate change. In fact, EPA also intends to pursue a legislative proposal for an additional $4 billion in mandatory spending for EPA to enforce its climate change regulations which 32 States oppose and will result in double digit electricity price increases in 43 States.

Mandatory spending would mean that EPA would hand out money with no congressional oversight. The President requests $3.5 million for 20 new attorneys because, "Each EPA action is expected to be challenged in court, which will require skilled and experienced attorneys specialized in the Clean Air Act to devote significant resources to defense of these actions."

I think that was your quote, Madam Administrator. These attorneys would defend a climate change rule which, according to EPA's own consistent testimony, will not affect climate change.

In fact, the Clean Power Plan would reduce CO_2 concentrations by less than 1 percent, reduce global temperature rise by less than 0.016 degrees Fahrenheit, and reduce sea level rise by the thickness of three sheets of paper.

If we would like to point to our international agreement with China as proof that global concentrations will change, it is important to keep in mind that China emits 800 million tons of CO_2 per month while the Clean Power Plan reduction would be 550 million tons per year. We are talking about 550 million tons per year as opposed to 800 million tons a month from China.

In November, EPA proposed lowering the ozone standard when the current standard is not implemented in 40 percent of the Country. Manufacturers will not be able to expand.

I remember years ago, we did a study in Oklahoma on what it would really mean if we had to go into a non-attainment status. It would be something very, very damaging. When we had the standards of 75 ppm, I will ask you to respond, how many States have not complied with the 2008 standards before we even go into more stringent standards.

Members of the committee and I are looking forward to questioning the EPA's priorities on the regulatory agenda.

Senator Boxer.

[The prepared statement of Senator Inhofe follows:]

STATEMENT OF HON. JAMES INHOFE, U.S. SENATOR
FROM THE STATE OF OKLAHOMA

"Administrator McCarthy, thank you for appearing this morning.

The President's $8.6 billion proposal to fund the EPA represents a $452 million increase from last year's enacted levels but sacrifices core responsibilities in the pursuit of new regulations.

EPA proposes cutting $333 million from the Clean Water State Revolving Loan Fund which provides grants and loans for wastewater treatment and pollution control. EPA is 3 years behind in reporting to Congress on wastewater and storm water needs. However, it doesn't stop EPA for pursing its new waters of the US rule which EPA cannot ensure us doesn't expand its authority over isolated ponds, storm sewer systems, water reuse systems, roadside ditches, rock quarries, farm activities, and even backyard creeks.

The President's budget proposes a 66 percent cut to the Diesel Emissions Reduction Grant Program which Senator Carper and I work to fund each year. Voluntary diesel engine retrofits through matching funds are a cost effective way of reducing

diesel engine pollution which EPA estimates causes 15,000 premature deaths each year.

EPA consistently misses its statutory deadline for proposing and finalizing renewable volume obligations (RVO) for refiners creating significant uncertainty and volatility buying and selling Renewable Identification Numbers (RINs), which are the credits used as proof of compliance with the Renewable Fuels Standard (RFS).

The President's budget cuts Superfund Homeland Security Preparedness and Response while he is out saying that terrorism is less of a threat to the American people than climate change. In fact, EPA also intends to pursue a legislative proposal for an additional $4 billion in mandatory spending for EPA to enforce its climate change regulations which 32 states oppose and will result in double digit electricity price increases in 43 states. Mandatory spending would mean that EPA would hand out money with no congressional oversight. The President requests $3.5 million for 20 new attorneys because, "each EPA action is expected to be challenged in court, which will require skilled and experienced attorneys specialized in the Clean Air Act to devote significant resources to defense of these actions." These attorneys would defend a climate change rule which, according to EPA's own consistent testimony, will not affect climate change.

In fact, the Clean Power Plan would reduce CO_2 concentrations by less than a percent, reduce global temperature rise by less than 0.016 degrees Fahrenheit, and reduce sea level rise by the thickness of three sheets of paper. If we would like to point to our international agreement with China as proof that global concentrations will change, it's important to keep in mind that China emits 800 million tons of CO_2 per month while the Clean Power Plan reduce 550 million tons per year.

In November, EPA proposed lowering the ozone standard when the current standard is not implemented in 40 percent of the country. Manufacturers won't be able to expand and with a non-attainment designation, federally supported highway and transit projects, both new capacity and in-progress projects, will be halted. This only increases cost of existing expansions, complicates the ability to quickly respond to congestion, and reduce states' competitiveness for additional expansion opportunities.

The members of this Committee and I are looking forward to questioning EPA's priorities and regulatory agenda."

OPENING STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Senator BOXER. Thank you very much, Senator.

Welcome, Administrator McCarthy. Thank you for your dedication and devotion to your work, to the American people, to clean air, clean water, safe drinking water, and making sure that we treat this planet the way it deserves to be treated so that our grandchildren can actually have a decent quality of life.

EPA has a vital mission that affects the well-being of every American: implementing our Nation's landmark laws. I mentioned a few, clean air, children's health, safe drinking water, toxics, and water quality in America's lakes and rivers. The health and safety of our children and families depends on the critical work you do and the way we support you or fail to support you.

I am pleased that EPA's budget request of $8.6 billion includes a $452 million increase above the Fiscal Year 2015 enacted level, but we need to remember that 6 years ago, EPA's budget was $10.3 billion, and the Fiscal Year 2016 budget request that we will discuss today is a 20 percent cut from that level. EPA is being asked to do more rather than less. I think it is important for us to keep that in mind.

Yes, I think my colleague is right. The budget does place an important focus on combating dangerous climate change. We are seeing the consequences of climate change all around us, from historic droughts to extreme wildfires to vanishing wildlife habitat. We are seeing the extreme weather predicted by scientists who sat there

in 2008 and said, you are going to see more snowfall, more droughts and more heat.

When my friend and colleague went to the floor to show that it was cold out and threw a snowball, he said he did it because he thinks we are too serious and he wants us to lighten up.

Senator INHOFE. Since you mentioned my name, I can interrupt you here. Yes, we need to lighten up.

Senator BOXER. Let the record show I quoted him correctly. He said "We need to lighten up."

Here is the deal. He proved my point and the point of those of us who believe climate change is real because we are seeing these extreme snowfalls, records are being broken while we are seeing extreme heat. That is the weather. The climate is different than the weather. We are clearly seeing the rise in overall temperatures.

This is happening right before us. Last week on the front page of the Post, we read that Native villages in Alaska are being threatened by deteriorating sea ice. Entire villages will have to be moved. One is being moved right now at a cost of upwards of $100 million. The article warns, "In the coming decades this could apply to numerous other towns." This has happened before.

Honest to God, I think the only place that doesn't get it is right here but that is the way it is and the way it will continue to be for a couple years, that is for sure.

I want to say EPA is doing essential work on behalf of the American people to address the growing threat of climate change. The budget would ensure that State governments have the resources, the technical assistance and the incentives to help cut carbon pollution from our Country's biggest source, power plants.

I urge you to keep up your good work. You are going to be attacked hard today on this. I know that and I appreciate the fact that my colleagues on the Republican side see it differently. I want to say that those of us on this committee on our side of the aisle feel you have to do this. It is in the law.

Carbon pollution is pollution. We already know from scientists that the co-benefits of reducing carbon mean better health for all of our people, regardless of where they live.

Another important area of EPA's budget is support for the Nation's water infrastructure. I commend EPA for proposing funding for the Water Infrastructure Financing and Innovation Act, which was created last year in the Water Resources Reform and Development Act of 2014.

I want to thank Senator Vitter, Senator Inhofe, Senator Cardin and Senator Carper for going along with this idea.

This is new financing. It is like TIFIA, it leverages funds. However, I agree with my friend and colleague that this is not a replacement for the State revolving fund. I am very concerned that inadequate levels of funding proposed for the State revolving fund is going to hurt our people at home.

Our Nation's water infrastructure needs far outstrip the funding available. The proposed $53.8 million cut to the State revolving funds will make this funding gap grow. We are in agreement on that, Mr. Chairman.

EPA is also doing essential work to protect the drinking water of 117 million Americans. I believe this clean water rulemakes a

lot of sense. I want to compliment you and the Corps of Engineers for your testimony at the last hearing. It was very contentious.

The bottom line is we need to make sure that if there is pollution upstream, that it does not wind up in the bodies of the people living downstream. We need to protect the Clean, Safe Drinking Water Act. One way to do it is by having this rule clarified.

In closing, EPA has a record that Americans support. You are one of the most popular agencies in the Country, whether it is Republicans, Democrats or Independents, because you are fighting for the health of the people.

I think you are doing a great job. I look forward to hearing from you later.

[The prepared statement of Senator Boxer follows:]

STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR
FROM THE STATE OF CALIFORNIA

Welcome Administrator Gina McCarthy. EPA has a vital mission that affects the wellbeing of every American—implementing our nation's landmark laws to address clean air, children's health, safe drinking water, toxics, and water quality in America's lakes and rivers. The health and safety of our children and families depends on the critical work you do.

I am pleased that EPA's budget request of $8.6 billion includes a $452 million increase above the fiscal year enacted level. But we need to remember that 6 years ago, EPA's budget was $10.3 billion, and the fiscal year budget request that we will discuss today is a 20 percent cut from that level. EPA is being asked to do more rather than less and it is important to keep that in mind.

This budget places an important focus on combating dangerous climate change. We are already seeing the consequences of climate change all around us—from historic droughts to extreme wildfires to vanishing wildlife habitat. And we are seeing extreme weather also predicted by scientists—record snowfalls and record heat. So I thank my Chairman for proving that point on the Senate floor recently. That was not his intent, but for me he helped my case.

Last week, on the front page of the Washington Post we read that native villages in Alaska are being threatened by deteriorating sea ice. Entire villages will have to be moved, which will cost upwards of a hundred million dollars. And the article warns that "in the coming decades [this] could apply to numerous other towns."

Another important area of EPA's budget is support for the nation's water infrastructure. I want to commend EPA for proposing funding for the Water Infrastructure Financing and Innovation Act (WIFIA), which was created last year in the Water Resources Reform and Development Act of 2014. This new financing tool will help leverage private financing for critical drinking water and wastewater infrastructure projects and can be an important complement to the Clean Water and Drinking Water State Revolving Funds.

However, WIFIA is not a replacement for the State Revolving Funds. I am concerned about the inadequate levels of funding proposed for these programs. Our nation's water infrastructure needs far outstrip the funding available, and the proposed $53.8 million cut to the State Revolving Funds will make this funding gap grow.

EPA is also doing essential work to protect the drinking water of 117 million Americans. The agency's proposed Clean Water rule will protect those water bodies that provide drinking water for 1 in 3 Americans while being clear about which waters are exempt. You have undertaken an open and transparent process that has given all sides the opportunity to comment. It is important to incorporate that feedback and finalize this vital rule.

EPA has a record that Americans support—clean air, clean water, and a healthy planet are shared values. I look forward to hearing from Administrator McCarthy today.

Senator INHOFE. Thank you, Senator Boxer.

Ms. McCarthy, we will recognize you for the reasonable time you may take. Then we will open it up to questions.

STATEMENT OF GINA MCCARTHY, ADMINISTRATOR, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, ACCOMPANIED BY: DAVID BLOOM, ACTING CHIEF FINANCIAL OFFICER, ENVIRONMENTAL PROTECTION AGENCY

Ms. MCCARTHY. Thank you, Chairman Inhofe, Ranking Member Boxer and members of the committee, for the opportunity to appear before you to discuss the Environmental Protection Agency's proposed Fiscal Year 2016 budget.

I am joined by the agency's Acting Chief Financial Officer, David Bloom.

The EPA's budget request of $8.592 billion in discretionary funding for the 2016 Fiscal Year provides resources that are vital to protecting human health and the environment, while building a solid path forward for sustainable economic growth.

Since 1970 when EPA was founded, we have seen over and over again that a safe environment and a strong economy go hand in hand.

The budget supports essential work to address climate change, improve air quality, protect our water, safeguard the public from toxic chemicals, support communities' environmental health, maintain Corps enforcement strengths, support needed research and work toward a sustainable future for all Americans.

Effective environmental protection is a joint effort of the EPA, States and our tribal partners. We are setting a high bar for continuing our partnership efforts and looking for opportunities for closer collaboration and targeted joint government projects, in planning processes through efforts like E-Enterprise.

That is why the largest part of our budget, $3.6 billion or 42 percent, is provided directly to our State and tribal partners. The Fiscal Year 2016 budget request includes an increase of $108 million for State and tribal categorical grants.

This budget requests $1.1 billion to address climate change and to improve air quality. These resources will help protect the most vulnerable to climate impacts and harmful health effects of air pollution through common sense standards, guidelines, as well as partnership programs.

Climate change is not just an environmental challenge. It is a threat to public health, our domestic and global economy and to our national and international security. The request supports the President's Climate Action Plan and in particular, the Clean Power Plan, which establishes carbon pollution standards for power plants.

In addition, the President's budget calls for $4 billion for a Clean Power State Incentive Fund to support State efforts to accelerate carbon pollution reductions in the power sector.

Protecting the Nation's water remains a top priority for EPA. In Fiscal Year 2016, we will finalize and support implementation of the Clean Water rule which will clarify types of waters covered under the Clean Water Act and foster more certain and efficient business decisions to protect the Nation's waters.

Recognizing the need for water infrastructure, the SRF and related efforts are funded at over $2.3 billion. We will work with our partners to help communities by focusing on issues such as financial planning for future public infrastructure investments and ex-

panded efforts through States to identify financing opportunities for resilient drinking water, wastewater and stormwater infrastructure.

Last month, the agency launched the Water Infrastructure and Resilience Financing Center. That is a key component of this expanded effort. We are proposing a multifaceted effort to help our communities, including low income neighborhoods, rural communities and communities of color.

This includes targeted funding and on the ground community assistance through EPA's regional coordinators and a network of circuit riders. An investment of $16.2 million will help local communities improve safety and security at chemical facilities and prevent and prepare for oil spills.

These efforts represent a shared commitment among those with a stake in chemical facility safety and security, ranging from facility owners to first responders.

The Fiscal Year 2016 budget request will let us continue to make a real and visible difference to communities every day. It gives us a foundation to improve infrastructure across the Country and it will sustain State, tribal and Federal environmental efforts across all our programs.

With this proposed budget, the President is not only sending a clear signal about the resources EPA needs to effectively and efficiently work with States and tribes to protect public health and the environment, it is also a part of an overall Federal a budget proposal that does not accept the bad public policy embodied in sequestration and does not hold back needed resources and nondefense spending in order to increase needed defense spending or vice versa.

Instead, the President's proposed Fiscal Year 2016 budget finds a path forward to avoid sequestration and properly support both domestic and national security interests.

Mr. Chairman, I thank you for the opportunity to testify and look forward to answering questions.

[The prepared statement of Ms. McCarthy follows:]

TESTIMONY OF
GINA MCCARTHY

ADMINISTRATOR
U.S. ENVIRONMENTAL PROTECTION AGENCY

BEFORE THE

THE SENATE ENVIRONMENT AND PUBLIC WORKS COMMITTEE

WEDNESDAY, MARCH 4, 2015

Chairman Inhofe, Ranking Member Boxer, and members of the committee, thank you for the opportunity to appear before you to discuss the Environmental Protection Agency's proposed FY 2016 budget. I'm joined by the agency's Acting Chief Financial Officer, David Bloom.

The EPA's budget request of $8.592 billion in discretionary funding for the 2016 fiscal year starting October 1, 2015 provides the resources vital to protecting human health and the environment while building a solid path for sustainable economic growth. Since the EPA was founded in 1970, we have seen over and over again that a safe environment and a strong economy go hand in hand. In the last 45 years, we have cut air pollution 70 percent and cleaned up half of our nation's polluted waterways. Meanwhile, the U.S. GDP has tripled, which shows that investments in public health and environmental protection are consistent with strong economic growth. Economic prosperity and quality of life depends on public health protection that ensures clean air; clean water; and safe, healthy land.

This budget will let us continue that trend. It funds essential work to address climate change, improve air quality, protect our water, safeguard the public from toxic chemicals, support communities' environmental health, maintain core enforcement strength and work toward a sustainable future for all Americans. Central to this work is supporting our state, local, and tribal partners, working with them to deliver on our environmental and health improvements as a shared responsibility. We are doing this while supporting a strong workforce at the EPA with the tools necessary to ensure effective use of the public funds provided to us.

Making a Visible Difference in Communities Across the Country

We are focused on continuing our work with partners to make a visible difference in communities and across the country—especially in areas overburdened by pollution—including low-income neighborhoods, rural communities, and communities of color.

This budget proposes a multifaceted effort to enable communities of all sizes, rural and urban, to find needed assistance and support for capacity building, planning, and implementation of environmental protection programs. In FY 2016, EPA will support this effort by providing targeted funding and regional coordinators to help communities find the best programs to address local environmental priorities. This budget also provides for a network of "circuit riders" to provide on-the-ground assistance to communities to build and strengthen the adaptive capacity and resilience to

climate change. EPA will also a support community revitalization and economic redevelopment by investing $110 million dollars, an increase of $30 million from last year, to plan, assess, clean up and reuse brownfields.

This request also includes an additional investment of $16.2 million over our current resources to help local communities improve safety and security at chemical facilities, and to prevent and prepare for oil spills. This investment will improve compliance outreach to industry, emergency planning assistance to local communities, updates to existing guidance and regulations, and enhancements to software used by emergency responders.

The EPA will also work to limit public exposure to uncontrolled releases of hazardous substances and make previously contaminated properties available for reuse by communities through a request of close to $540 million in the Superfund Remedial program and another $191 million in the Superfund Emergency Response and Removal program, which is an increase of $48 million across the two programs.

Addressing Climate Change and Improving Air Quality

The fiscal year 2016 budget request for the agency's work to address climate change and to improve air quality is $1.1 billion. These resources will help protect those most vulnerable to climate impacts and the harmful health effects of air pollution through commonsense standards, guidelines, and partnership programs.

Climate change is one of the greatest challenges of our time. Climate change is not just an environmental challenge, it is a threat to public health, to our domestic and global economy, and to our national and international security. The U.S. has already and will continue to shift the international discussion on climate change from one that focuses on mitigation costs to one that embraces new investment opportunities. If done right, we can cut the carbon pollution that is fueling climate change and position the business community, its entrepreneurs, and its innovators to lead the world in a global effort while at the same time, expanding the economy. States and businesses across the country are already working to build renewable energy infrastructure, increase energy efficiency, and cut carbon pollution—creating sustainable, middle class jobs and displaying the kind of innovation that has enabled this country to overcome so many challenges.

This request supports the President's Climate Action Plan and makes climate action a priority. In particular, the Clean Power Plan, which establishes carbon pollution standards for power plants, is a top priority for the EPA and will help spur innovation and economic growth while creating a clean energy economy. The Plan gives states the flexibility they need to design and implement plans that reduce their carbon pollution while meeting the needs of their residents and businesses. The budget request includes an increase of $25 million in direct grant support to states to establish the programmatic infrastructure necessary for effective implementation as well as resources for EPA to provide critical support to the states through technical assistance, developing guidance, modeling, and other tools.

In addition, the President's Budget calls for a $4 billion Clean Power State Incentive Fund to be administered through a mandatory spending account to support state efforts to accelerate carbon

pollution reductions in the power sector. This funding will enable states to invest in a range of activities that complement and advance the Clean Power Plan, including but not limited to direct investments and financing for renewable energy and energy efficiency programs; funding for low-income communities to address disproportionate impacts from environmental pollution; and assistance and incentives for businesses to expand infrastructure for innovative projects that reduce carbon pollution.

The President's Climate Action Plan also calls for greenhouse gas reductions from the transportation sector by increasing fuel economy standards. With input from industry and stakeholders, the EPA, working with the National Highway Transportation Safety Administration, expects to finalize Phase II greenhouse gas and fuel efficiency standards for heavy-duty vehicles. These standards will deliver significant savings at the pump, reduce carbon pollution, and reduce fuel costs for businesses while improving the efficiency of moving goods across the United States.

Protecting the Nation's Waters

Protecting the nation's waters remains a top priority for the EPA. We will continue to build upon decades of efforts to ensure our waterways are clean and our drinking water is safe. Water pollution endangers wildlife, compromises the safety and reliability of our drinking water sources and treatment plants, and threatens the waters where we swim and fish. In FY 2016, we will begin implementation of the Clean Water Rule, which will clarify types of waters covered under the Clean Water Act and foster more certain and efficient business decisions to protect the nation's waters.

Aging systems and the increasing impacts of climate change create opportunities for innovation and new approaches for drinking water and wastewater infrastructure. Building on the strong funding level of $2.3 billion provided through the Clean Water and Drinking Water State Revolving Funds, $50 million is included for technical assistance, training, and other efforts to enhance the capacity of communities and states to plan and finance drinking water and wastewater infrastructure improvements. The EPA will work with states and communities to promote innovative practices that advance water system and community resiliency and sustainability. Dedicated funding through the Clean Water SRF will advance green infrastructure design and practices such as incorporating permeable permanent natural structures, green roofs, and wetlands which can help cost-effectively meet Clean Water Act requirements and protect and restore the nation's water resources.

In January 2015, the agency launched a key component of this expanded effort, the Water Infrastructure and Resiliency Finance Center. We will work with our partners to help communities across the country by focusing on issues such as financial planning for future public infrastructure investments and expanded efforts with states to identify financing opportunities for resilient drinking water, wastewater and stormwater infrastructure. We will enhance our partnership and collaboration with the U.S. Department of Agriculture on training, technical assistance, and funding opportunities in rural areas. The Water Infrastructure and Resiliency Finance center is part of the Build America investment initiative, a government-wide effort to increase infrastructure investment and promote economic growth by creating opportunities for state and local governments and the private sector to collaborate on infrastructure development.

Separately, EPA will continue efforts to protect and restore ecosystems through its geographic programs. EPA and its federal partners are making steady progress on reducing unexpended balances of Great Lakes Restoration Initiative funding, and will continue and strengthen efforts to further reduce these balances and examine potential ways to increase expenditure rates in future years.

Protecting Our Land

The EPA strives to protect and restore land to create a safer environment for all Americans by cleaning up hazardous and non-hazardous wastes that can migrate to air, groundwater and surface water, contaminating drinking water supplies, causing acute illnesses and chronic diseases, and threatening healthy ecosystems. We preserve, restore, and protect our land, for both current and future generations by cleaning up contaminated sites and returning them to communities for reuse. Our funds will assist communities in using existing infrastructure and planning for more efficient and livable communities, and encouraging the minimization of environmental impacts throughout the full life cycle of materials.

In FY 2016, we will increase the Superfund Remedial program by $39 million to accelerate the pace of cleanups, supporting states, local communities, and tribes in their efforts to assess and cleanup sites and return them to productive reuse, and encourage renewable energy development on formerly hazardous sites when appropriate. We will expand the successful Brownfields program, providing grants, and supporting area-wide planning and technical assistance to maximize the benefits to the communities. In FY 2016, the EPA is investing $110 million in funding for Brownfields Project grants to local communities, an additional $30 million over the FY 2015 Enacted Budget, increasing the number of grants for assessment and cleanup of contaminated sites. This investment builds on the program's successful community-driven approach to revitalizing contaminated land and further supports the agency's efforts to make a visible difference in communities.

Taking Steps to Improve Chemical Facility Safety

In support of the White House Executive Order 13650 on Improving Chemical Facility Safety and Security, the EPA is requesting $27.8 million for the State and Local Prevention and Preparedness program, an increase of $12 million above the FY 2015 enacted level. This increase will allow the EPA to continue to improve the safety and security of chemical facilities and reduce the risks of hazardous chemicals to facility workers and operators, communities, and responders.

These efforts represent a shared commitment among those with a stake in chemical facility safety and security: facility owners and operators; federal, state, local, Tribal, and territorial governments; regional entities; nonprofit organizations; facility workers; first responders; environmental justice and local environmental organizations; and communities. In FY 2016, we are implementing actions to strengthen community planning and preparedness, enhance federal operational coordination, improve data management, modernize policies and regulation, and incorporate stakeholder feedback and best practices.

Continuing EPA's Commitment to Innovative Research & Development

In building environmental policy, scientific research continues to be the foundation of EPA's work. Environmental issues in the 21st century are complex because of the interplay between air quality, climate change, water quality, healthy communities, and chemical safety. Today's complex issues require different thinking and different solutions than those used in the past. In FY 2016, we are requesting $528 million for research and development to evaluate and predict potential environmental and human health impacts including impacts related to air pollution, water quality, climate change and biofuels. This will allow all decision makers at all levels of government to have the science needed to develop and implement environmental policies and strategies. This request will also support expanding the EPA's computational toxicology effort—which is letting us study chemical risks and exposure exponentially faster and more affordably than ever before. We are also providing support tools for community health, investigating the unique properties of emerging materials, such as nanomaterials, and research to support the nation's range of growing water-use and ecological requirements.

Supporting State and Tribal Partners

Effective environmental protection is a joint effort of EPA, states and our tribal partners, and we are setting a high bar for continuing our partnership efforts. That's why the largest part of our budget, $3.6 billion dollars or 42 percent, is provided directly to our state and tribal partners. In FY 2016, we are requesting an increase of $108 million in funding for State and Tribal Assistance categorical grants. The increase for State and Tribal assistance includes an additional $31 million over the FY 2015 enacted level for the Tribal General Assistance Program, supporting Tribes in the development of sustainable and robust environmental regulatory programs for Indian country.

As one example of our efforts, we are also including opportunities for closer collaboration and targeted joint planning and governance processes. One example is the E-Enterprise approach, a transformative 21st century strategy to modernize the way in which government agencies deliver environmental protection. With our co-regulatory partners, we are working collaboratively to streamline, reform, and integrate our shared business processes and related systems. These changes, including a shift to electronic reporting, will improve environmental results, reduce burden, and enhance services to the regulated community and the public by making government more efficient and effective. State-EPA-Tribal joint governance serves to organize the E-Enterprise partnership to elevate its visibility, boost coordination capacity, and ensure the inclusiveness and effectiveness of shared processes, management improvements, and future coordinated projects. Projects following the E-Enterprise approach will yield the benefits of increased transparency, efficiency, and burden reduction for communities, businesses, and government agencies when implemented.

Maintaining a Forward Looking and Adaptive EPA

The EPA has strategically evaluated its workforce and facility needs and will continue the comprehensive effort to modernize its workforce. By implementing creative, flexible, cost-effective, and sustainable strategies to protect public health and safeguard the environment, the EPA will target resources toward development of a workforce and infrastructure that can address current challenges and priorities.

We are requesting funding in this budget to help us fast-track efforts to save taxpayer dollars by optimizing and renovating critical agency space. That includes our laboratory buildings across the country, where we conduct critical scientific research on behalf of the American public. In the past three years, the EPA realized $8.3 million in rent avoidance by releasing over 225 thousand square feet of space nationwide. We've taken a careful look at our workforce and facility needs so we can continue to optimize and update our physical footprint in FY 2016. We'll also target resources to prepare our outstanding agency workforce for the future, and continue our E-Enterprise effort with states to improve and modernize joint business processes—for instance, replacing outdated paper processes for regulated companies with electronic submissions.

The EPA continues to examine its programs to find those that have served their purpose and accomplished their mission. The FY 2016 President's Budget also eliminates some mature programs where state and local governments can provide greater capacity. Those grant programs are the Beaches Protection categorical grants, the State Indoor Air and Radon grants, the Targeted Airshed grants and the Water Quality Research and Support grants, totaling $44.6 million.

The EPA's fiscal year 2016 budget request will let us continue to make a real and visible difference to communities every day. It will give us a foundation to revitalize the economy and improve infrastructure across the country. And it will sustain state, Tribal, and federal environmental efforts across all our programs.

I thank you for the opportunity to testify today. While my testimony reflects only some of the highlights of the EPA's FY 2016 budget request, I look forward to answering your questions.

RESPONSE BY GINA MCCARTHY TO AN ADDITIONAL QUESTION FROM SENATOR BOOKER

BEACH ACT

Question 1. The BEACH Act authorized the EPA to award grants to eligible states, territories, and tribes to develop and implement beach water quality monitoring and notification programs for coastal recreational waters. As a result, EPA's Beach Grants have made nearly $10 million a year available for the past 4 years. The program allows for a more standardized approach to the monitoring of water quality and the notification of beach goers if the water they are swimming in is unsafe for recreation.

• What is EPA's justification for zeroing out funding for the BEACH Act grant program?

• Given the reduction in EPA's proposed fiscal year from $10 million to $0, how does EPA plan to assist State and local public health officials in identifying, notifying the public of, and ultimately reducing the risk of illness and disease to swimmers at our recreational beaches?

Response. The agency is proposing to eliminate certain mature program activities that are well-established, well understood, and where there is the possibility of maintaining some of the human health benefits through implementation at the local level. While beach monitoring continues to be important to protect human health, states and local governments now have the technical expertise and procedures to continue beach monitoring without Federal support, as a result of the significant technical guidance and financial support the Beach Program has provided.

RESPONSES BY GINA MCCARTHY TO ADDITIONAL QUESTIONS FROM SENATOR FISCHER

Question 1. In your budget justification document you say:

"In support of the President's Climate Action Plan, the EPA will work to assist other Federal agencies to improve the analysis of climate change issues under NEPA, including estimating greenhouse gas emissions associated with Federal actions and consideration of mitigation measures, as well as fostering climate resiliency."

Are you already implementing CEQ's draft guidance that would require all Federal agencies to address global climate change in NEPA reviews?

Response. NEPA currently requires that agencies consider greenhouse gas emissions and climate change in the NEPA process as it would other pollutants. The draft CEQ guidance will help promote consistency and efficiency in meeting NEPA obligations.[1] Our ongoing comments to other agencies reflect the concepts outlined in the draft guidance, and are meant to help agencies meet their existing NEPA responsibilities. As noted in the draft guidance, "Climate change is a fundamental environmental issue, and the relation of Federal actions to it falls squarely within NEPA's focus."

Question 2. In your role as a reviewer of Environmental Impact Statements developed by other agencies, do you believe you can require other agencies to adopt measures to mitigate global climate change?

Response. The EPA does not have authority to require other agencies to adopt mitigation measures as part of the NEPA process. However, NEPA does require that agencies consider appropriate mitigation measures for the environmental impacts associated with their proposed actions, and the agency will continue to recommend that agencies consider ways to reduce greenhouse gas emissions associated with their actions.

Question 3. Do you think that the draft CEQ guidance would give you the power to second-guess a decision by another Federal agency that any effect on global climate change is insignificant and no EIS is needed?

Response. The EPA's role is to make recommendations for the other agencies to consider as they make their decisions on actions that may impact the environment. NEPA requires agencies to carry out their NEPA responsibilities in a manner that is reasonable, and the same rule of reasonableness applies to the consideration of climate impacts. Embedded in implementing NEPA are the rule of reason, proportionality, and flexibility to provide the agency preparing the analysis and documentation to focus on the issues that are important, hear from all stakeholders and consider their input based upon the substance and expertise provided, and exercise

[1]http://www.gpo.gov/fdsys/pkg/FR–2014–12–24/pdf/2014–30035.pdf

their professional judgment in projecting the potential environmental—including all elements of the human environment which encompass ecological, social, and economic effects of the proposal and any reasonable alternatives. The CEQ's draft guidance seeks to provide greater clarity to agencies as they carry out their NEPA responsibilities.

Question 4. Have you done any outreach to stakeholders on the draft CEQ guidance?

Response. CEQ, as the drafter of the guidance, is managing the public input process. The EPA has not conducted any independent stakeholder outreach.

Question 5. How will the new guidance affect how EPA complies with NEPA for its own actions, such as issuing Clean Water Act permits or developing regulations?

Response. The EPA is working to ensure that NEPA compliance for our own actions consider, as appropriate and consistent with the draft CEQ guidance, the extent to which the proposed action has associated greenhouse gas emissions, and the extent to which adaptation and resilience measures may be necessary in light of expected climate change. Some of the specific actions included in this question, such as some Clean Water Act permits and issuing of regulations, do not fall within the scope of NEPA because they are specifically exempted by statute, e.g., see Section 511 (c) of the Clean Water Act.

RENEWABLE FUELS STANDARDS (RFS)

Question 6. In 2007, Congress put the Renewable Fuel Standard in place for 15 years, setting a stable policy environment to drive investment and growth in renewable fuel. This approach has guided billions of dollars from around the world and here at home toward innovation inside the United States. American agriculture has also responded to this investment signal. For example, just this year, 3 cellulosic biofuel refineries opened, each co-located with a corn ethanol facility. Each biorefinery is producing clean, cellulosic biofuel. Using specially designed equipment, all three facilities use corn stover, an agricultural waste material collected from the very same fields that provide corn to ethanol facilities. This didn't happen by accident. Farmers make planting decisions based on the RFS. Equipment manufacturers' invest million in R&D perfecting new equipment that can be available to serve this market. Congress made a promise in 2007, and it is the EPA's responsibility to uphold that promise with a regulatory process that meets our intent. The 2014 RVO proposal would have stranded billions of dollars of investment and ripped the rug out from under those in the private sector who responded to the investment signals of the RFS. Will your new proposal retain the commitment to American agriculture that we made nearly a decade ago?

Response. The EPA understands the importance of the RFS program, and is committed to the program's goals, namely, reducing emissions of greenhouse gases from the transportation sector and increasing American energy security. The agency is aware that the agricultural community, as well as renewable fuel producers and other stakeholders, have invested significant time, energy, and resources into ensuring that the objectives of the RFS program become a reality. Renewable fuel use has increased substantially over the past decade, and we have seen significant advancements in renewable fuel production capacity and efficiency, including recent advancements in the commercial-scale production of cellulosic biofuel. Congress designed the RFS program to rely primarily on growth in conventional biofuel beginning with its inception in 2006, but then to transition to growth primarily in cellulosic and other advanced biofuel growth for 2015 and beyond. Our proposed standards are consistent with this intent of Congress.

The annual rule-setting process under the statute has proven to be very challenging, and we recognize that the delay in issuing the 2014 standards has exacerbated uncertainty in the market for both renewable fuel producers and obligated parties. However, the EPA is committed to getting this program back on the statutory timeline to provide needed market certainty and support the development and use of renewable fuels by completing a rulemaking for the 2014, 2015 and 2016 RFS standards by November 30, 2015.

Question 7. Your staff has recently stated that you anticipate putting out RFS volumes by late June. Do you see that as acceptable? Given that we have biodiesel producers across the country shutting down or idling their plants, why do we need to wait another 4 months? If we wait until June we've lost another half of a year.

Response. The EPA recognizes that delays in issuing the rule have contributed to uncertainty in the market. We proposed volume standards for 2014, 2015, and 2016 on June 10, 2015 (80 FR 33100) and are committed to finalizing these standards by November 30, 2015. The agency also will finalize the applicable volume of

biomass-based diesel for 2017 along the same timeline. By doing so we will get the program back on the statutory timeline and establish a more stable footing for the program's future.

Question 8. Your staff also recently stated that 2014 numbers will be based on actual production. What does that mean exactly? Does that mean the volumes will be set at the levels that were actually produced under the RFS in 2014? And can we assume that we will see growth from there in the biodiesel category in 2015 and 2016?

Response. The EPA has proposed 2014 standards that reflect the volumes of renewable fuel that were actually used in 2014, as it is those volumes that are eligible to be used to meet applicable standards under the RFS program. The agency did so because the 2014 compliance year is now over, and any standard the EPA sets for 2014 can no longer influence renewable fuel production or use in that year. Details of how we calculated the 2014 volumes are addressed as part of the proposal (80 FR 33100, June 10, 2015).

Question 9. You recently approved an application from Argentinian companies to essentially streamline biodiesel imports from Argentina under the RFS. Why would you do that when the overall RFS hasn't been set for 2 years and the U.S. industry is in disarray? It almost shows a disregard for the U.S. companies that we know are struggling as a direct result of the delays on the RFS. Can you explain why you would do that at this time? Why not wait until the RFS volumes are set and then make a decision on the Argentina imports?

Response. The agency notes that under the existing regulations, biofuels were already being imported from Argentina. The CARBIO plan provides for even more oversight to ensure that feedstocks used to produce compliant renewable fuels under the program are coming from qualifying land. CARBIO's plan includes a robust tracking program that requires that an independent third party conduct an annual survey of the entire biofuel supply chain, from soybean production through intermediate processing, to biodiesel production. This approved plan enhances existing regulatory oversight requirements currently applied to qualifying renewable fuels being imported from Argentina.

Question 10. I understand that in setting the annual biodiesel volumes you are required under the law to look at production capacity and other factors. So now that we know this extra production exists and is likely coming to the United States, how will you account for that as you set annual RFS standards for biodiesel? In other words, will you increase volumes more aggressively to allow U.S. producers to continue to grow, so that they're not displaced by these Argentinian imports?

Response. The proposed biomass-based diesel standards establish minimum volumes for biomass-based diesel to provide additional certainty to the biodiesel and renewable diesel industries. The proposed biomass-based diesel standards ensure steady growth through 2017.

All of the RFS standards that we proposed take into consideration domestic production, imports and exports. The market will determine the precise mix of fuels and their sources for complying with the standards, as a result of a number of market forces and national biofuel or related policies both here in the U.S. and in other countries. Since those market forces and policies change over time, we did not attempt to estimate precisely the resulting volumes that would be imported from specific countries. The proposed standards provide ample room for the growth of biodiesel volumes from domestic production in addition to potential import volumes.

EPA REGION 7

Question 11. Private Nebraska building contractor entities have shared inquiries and questions regarding EPA Region 7, Kansas City, and the utilization of resources and personnel enforcing lead paint regulations against Nebraska home and building contractors. In particular, private building contractors have expressed concerns involving the manner and rationale of investigations conducted by Region 7 and the protocol for fines pursued for stated violations.

Response. We interpret this to be a statement to provide context to Question 13.

Question 12. In order to address concerns expressed by Nebraska private contractor interests, I request that EPA provide the following information involving Region 7, Kansas City and the regulation of lead paint in private homes and commercial businesses:

Response. We interpret this to be a statement to provide context to Question 13.

Question 13. Please provide a budget breakdown of:

• The amount of Region 7 funds expended for outreach and education to the building contractor community in Nebraska.

• The amount of funds directly tied to educating property owners and building contractors on EPA lead paint rules and regulations.

• What amount of Region 7's Budget is dedicated to investigations and pursuit of fines?

Response. Region 7 has responsibilities for various Toxic Substance Control Act regulations related to lead-based paint including TSCA Section 402(c), 15 U.S.C. Section 2682, Renovation, Repair, and Painting Program (RRP) which addresses lead-based paint hazards created by renovation, repair, and painting activities that disturb lead-based paint in housing and child occupied facilities built before 1978. Within Region 7, the states of Iowa and Kansas have requested and been approved for implementing the RRP Program. Neither Nebraska nor Missouri have sought such approval and, as such, Region 7 is responsible for direct implementation of the regulation in these two states. Additionally, Region 7 is responsible for direct implementation of the TSCA Section 1018, Lead-based Paint Disclosure Rule, in Iowa, Nebraska, Kansas and Missouri. This rule is not delegable to states.

Region 7 implements all agency enforcement and compliance programs (which includes supporting many environmental statutes such as Resource Conservation and Recovery Act; Clean Water Act; Safe Drinking Water Act; Clean Air Act; Residential Lead-Based Paint Hazard Reduction Act; etc.) and for the Lead Risk Reduction program (which includes supporting the RRP and Disclosure Rule, providing education and outreach, implementing lead-based paint activities, and other program-related activities). In fiscal year 4, Region 7 dedicated 4.3 FTE and $314,000 to support RRP and Disclosure Rule activities (which includes State grant oversight, State technical support, outreach/compliance assistance, enforcement, and other related activities). In fiscal year 5, Region 7 has allocated 4.3 FTE and approximately $275,000 to support RRP and Disclosure Rule activities. While Region 7 receives funding for the agency's programs, Region 7 does not allocate its funding on a state-by-State basis or at an activity level.

Question 14. Does Region 7 contract with private or commercial entities to investigate reported violations? And Does Region 7 offer financial incentives to individuals who report violations?

Response. The EPA, through a cooperative agreement with the National Older Worker Career Center (NOWCC), utilizes the NOWCC personnel for various activities (i.e. inspections, outreach, administrative support, etc.). The NOWCC is a national non-profit organization which helps to identify and place older workers with the EPA through the Senior Environmental Employment Program. Region 7 is a participant and provides funding to the SEE Program to obtain support for lead-based paint related inspections and other activities. The personnel provided by the NOWCC for the program are considered grant enrollees with the NOWCC. These personnel would conduct both routine inspections and inspections assigned as a result of a tip or complaint.

Region 7 does not offer incentives to individuals who report violations. Individuals frequently contact Region 7 to report suspected violations. These individuals are generally contractors concerned that non-compliance by others may place them at a competitive disadvantage; families concerned about the risks of lead dust to children created through painting or renovation activities in their home; and/or, local agencies who have identified painting or renovation activities which they perceive to be non-compliant and which may pose risks to children.

RESPONSES BY GINA MCCARTHY TO ADDITIONAL QUESTIONS FROM SENATOR INHOFE

OZONE

Question 1. In the proposed rule, you State that EPA will take a series of actions in the next year to implement the new standard. (EPA says it will issue guidance for State designations within 4 months of finalizing the rule, provide guidance for infrastructure SIPs, and propose any needed implementation rules within 1 year.)

• Approximately how much money, resources, and staff will be required to complete this work in fiscal year 6?

• Has EPA requested the resources needed to complete all of this work?

• Where in the budget are these resources requested?

Response. Within the levels in the fiscal year President's Budget, the agency requests the resources and FTE necessary to continue its Clean Air Act-prescribed responsibilities to administer and implement the NAAQS. This includes funding for

review of the ozone NAAQS and for implementation of a potentially revised ozone standard, including development of transition guidance and area designation guidance, within current statutory and resource limitations. The agency also will continue consulting with states to determine additional methods to improve the SIP development and implementation process that are within current statutory limitations.

Question 2. The proposal relies heavily on "unknown technologies" for compliance (Table 4–10 in the draft RIA: 66 percent of NOx controls in the East are unknown and 70 percent in the West are unknown). However, only "extreme" nonattainment areas can include unknowns in their SIPs.

• How do you expect states to comply with a standard when your agency can't even identify ways to make it feasible?

• Do you expect states to have to choose between extreme sanctions or self-designating themselves as "extreme" nonattainment areas, accepting all the extreme stationary source requirements that go along with that designation?

• Your RIA already assumes in the "known controls" that the existing source proposal will be complied with fully, so how is it even remotely possible to achieve your proposed standard?

Response. The EPA's application of unknown control measures reflects the agency's experience that some portion of controls to be applied in the future may not be currently available but will be deployed or developed over time. The EPA's application of unknown control measures does not mean the agency has concluded that all unknown control measures are currently not commercially available or do not exist. Unknown control technologies or measures can include existing controls or measures for which the EPA does not have sufficient data to accurately estimate engineering costs. In addition, there will likely be some emissions reductions from currently unknown control technologies as a result of state-specific rules that are not yet finalized.

Question 3: How much of future attainment relies on "unknown controls"? How does EPA calculate the cost these future "unknown controls"? Why has EPA lowered the cost of those unknown controls by half since developing the 2011 ozone rule?

Response. Following advice from the EPA Advisory Council on Clean Air Compliance Analysis (COUNCIL), in the 2014 analysis EPA relied on a methodology to estimate the cost of unknown controls that used an average cost-per-ton for the needed emissions reductions. The agency agrees with the COUNCIL that the approach is both transparent and strikes a balance between the likelihood that some unidentified abatement would be achieved at costs that are lower than average and that some would be achieved at costs that are higher than average.

Question 4. In 2011, President Obama pulled the plug on this same proposal due to "regulatory burdens and regulatory uncertainty." Our economy was still struggling to recover from the recession, and the $90 billion price tag was something even he was unable to justify.

• o you really think that our economy is in better shape now to handle a $3 trillion rule than it was in 2011?

• What has changed since the President's decision that signals now is an appropriate time to radically revise the standard before the benefits of the last one have been fully implemented?

Response. Sections 108 and 109 of the Clean Air Act (CAA) govern the establishment, review, and revision, as appropriate, of the NAAQS to protect public health and welfare. The CAA requires the EPA to periodically review the air quality criteria the science upon which the standards are based and the standards themselves. This rulemaking is being conducted pursuant to these statutory requirements.

The EPA sets the National Ambient Air Quality Standards at a level that is requisite to protect the public health and welfare, based on the best available science. The U.S. Supreme Court ruled in Whitman v. American Trucking Associations, 531 U.S. 457 (2001), that under Section 109 of the Clean Air Act, the EPA may not consider the costs of implementation in setting standards.

Under the Clean Air Act, states ultimately determine what local measures may be required to address local sources of air pollution. For that reason, the EPA presents an illustrative estimation of the costs and benefits of complying with proposed revisions to a NAAQS. EPA estimates that reducing pollution to meet a revised ozone NAAQS in 2025 will yield health benefits of $6.4 to $13 billion annually for a standard of 70 ppb, and $19 to $38 billion annually for a standard of 65 ppb, except for California, which was analyzed separately. Nationwide costs, except California, are estimated at $3.9 billion in 2025 for a standard of 70 ppb, and $15 billion

for a standard of 65 ppb. The estimated benefits of a strengthened ozone standard outweigh the estimated costs by as much as a ratio of $3.33 to $1.

For decades, ozone pollution has been reduced by the combined efforts of Federal, state, tribal and local governments. The costs and benefits of Federal rules are evaluated during the public process for each rule. More than forty years of experience with the Clean Air Act has shown that America can build its economy and create jobs while cutting pollution to protect the health of our citizens and our workforce.

Question 5. Compared to just 4 years ago, EPA has lowered cost estimates for the same stringent ozone standards by as much as $51 billion. Have compliance costs for ozone controls really dropped by over 80 percent since 2010?

Response. The cost estimates for the 2014 proposal are different than the 2010 reconsideration proposal because we are analyzing changes between different current and proposed standards, air quality, and needed emissions reductions. In part because of recent improvements in air quality and Federal and State actions that will come into effect over the next decade, meeting the proposed standards will require fewer emissions reductions than the reconsideration, meaning the estimated costs are lower.

Question 6. Over the last 4 years, EPA has slashed its cost estimates for the same stringent ozone standards.

• Has the cost of compliance technologies gone down, or did EPA change the assumptions in its cost-benefit analysis?

• How much of that reduction is due to projected air quality improvements versus changes in EPA's control cost assumptions?

Response. The cost estimates for the 2014 proposal are different than the 2010 reconsideration proposal because we are analyzing changes between different current and proposed standards, air quality, and needed emissions reductions. In part because of recent improvements in air quality and Federal and State actions that will come into effect over the next decade, meeting the proposed standards will require fewer emissions reductions than the reconsideration, meaning the estimated costs are lower.

Question 7. In 2010, EPA projected that the same ozone standards that EPA is now proposing could cost as much as $44 billion per year. These are straight-up, added costs to American manufacturing. I'm concerned that, during this slow economic recovery, we are driving manufacturing out of the U.S., to other countries with lax environmental standards. In analyzing these proposed regulations, does EPA consider the effects of driving manufacturing offshore, to countries with little or no environmental controls?

Response. The EPA sets the National Ambient Air Quality Standards at a level that is requisite to protect the public health and welfare, based on the best available science. The U.S. Supreme Court ruled in Whitman v. American Trucking Associations, 531 U.S. 457 (2001), that under Section 109 of the Clean Air Act, the EPA may not consider the costs of implementation in setting standards.

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For decades, ozone pollution has been reduced by the combined efforts of Federal, state, tribal and local governments. The costs and benefits of Federal rules are evaluated during the public process for each rule. More than forty years of experience with the Clean Air Act has shown that America can build its economy and create jobs while cutting pollution to protect the health of our citizens and our workforce.

Question 8. High levels of natural background ozone may cause many otherwise clean states, especially in the West, to be unable to meet EPA's stringent ozone proposal even with costly emission controls.

• EPA says it can deal with these concerns through its "exceptional events" program. Yet, since 2008, Utah has submitted 12 exception event demonstrations, and EPA has yet to approve one. Historically, how many times has the exceptional exceedance policy been used by the states and EPA? How long and what was the cost to taxpayers each time it was used? How many times annually do you expect it to be needed going forward?

• EPA also says it can deal with these concerns through "Rural Transport Areas." Yet EPA has no track record for Rural Transport Areas under an 8 hour ozone standard like in the proposal. Why should we think the Agency can use Rural Transport Areas to provide regulatory relief to states with high background ozone?

Response. Existing and upcoming EPA regulations and guidance will assist states in ensuring background ozone does not create unnecessary control obligations as they continue their work to improve air quality.

Assuming a State can provide an adequate assessment or demonstration to legally invoke regulatory relief, there are a few types of CAA-authorized relief that are described in the ozone NAAQS proposal. As examples, an area may be able to rely upon the exceptional events provisions of the Act to exclude certain emissions data from consideration during the process of area designations under the possible revised NAAQS, which could impact whether an area is designated nonattainment. An area also may be able to rely on the international emissions provisions of the Act when making attainment demonstrations, which could limit their ultimate control requirements. Finally the Administrator can determine that certain qualifying nonattainment areas are Rural Transport Areas, thus eliminating the need for states to develop an attainment plan. All of these CAA-authorized provisions have been used in the past for implementing ozone standards.

The states typically submit exceptional events demonstrations between the promulgation of a new or revised NAAQS and the initial area designations for that NAAQS, in order avoid designation as a nonattainment area through exclusion of data affected by exceptional events. The EPA recognizes the challenges associated with developing, submitting and reviewing exceptional events demonstration packages and is actively developing Exceptional Events Rule revisions and additional guidance on demonstrating ozone-related exceptional events associated with wildfire, which we anticipate proposing in the fall of 2015 and finalizing in the summer of 2016. This schedule will ensure the final rule revisions and ozone-related guidance are available in advance of implementation activities (e.g., Governors' designation recommendations) for any potential new or revised ozone NAAQS. Because states submit exceptional events demonstration packages directly to their reviewing EPA regional office, the EPA does not have a national tracking system for the submission, review, and expended resources associated with the exceptional events process. Some air agencies and EPA regions have developed their own processes, systems, and criteria to track exceptional event-related information.

Question 9. Yellowstone national park's current ozone level is 66ppb——

• Is the Agency considering setting a standard that is below the current ozone levels at Yellowstone National Park?

• I understand EPA has been criticized regarding the way background ozone concentrations are calculated and used. What steps is the agency taking to improve that process?

Response. Based on a significantly expanded body of scientific evidence, including more than 1,000 new studies since the last review of the standards, the EPA is proposing that the current primary ozone standard set at a level of 0.075 ppm is not requisite to protect public health with an adequate margin of safety, and that it should be revised to provide increased public health protection. This proposed conclusion is supported by the independent group of science experts who form the Clean Air Science Advisory Committee (CASAC). Specifically, the EPA is proposing to revise the level of that standard to within the range of 0.065 ppm to 0.070 ppm to increase public health protection, including for "at-risk" populations such as children, older adults, and people with asthma or other lung diseases, against an array of ozone-related adverse health effects. For short-term ozone exposures, these effects include decreased lung function, increased respiratory symptoms and pulmonary inflammation, effects that result in serious indicators of respiratory morbidity such as emergency department visits and hospital admissions, and non-accidental mortality. For long-term ozone exposures, these health effects include a variety of respiratory morbidity effects and respiratory mortality.

Existing and upcoming EPA regulations and guidance will assist states in ensuring background ozone does not create unnecessary control obligations as they continue their work to improve air quality.

Question 10. I understand that EPA does not exclude Mexican and Canadian ozone emissions when it determines background levels of ozone. What could a county in my district due to control emissions in a foreign country?

Response. Existing and upcoming EPA regulations and guidance will assist states in ensuring background ozone does not create unnecessary control obligations as they continue their work to improve air quality. For purposes of implementing the ozone standards, sources of ozone precursor emissions emanating from outside the

U.S. are considered background sources. The CAA contains attainment planning provisions that allow states to account for international emissions that are beyond their control. If used appropriately, these provisions could limit the ultimate control requirements that would apply to local sources. These CAA provisions have been used in the past in implementing the ozone standards.

Question 11. High levels of ozone transported from Asia and Mexico may mean that many otherwise clean states, especially in the West, will be unable to meet EPA's stringent ozone proposal even with costly emission controls. EPA says it can deal with these concerns through Clean Air Act provisions on international transport.

• EPA has been notoriously slow in providing states similar regulatory relief for natural ozone under the Exceptional Events Program. Why should states believe that EPA will be any better in approving regulatory relief for international ozone transport?

• Will EPA commit to not designate as nonattainment any counties that fail the proposal's ozone standards because of international transport?

Response. Existing and upcoming EPA regulations and guidance will assist states in ensuring background ozone does not create unnecessary control obligations as they continue their work to improve air quality.

Assuming a State can provide an adequate assessment or demonstration to legally invoke regulatory relief, there are a few types of relief that are included in the proposal. As examples, an area may be able to rely on existing CAA-authorized provisions to obtain relief from designation as a nonattainment area, or relief from adopting additional controls to demonstrate attainment.

Question 12. EPA halted implementation of the 2008 ozone standard from 2010–2012 while it reconsidered that standard. That delay put State implementation of the 2008 ozone standard well behind the normal schedule. States are now committing time and money to catch up on the 2008 ozone standard. In fact, EPA just issued the implementation rules for the 2008 standard on February 13, 2015. Why is EPA proposing new ozone standards when it hasn't given states a chance to implement the current ones?

Response. Sections 108 and 109 of the Clean Air Act (CAA) govern the establishment, review, and revision, as appropriate, of the NAAQS to protect public health and welfare. The CAA requires the EPA to periodically review the air quality criteriathe science upon which the standards are based and the standards themselves. This rulemaking is being conducted pursuant to these statutory requirements.

Question 13. EPA chose to project the costs of its proposed ozone standard to 2025, 8 years after counties will be designated as nonattainment areas under the proposal.

• What consequences will those counties face while designated nonattainment?

• Does EPA's modeling capture the cost of lost economic activity that counties in nonattainment areas will experience during those 8 years?

Response. The Clean Air Act provides for a range of actions to take place when an area is designated nonattainment. The specifics are discussed in further detail in section VII.4 of the preamble to the proposed rule (Nonattainment Area Requirements beginning on 79 FR 75373).

Consistent with Executive Order 12866, and OMB guidance, the EPA prepared a Regulatory Impact Analysis accompanying the proposed updates to the ozone NAAQS that shows the benefits and costs of illustrative control scenarios that states may choose in complying. Because states have flexibility in how to meet their goals, the actions taken to meet the goals may vary from what is modeled in the illustrative scenarios. Specific details, including information about how costs and benefits are estimated for these illustrative scenarios are available in the RIA (http://www.epa.gov/ttn/ecas/regdata/RIAs/20141125ria.pdf).

Question 14. EPA chose to project the costs of its proposed ozone standard to 2025, saying that would be the year in which most counties would have to attain the standards if granted compliance extensions.

• Since EPA bases its entire economic analysis on these assumed extensions, will the Agency commit to extending compliance deadlines to the maximum extent possible when finalizing the ozone standards?

• If EPA assumed longer compliance deadlines, shouldn't it write those compliance extensions into the final rule?

Response. The EPA intends to take action to provide for compliance flexibility similar to what has been provided under prior standards.

Question 15. EPA reassures that counties won't be designated as nonattainment areas under its proposed stringent ozone standards for another 3 years. But won't those new standards be immediately effective on PSD permits, making it harder for business to build and expand facilities to create new jobs?

Response. New or modified major stationary sources that must get a PSD permit must show that the project will not cause or contribute to a violation of a revised ozone standard upon the effective date of that standard. The EPA has proposed a grandfathering provision for PSD permit applications that are administratively complete before the new NAAQS is signed, or where a draft permit or preliminary determination has been published before the effective date of a revised standard. Those in-pipeline permit applications meeting the qualification criteria in EPA's final rule would not need to be revised in order to be approved.

Question 16. EPA has said that most counties won't need to attain its stringent ozone standards until 2025. But counties in nonattainment areas will face severe regulatory consequences in just 3 years, and the new standards become immediately effective for permits to expand business. EPA seems to want us to think these proposed standards are a "next decade" problem, but aren't they a now problem?

Response. Approximately 2 years after a standard is revised, the EPA is required to determine attainment and nonattainment areas. For areas designated nonattainment, additional preconstruction permitting requirements must be implemented and, depending on the severity of the poor air quality in the area, the State must begin developing attainment plans for the area. The first attainment deadline under the Act is 3 years following designation, which would be by the end of 2020 if areas are designated in the fall of 2017. This attainment deadline would apply only to those areas with air quality closest to the standard at the time of designation and such areas would not be required to develop an attainment plan.

Question 17. EPA can't even point to controls capable of almost half the emissions reductions needed in the east and all of the reductions required in California to meet its stringent proposed ozone standard. This sounds like shoot first, ask questions later rulemaking. Should we be imposing this much burden on the American people when EPA doesn't even know how this rule can be accomplished?

Response. The U.S. Supreme Court ruled in Whitman v. American Trucking Associations, 531 U.S. 457 (2001), that under Section 109 of the Clean Air Act, the EPA may not consider the costs of implementation in setting National Ambient Air Quality Standards. The Court indicated specifically that EPA was not to consider potential job losses due to implementation of a standard, even if such job losses "might produce health losses". 531 U.S. at 466. Moreover, if EPA were to consider such costs, it would be "grounds for vacating the NAAQS, because the Administrator had not followed the law". Id. at n. 4.

Under the Clean Air Act, states ultimately determine what local measures may be required to address local sources of air pollution. For that reason, the EPA presents an illustrative estimation of the costs and benefits of complying with proposed revisions to a NAAQS. EPA estimates that reducing pollution to meet a revised ozone NAAQS in 2025 will yield health benefits of $6.4 to $13 billion annually for a standard of 70 ppb, and $19 to $38 billion annually for a standard of 65 ppb, except for California, which was analyzed separately. Nationwide costs, except California, are estimated at $3.9 billion in 2025 for a standard of 70 ppb, and $15 billion for a standard of 65 ppb. The estimated benefits of a strengthened ozone standard outweigh the estimated costs by as much as a ratio of $3.33 to $1.

For decades, ozone pollution has been reduced by the combined efforts of Federal, state, tribal and local governments. More than forty years of experience with the Clean Air Act has shown that America can build its economy and create jobs while cutting pollution to protect the health of our citizens and our workforce.

Question 18. EPA's modeling for its proposed stringent ozone standards caps costs for emissions reductions required from so-called "unknown controls" based on costs of known controls. This defies the basic economics of increasing marginal costs. Does EPA really believe that the costs of reaching the highest low-hanging fruit are the same as those to get the fruit at the top of the tree?

Response. Following advice from the EPA Advisory Council on Clean Air Compliance Analysis (COUNCIL), in the 2014 analysis EPA relied on a methodology to estimate the cost of unknown controls that used an average cost-per-ton for the needed emissions reductions. The agency agrees with the COUNCIL that the approach is both transparent and strikes a balance between the likelihood that some unidentified abatement would be achieved at costs that are lower than average and that some would be achieved at costs that are higher than average.

Question 19. We hear a lot about the need to repair "crumbling roads and bridges." However, stringent ozone standards could make it harder for states to

show that proposed highway project "conform" with ozone standards. Has EPA considered the economic and safety impacts that could result if these stringent ozone standards block crucial transportation projects?

Response. Road maintenance and safety projects are exempted from transportation conformity requirements. The transportation conformity rule provides exemptions for a number of project types that address needed repairs and the need to improve highway safety. These include:

- reconstructing bridges as long as the number of travel lanes is not increased;
- pavement resurfacing and/or rehabilitation;
- pavement marking;
- projects that correct, improve or eliminate a hazardous location or feature;
- projects that increase sight distance;
- installation of guardrails, median barriers and crash cushions;
- lighting improvements; and
- projects that improve safety at railroad crossings.

The EPA places a high priority in assisting areas to determine exempt projects and to make required conformity determinations for other projects.

Question 20. According to EPA, ozone-forming emissions have been cut in half in the last three decades. This progress will continue under current regulations. Wouldn't you agree that Americans are already enjoying the benefits of cleaner air, and will enjoy even more future benefits, regardless whether the existing standards are adjusted?

Response. The Clean Air Act requires primary NAAQS that are "requisite to protect the public health" with an "adequate margin of safety." The EPA is proposing that the current primary ozone (O3) standard set at a level of 0.075 ppm does not meet this requirement, and that it should be revised to provide increased public health protection. Specifically, the EPA is proposing to retain the indicator (ozone), averaging time (8-hour) and form (annual fourth-highest daily maximum, averaged over 3 years) of the existing primary O3 standard and is proposing to revise the level of that standard to within the range of 0.065 ppm to 0.070 ppm. EPA analyses indicate that most of the country will be able to meet a revised standard with a level in this range, based on existing Federal control requirements.

Question 21. EPA's modeling indicates that its proposed ozone standards may actually increase mortality in cities like Houston. Can you please explain how this proposal could end up increasing deaths in some areas?

Response. The proposed revisions to the National Ambient Air Quality Standards for ozone discussed the possibility that some control strategies designed to reduce the highest ambient ozone concentrations can also result in increases in relatively low ambient ozone concentrations. That discussion can be found at http://www.gpo.gov/fdsys/pkg/FR–2014–12–17/pdf/2014–28674.pdf. We are currently reviewing comments on this interaction, and other issues raised by the proposal.

The proposal, based on extensive scientific evidence, found that reducing high ozone concentrations will reduce risk—including risk of ozone-related mortality—broadly across the country. This includes the risk associated with exposure to high ozone concentrations in all of the urban areas evaluated in the risk and exposure assessment.

Question 22. Ozone is mainly outdoors. Yet most people spend 90 percent of their time indoors. Do you think this is why recent published studies found that indoor air quality and poverty were much more strongly linked to asthma than outdoor air quality?

Response. The Clean Air Act directs the EPA to set National Ambient Air Quality Standards to limit harmful pollutants in the atmosphere. The EPA's proposed revision to the ozone NAAQS is based on extensive scientific evidence, including more than 1,000 new studies since the last review of the standards. This evidence shows that ozone can harm public health and welfare. The proposed updates will improve public health protection, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma.

Question 23. Only 1 of the 12 studies considered by EPA show any link between long-term ozone exposure and mortality. And this study did not find any link in California, where ozone levels are the highest in the country. Shouldn't we be concerned that EPA is cherry-picking science to support its regulatory agenda?

Response. Based on a significantly expanded body of scientific evidence, including more than 1,000 new studies since the last review of the standards, the EPA is proposing that the current primary ozone standard set at a level of 0.075 ppm is not requisite to protect public health with an adequate margin of safety, and that it should be revised to provide increased public health protection. This proposed con-

clusion is supported by the independent group of science experts who form the Clean Air Science Advisory Committee (CASAC). Specifically, the EPA is proposing to revise the level of that standard to within the range of 0.065 ppm to 0.070 ppm to increase public health protection, including for "at-risk" populations such as children, older adults,

and people with asthma or other lung diseases, against an array of ozone-related adverse health effects. For short-term ozone exposures, these effects include decreased lung function, increased respiratory symptoms and pulmonary inflammation, effects that result in serious indicators of respiratory morbidity such as emergency department visits and hospital admissions, and nonaccidental mortality. For long-term ozone exposures, these health effects include a variety of respiratory morbidity effects and respiratory mortality.

Question 24. I'm concerned that EPA is cherry-picking and contorting science to support its ozone proposal. For instance, one study found no statistically significant difference in lung function in humans exposed to ozone at levels above and below the standards in EPA's ozone proposal. Yet EPA "reanalyzed" that data and decided there was a statistically significant impact after all leading that study's author to say that EPA "misinterpreted" his data. Shouldn't EPA just go where the science points, rather than trying to shoehorn findings into its regulatory agenda?

Response. In reviewing a significantly expanded body of scientific evidence, including more than 1,000 new studies since the last review of the standards, the EPA in some instances conducted further analysis of the data underlying the studies. This review and these analyses are discussed in the Integrated Science Assessment, the Health Risk and Exposure Assessment and the Policy Assessment. Each of these documents are available at http://www.epa.gov/ttn/naaqs/standards/ozone/s—o3—index.html. Based on the body of scientific evidence, the EPA is proposing that the current primary ozone standard set at a level of 0.075 ppm is not requisite to protect public health with an adequate margin of safety, and that it should be revised to provide increased public health protection. This proposed conclusion is supported by the independent group of science experts who form the Clean Air Science Advisory Committee (CASAC).

Question 25. All of the clinical studies cited by CASAC in support of the 60 ppb standard were created by the EPA. Yet, all of the non-EPA literature on health impacts of 60 ppb ozone cited by CASAC does not support a 60 ppb standard. Is this what EPA meant when it said that "increasing uncertainty in the scientific evidence at lower ozone concentrations" led it to not include a 60 ppb standard in the ozone proposal?

Response. Compared to ozone standard levels from 65 to 70 ppb, the extent to which standard levels below 65 ppb could result in further public health improvements becomes notably less certain. For example, as explained in the preamble to the proposed rule (79 FR 75309), there are uncertainties associated with the adversity of exposures to 60 ppb of ozone, particularly single occurrence of such exposures; air quality analyses in locations of multicity epidemiologic studies; and epidemiology-based risk estimates. The EPA determined that it is not appropriate to place significant weight on these factors or to use them to support the appropriateness of standard levels below 65 ppb.

Question 26. EPA has released maps showing only the projected counties in nonattainment in 2025.

• Under EPA guidance does the agency designate non-attainment area boundaries starts with metropolitan area as the "presumptive" nonattainment area? Why are your maps inconsistent with your guidance?

Response. The EPA has not yet issued guidance for designating areas for a potentially revised ozone standard, but intends to do so shortly after any standard is revised. Nonattainment area boundaries for a revised ozone standard will depend on a number of factors that are currently highly uncertain.

Question 27. How many counties still do not meet the 1997 ozone standards? How about the 2008 standards? Doesn't it make sense to work on attaining the existing standards, the tightest standards ever, before promulgating new standards?

Response. The 1997 ozone standard was revoked on April 6, 2015. However, before that revocation, as of April 1, 2015, there were 7 designated nonattainment areas (consisting of 36 counties) that had not yet attained the standard based on preliminary 2014 ozone monitoring data. For the 2008 ozone standard, there are, as of April 1, 2015, 28 designated nonattainment areas (consisting of 163 counties) that have not yet attained the standard based on preliminary 2014 ozone monitoring data.

The EPA sets the National Ambient Air Quality Standards at a level that is requisite to protect the public health and welfare, based on the best available science.

The U.S. Supreme Court ruled in Whitman v. American Trucking Associations, 531 U.S. 457 (2001), that under Section 109 of the Clean Air Act, the EPA may not consider the costs of implementation in setting standards.

Question 28. Why does EPA leave California off of its maps and analyses? If California is being give a longer period of time to attain the standards, shouldn't other places in the country be granted that latitude as well? How much ($/ton) are NOx offset reductions selling for in Houston? Los Angeles? Other places?

Response. While EPA analyzed costs and benefits for California separately from the rest of the United States, all of these analyses are described in full in the Regulatory Impact Analysis for the ozone proposal. The maximum amount of time a nonattainment area has to attain the standards is dictated by specific provisions of the Clean Air Act, and depends on the area's classification. Because a number of California counties likely would have attainment dates ranging from 2032 to late 2037, California is not shown on maps that illustrate projected attainment status in 2025.

The EPA does not centrally track or collect data on the selling prices of emissions offsets. Offset transactions are typically private transactions between emissions sources and the price paid per ton of emissions used for offsets is not required to be reported or disclosed to the EPA by permit applicants.

CLIMATE

Question 1. The budget request includes a $4 Billion incentive program for states that reduce CO_2 emissions beyond the existing source proposal.

- How do you propose to implement this program?
- Do you plan to send Congress a legislative proposal?
- If the proposal is to give states money if they go beyond EPA mandates, will the result be to transfer taxpayer dollars away from states with large emission reduction burdens under your plan to states that have a smaller burden. For example, Vermont has no emissions reduction obligation under your plan because its power plants are small. So, would you automatically transfer taxpayer money from Southeastern and Southwestern states to Vermont?

Response. The fiscal year President's Budget includes an incentive fund for States choosing to go beyond the Clean Power Plan, which will be finalized this summer. The Clean Power State Incentive Fund will provide $4 billion to support States exceeding the minimum requirements established in the final Clean Power Plan for the pace and extent of carbon pollution reductions from the power sector. This funding will enable States to invest in a range of activities that complement and advance the Clean Power Plan, including efforts to address disproportionate impacts from environmental pollution in low-income communities and support for businesses to expand efforts in energy efficiency, renewable energy, and combined heat and power through, for example, grants and investments in much-needed infrastructure.

Each State with an emissions reduction goal under the Clean Power Plan will have a reserved portion of the Fund, based on a combination of population and State power sector emissions. States across the country are well-positioned to act quickly and resolutely to reduce carbon pollution from the power sector—beyond the requirements of the final Clean Power Plan. If a State elects not to participate, its funding allocation will return to the Treasury. Additional details on the Fund will be made available this summer.

Question 2. With respect to the Clean Power Plan, your justification statement says: "In fiscal year 6, the EPA will encounter a staggering workload to implement these rules and agency resources have been shifted to help meet the demand. Because of the breadth, complexity and precedent-setting nature of work, the agency expects a marked increase in demands for legal counsel in both headquarters and Regional Offices. In addition, each EPA action is expected to be challenged in court, which will require skilled and experienced attorneys specialized in the Clean Air Act to devote significant resources to defense of these actions."

- In your own budget justification statement you say that these rules will result in a "staggering workload" to implement and defend these two rules. Don't you think those taxpayer dollars would be better spent increasing funding to states to implement existing programs rather than spending it on lawyers?

Response. Successfully addressing climate change will require the EPA and State governments to work together, and the President's proposed budget provides additional resources for that work, both to the Agency and to the states.

With additional legal counseling resources, the EPA would provide significant benefits to our partners, stakeholders, and regulated communities. For example, counseling attorneys work closely with their program clients in rule development to ensure stakeholder input is appropriately considered. EPA counseling lawyers are

also a vital resource to States as States develop implementation plans under the Clean Air Act.

The President's proposed budget also provides significant resources for States. It includes $25 million in grants for States to develop their Clean Power Plan strategies, and sets up a Clean Power State Incentive fund of $4 billion.

Question 3. Recent correspondence between your agency and the House Energy and Commerce Committee indicated EPA has not "explicitly modeled the temperature impacts of the Clean Power Plan" and could not State what, if any impact the rule would have on global temperatures or sea rise levels.

• Why hasn't EPA done the modeling? Is it a matter of budgeting?

• Why is your agency attempting to impose this extremely complex rule and spend billions of taxpayer dollars to address global warming when you haven't even checked to see if the rule would actually achieve your global warming goals?

Response. The EPA included with the proposed Clean Power Plan a Regulatory Impact Analysis that estimated the total monetized climate-related benefits and costs of the rule, following applicable statutes, Executive Orders, and other guidance. Although the EPA has not explicitly modeled the temperature or sea level rise impacts of this rule, the Clean Power Plan is an important and significant contribution to emission reductions, thereby slowing the rate of global warming and associated impacts.

Question 4. Your budget would eliminate funding under the Indoor Radon Abatement Act which authorizes grants to states to address radon (-$8 million) even though indoor radon is the second-leading cause of lung cancer and the leading cause of lung cancer for non-smokers and the funding was targeted this funding to support states with the greatest populations at highest risk. According to your Budget in Brief, indoor radon causes an estimated 21,000 lung cancer deaths annually in the U.S. Carbon dioxide causes no deaths.

• Why would the budget propose spending $279 million to rework the U.S. energy economy (climate regulations) while ignoring real environmental threats?

Response. Over the past 23 years, the State Indoor Radon Grant program has provided funds to support states's efforts to reduce risks from radon exposure to establish their own programs. Because exposure to radon gas continues to be an important risk to human health, in fiscal year the

EPA will continue to focus on reducing radon risk in homes and schools, including through partnerships with the private sector, remaining State programs and public health groups, as well as driving action at the national level with other Federal agencies, through the Federal Radon Action Plan. The EPA also will continue information dissemination, participation in the development of codes and standards, and social marketing techniques aimed at informing the public on the risks of radon.

Question 5. Section 110(c) of the Clean Air Act requires EPA to issue a Federal implementation Plan (FIP) if a State does not submit a State Implementation Plan (SIP), does not submit a satisfactory SIP or does not make a satisfactory SIP revision (42 U.S.C. 7410(c)). Please provide a list of enforcement mechanisms with cites to the relative legal authority the EPA will use to enforce all components of a Federal plan on a State that does not does not submit a SIP, does not submit a satisfactory SIP—in whole or in part—or fails to make a satisfactory revision that meets the criteria of the proposed Clean Power Plan.

Response. Under Section 111(d) the EPA is proposing a two-part process where the EPA sets state-specific goals to lower carbon pollution from power plants, and then the states must develop plans to meet those goals. States develop plans to meet their goals, but EPA is not prescribing a specific set of measures for states to put in their plans. This gives states flexibility. States will choose what measures, actions, and requirements to include in their plans, and demonstrate how these will result in the needed reductions. The Clean Air Act provides for EPA to write a Federal plan if a State does not put an approvable State plan in place. In response to requests from states and stakeholders since the proposed Clean Power Plan was issued, EPA announced in January 2015 that we will be starting the regulatory process to develop a rule that would set forth a proposed Federal plan and could provide an example for states as they develop their own plans. EPA's strong preference remains for states to submit their own plans that are tailored to their specific needs and priorities. The agency expects to issue the proposed Federal plan for public review and comment in summer 2015.

Question 6. During the hearing, I asked you if the EPA would consider withholding Federal highway funding if a State that does not submit a SIP, does not submit a satisfactory SIP—in whole or in part—or fails to make a satisfactory revision that meets the criteria of the proposed Clean Power Plan. You responded,

"Ms. McCarthy. This is not a traditional State SIP under the national ambient air quality standards. There are other processes for us to work with States. Clearly our hope is that States will provide the necessary plans. If not, there will be a Federal system in place to allow us to move forward."

Will you clarify for the record whether EPA would consider withholding Federal highway funding to enforce any elements of the proposed Clean Power Plan?

Response. When the EPA finalizes the Clean Power Plan we will be very clear that sanctions will not be imposed for a state's failure to submit or enforce a State plan under the Clean Power Plan.

WATERS OF THE UNITED STATES

Question 1. Please provide me with examples where EPA or the Corps has used a groundwater connection to establish jurisdiction over a body of water that has no surface connection, direct or indirect, to a navigable water. For any such examples, please also provide the distance between the body of water that lacks such a surface connection and the nearest water of the United States. Please exclude any allegations that a groundwater connection establishes the existence of a point source discharge where the body of water with no surface connection was itself determined to be a point source, rather than a water of the United States.

Response. The agencies existing regulations and guidance allow for establishing that a wetland is adjacent to jurisdictional tributary based on the presence of a confined surface or shallow subsurface connection. This connection would then serve as the basis for determining whether a significant nexus with a downstream traditional navigable water is present. This is explicitly recognized in the agencies' 2008 (post-Rapanos) guidance documents. Federal courts have upheld jurisdiction consistent with this regulation and guidance, relying on a groundwater connection as the basis for a significant nexus finding. See Northern California River Watch v. city of Healdsburg. The agencies make clear in the final Clean Water Rule that groundwater is never jurisdictional under the Clean Water Act.

Question 2. Is it currently the national policy of either EPA or the Corps of Engineers to establish jurisdiction over all wetlands in flood plain?

Response. No. Existing law and policy requires the agencies to determine, on a case-specific basis, whether or not a particular wetland located in the floodplain is jurisdictional. Location in the floodplain does not itself make a wetland jurisdictional.

Question 3. Is it currently the national policy of either EPA or the Corps of Engineers to establish jurisdiction over all waters in flood plain?

Response. No. Existing law and policy requires the agencies to determine, on a case-specific basis, whether or not a particular water located in the floodplain is jurisdictional. Location in the floodplain does not itself make a water jurisdictional.

HYDRAULIC FRACTURING

Question 1. The EPA continues its study into the relationship between drinking water and hydraulic fracturing, which was initiated in 2010. Well over $20 million has been spent on this study and the timeline continues to slip. In fact, the draft assessment report was expected in December 2014 yet today, there is no indication when this will be released.

- What is the current timeline for release of the EPA's drinking water study?
- Will the report undergo interagency review prior to its release? If so, which agencies will be a part of the review? If not, why not?
- After the draft assessment report is released, what is the timeline moving forward?

Response. To date, the EPA's hydraulic fracturing drinking water study has produced 25 scientific products, including 12 EPA technical reports. Additionally, on June 4, 2015, the EPA released the draft hydraulic fracturing drinking water assessment report. The assessment is a state-of-the-science integration and synthesis of over 950 publications and sources of data. The draft assessment was released for public comment, and submitted to the EPA Science Advisory Board for external, independent peer review.

The EPA shared findings from the draft hydraulic fracturing drinking water assessment report with other Federal agencies and departments prior to the release of the assessment on June 4.

The draft assessment report was released for public comment and peer review on June 4, 2015. The EPA Science Advisory Board will conduct the external peer review of the draft assessment. Their preliminary schedule for review includes several

teleconferences and an October 28–30, 2015 meeting of the SAB ad hoc review panel. The SAB anticipates release of the final peer review report in spring 2016. After receipt of the SAB's peer review report, EPA will finalize the hydraulic fracturing drinking water assessment report. The final report will reflect SAB input and the input of submitted public comments. The EPA anticipates completing the final assessment report in 2016.

Question 2. You've said that hydraulic fracturing can be done safely and have agreed with former EPA Administrator Lisa Jackson that there have been no confirmed cases of hydraulic fracturing impacting drinking water. The White House Council on Economic Advisors released a report last week that touted the economic benefits because of the increase in domestic oil and natural gas and clearly linked the production increases to the use of hydraulic fracturing and horizontal drilling. What is your vision for getting the American public to understand that hydraulic fracturing is safe and that fracking has unlocked an American energy revolution that has lowered all Americans's energy prices, created jobs, helping lower GHG emissions and revitalizing such industries as the manufacturing, steel and chemical sectors?

Response. The EPA's vision is to make sure that the American public has the best scientific information available to understand the potential impacts of hydraulic fracturing activities on drinking water resources. Once EPA responds to public and SAB peer review comments and finalizes the assessment, EPA expects that it will be a critical resource for State regulators, tribes, local communities, and industry who can use the information to better identify how best to protect public health and drinking water resources.

The hydraulic fracturing drinking water assessment report identified potential vulnerabilities to drinking water resources due to hydraulic fracturing activities. The draft assessment concluded that there are both above and below ground mechanisms by which hydraulic fracturing activities have the potential to impact drinking water resources. These mechanisms include water withdrawals in time of or in areas with low water availability, spills of hydraulic fracturing fluids and produced water; fracturing directly into underground drinking water resources; below ground migration of liquids and gases; and inadequate treatment and discharge of waste water.

We found specific instances where one or more mechanisms led to impacts on drinking water resources, including contamination of drinking water wells. The number of cases, however, was small compared to the number of hydraulically fractured wells.

This finding could reflect a rarity of effects on drinking water resources, but may also be due to other limiting factors. These factors include: insufficient pre-and post-fracturing data on the quality of drinking water resources; the paucity of long-term systematic studies; the presence of other sources of contamination precluding a definitive link between hydraulic fracturing and an impact; and the inaccessibility of some information on hydraulic fracturing activities and potential impacts.

Question 3. In the draft fiscal year budget proposal, it states that EPA will respond to peer review comments from the Agency's Science Advisory Board (SAB) in order to finalize the study. It further suggests that the report will provide a synthesis of the State of the science, including the results of research focused on whether hydraulic fracturing affects drinking water resources, and if so, will identify the driving factors.

- Clearly you already have a plan for additional research. Can you share those plans?
- More importantly, will the Agency actually consider the recommendations of its own Science Advisory Board in this process, particularly if those recommendations do not align with EPA's own research initiatives, which you just addressed?

Response. The President's fiscal year budget request includes $4.0M to address the peer review and public comments received on the Hydraulic Fracturing Drinking Water Assessment report, including performing additional analyses in response to these comments.

The Department of Energy, Department of Interior, United States Geological Service, and EPA developed the Federal Multiagency Collaboration on Unconventional Oil and Gas (UOG) to coordinate on-going and future high priority research associated with safely and prudently developing onshore shale gas, tight gas, shale oil, and tight oil resources. The three agencies shared the "Federal Multiagency Collaboration on Unconventional Oil and Gas Research—A Strategy for Research and Development" (Strategy) in July 2014 (http://unconventional.energy.gov/pdf/Multiagency—UOG—Research—Strategy.pdf). Separate from the hydraulic fracturing drinking water assessment, resources are requested to further research outlined in

the Strategy to better understand and mitigate the potential impacts of UOG practices.

Throughout the development of hydraulic fracturing drinking water assessment, the EPA has actively engaged input from the agency's Science Advisory Board (SAB). A previous SAB panel provided comment on the hydraulic fracturing study plan published in 2011. A separate SAB panel provided comment on the hydraulic fracturing drinking water study progress report published in 2012. The same SAB ad hoc panel will review the draft assessment report. The external peer review by the SAB is expected to provide detailed comments and suggestions concerning the draft assessment. EPA will consider and evaluate all comments received from the SAB. SAB comments, along with comments received from the public, will help inform and guide the EPA as it develops the final draft of the assessment.

Question 4. Director McCarthy, the President's new economic report says that 1) "natural gas is already playing a central role in the transition to a clean energy future," 2) that an effective regulatory structure for addressing environmental concerns already "exists primarily at the State and local level," and 3) that unconventional natural gas production technology unleashed in the U.S. "can help the rest of the world reduce its dependence on high-carbon fuels." Given this positive view from the White House, which is supported by a broad scientific consensus, how do you intend to ensure that your agency's proposed regulations on methane will not short-circuit the U.S. energy revolution that is driving so much job creation?

• Can we assume that the upcoming EPA study on hydraulic fracturing will not conflict with this latest White House report that recognizes the clear advantages of unconventional energy development?

Response. Responsible development of America's shale gas resources offers important economic, energy security, and environmental benefits. Recognizing this, in April 2012, President Obama signed E.O. 13605, Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources, which, among other things, charges Federal agencies to pursue multidisciplinary, coordinated research. The EPA is working with other Federal agencies, states and other stakeholders to understand and address potential concerns with hydraulic fracturing so the public has confidence that natural gas production will proceed in a safe and responsible manner.

The EPA's study of the potential impacts of hydraulic fracturing for oil and gas on drinking water resources in the United States reflects the multiple, complex activities associated with the use of water in hydraulic fracturing, beginning with water acquisition and ending with the wastewater treatment and disposal. When completed, the products from the EPA's hydraulic fracturing study are intended to provide information needed to inform decisionmakers involved with ensuring that hydraulic fracturing activities do not impact the nation's drinking water resources.

Question 5. In February 2014 the EPA's IG sent a memo to the EPA Office of Water outlining an initiative the IG has underway that will "determine and evaluate what regulatory authority is available to the EPA and states, identify potential threats to water resources from hydraulic fracturing, and evaluate the EPA's and states' responses to them." Do you consider this a duplication of the EPA's efforts as it relates to the multi-year and multi-million dollar hydraulic fracturing and water study currently in process at the EPA and if not, then how do these studies differ? Hasn't EPA independently done this type of evaluation (see the letter from EPA to NRDC)?

Response. The OIG does not consider its evaluation in this case as duplicative of the study by the EPA's Office of Research and Development (ORD). ORD's Final Study Plan is scoped to the hydraulic fracturing water lifecycle, defined by ORD to include water acquisition, chemical mixing, injection, flowback and produced waters, and wastewater treatment. The OIG will not undertake a review of these matters. The OIG is not conducting independent scientific evaluations, laboratory studies or toxicological studies as planned in ORD's study.

SRF PROGRAM

Question 1. It is my understanding that since the program's inception in 1988, the Clean Water State Revolving Loan Funds have provided a total of $105 billion in assistance, leveraging Federal capitalization grants totaling approximately $36.2 billion. Further, since the program's inception in 1997, Drinking Water State Revolving Loan Funds have provided approximately $33 billion in assistance, leveraging Federal capitalization grants totaling approximately $19 billion. This means that for every Federal dollar invested in the Clean Water SFR community wastewater systems have received nearly $3 dollars in assistance and for every dollar in the Drink-

ing Water SRF community water systems have received approximately $1.75 dollars in assistance.

• Do you agree that the SRF program has been among the most successful programs we have in government?

• It that is so, why does the President's budget perennially underfund these programs?

Response. Yes, and the Administration strongly supports the successful Clean Water and Drinking Water State Revolving Loan Fund programs. The President's fiscal year budget request recognizes that both SRF programs report long-running significant water infrastructure needs. In fiscal year 6, the Administration is requesting a total of $2.3 billion for the SRF programs—$1.186 billion for the DWSRF and $1.116 billion CWSRF. In addition, the fiscal year request includes $50 million in technical assistance, training, and other efforts to enhance the capacity of communities and states to plan and finance drinking water and wastewater infrastructure improvements. The fiscal year budget also requests funds to lay the groundwork for a Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) program that would provide additional assistance. EPA has also launched the Water Infrastructure and Resilience Finance Center to help communities address their wastewater, drinking water, and stormwater needs within constrained budgets, particularly through innovative financing and by building resilience to climate change.

Question 2. Under the Clean Water Act, EPA is supposed to send a report to Congress on the funding needs for both wastewater and drinking water infrastructure. The last report to

Congress on wastewater needs was based on the 2008 Clean Water Needs Survey. The estimate of need in that survey—$298 billion over 20 years—is woefully out of date. That estimate is based on cities' own capital improvement plans. It does not reflect new mandates like the hugely costly sewer overflow control measures that EPA is imposing on cities in enforcement actions or costly new requirements for nutrient reductions and stormwater controls.

By failing to provide an updated estimate of needs, EPA is doing a disservice to Congress, to cities, and to itself. We all need reliable information to make good decisions and EPA is required by law to update the needs survey every 4 years.

• When will EPA provide Congress with the updated the Clean Water Needs Survey?

Response. The 2012 Clean Water Needs Survey Report to Congress is currently undergoing review. When the review is complete and the Report is cleared, it will be immediately provided to Congress.

Question 3. We all know that the needs for both water and wastewater are huge. According to the U.S. Conference of Mayors, cities are spending $115 billion a year to provide water and wastewater services and meet Federal mandates. So, the proposal to provide a combined $2.3 billion for the Clean Water and Drinking Water State Revolving Funds is a drop in the bucket. Since the Federal Government does not provide funding to meet those mandates, I think it is important to take a hard look at how we are asking cities to spend their citizen's money.

• We all support clean and safe water. But, I am told that EPA enforcement officials extract penalties on top of commitments of hundreds of millions of dollars to address sewer overflows. Is that right?

• I also am told that EPA enforcement officials will require complete elimination over sewer overflows if they think a city can pay for it, when a less expensive approach could meet water quality standards. Is that right? Is EPA requiring cities to do more than meet the standards that states have set and EPA has approved that will protect water quality?

Response. Sewer overflows, which contain raw sewage, may present significant environmental and human health risks to communities. Raw sewage contains bacteria, viruses, parasites, industrial wastewater, and inhalable mold and fungi which can be particularly problematic for children and the elderly.

The ability to assess a penalty when appropriate is important both to ensure future compliance and meet the standard under which courts review such consent decrees. Under the EPA's current approach, the agency tailors the terms of a settlement agreement, including any civil penalty, to the individual facts and circumstances of each case. Moreover, in determining appropriate civil penalties, the EPA uses the significant flexibility provided under the EPA's Clean Water Act Penalty Policy (including consideration of a city's specific financial circumstances) to substantially mitigate civil penalties in municipal cases. The agency remains committed to ensuring that we take into account the individual circumstances of each community, so that we can meet the objective we share with every community to

achieve clean water and encourage future compliance with the Clean Water Act in a way that makes sense for that community.

For combined sewer systems, the level of control is governed by the Combined Sewer Overflow Control Policy, with which each "permit, order, or decree" for municipal combined sewer system discharges "shall conform" as required by Congress in section 402(q) of the Clean Water Act.[1] The Clean Water Act requires permit holders to meet both water quality and technology standards and either can govern the requirements for compliance.

Separate sanitary sewer systems must be designed to contain and treat raw sewage generated by a community. An enforceable requirement of National Pollutant Discharge Elimination System (NPDES) permits is that cities properly operate and maintain their sewer collection and treatment systems.

Question 4. Given the enormous cost of meeting water and wastewater mandates, affordability is a significant issue. It is my understanding that at EPA Headquarters, you talk about giving cities more time to meet mandates; you talk about adaptive management; and you talk about using green infrastructure alternatives. However, when they bring enforcement actions against cities, EPA regions and Headquarters enforcement officials are not providing these flexibilities.

- How are you addressing the real affordability concerns of cities?
- Do you think your enforcement officials should try to extract every last dollar from a city that you claim they can afford even if spending more money will not provide additional water quality benefits?
- If a city steps up and agrees to spend hundreds of millions or in some cases billions of dollars, do you think it is also appropriate to impose penalties on that city when the penalty will simply go to the U.S. Treasury and will reduce the amount of funding available to help improve the environment?

Response. The EPA is sensitive to the significant investment cities must make to ensure clean and safe water. The EPA's guidance "Combined Sewer Overflows Guidance for Financial Capability Assessment and Schedule Development" (FCA Guidance), adopted in March 1997, provides a flexible framework for considering the site-specific factors that impact a given community's rate base.[1] The guidance encourages communities to consider and present any other documentation of their unique financial circumstances so that it may be considered as part of the analysis. These flexibilities were further clarified in November 2014, in the EPA's "Financial Capability Assessment Framework for Municipal Clean Water Act Requirements," which was developed with significant input from a variety of stakeholders including the United States Conference of Mayors, the National League of Cities, and the National Association of Counties.[2] As detailed in the EPA's January 13, 2013, "Assessing Financial Capability for Municipal Clean Water Act Requirements" Memorandum, nothing in the Federal Clean Water Act prohibits communities from introducing a sewer rate structure based on differential household incomes.[3]

Section 204(b)(1) of the Clean Water Act recognizes the use of lower rates for low-income residential users as satisfying the stipulation that recipients of services must pay their proportionate share. The EPA's regulations at 40 C.F.R. Section 35.2140(i) reflect this and authorize low-income residential user rates. Local officials have a great deal of latitude under these regulations and the EPA continues to encourage communities to consider and adopt rate structures that ensure that lower-income households continue to be able to afford vital wastewater services.

The EPA utilizes its Clean Water Act Penalty Policy to provide flexibility to substantially mitigate civil penalties in municipal cases, including taking into account a city's specific financial circumstances.[4] The agency remains committed to ensuring that we consider the individual circumstances of each community so that we can meet our shared objective of achieving clean water and encouraging future compliance with the Clean Water Act in a way that makes sense for individual communities.

Question 5. I am very concerned that the way EPA looks at affordability when they decide what mandates to impose on communities means that our poorest citizens will end up paying 10 percent or more of their income on sewer bills.

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[1]Link to CSO Control Policy: http://water.epa.gov/polwaste/npdes/cso/upload/owm0111.pdf

[1]CSO Guidance for FCA and Schedule Development: http://water.epa.gov/polwaste/npdes/cso/upload/csofc.pdf

[2]FCA Framework Memo: http://water.epa.gov/polwaste/npdes/cso/upload/municipal—fca—framework.pdf

[3]Link to Assessing Financial Capability for Municipal Clean Water Act Requirements Memo: http://water.epa.gov/polwaste/npdes/stormwater/upload/sw—regionalmemo.pdf

[4]CWA Penalty Policy: http://www2.epa.gov/sites/production/files/documents/cwapol.pdf

Last Congress, in Title V of the Water Resources Reform and Development Act, we amended the Clean Water Act to give direction on how to identify what communities would experience a significant hardship raising the revenue to finance projects to meet Clean Water Act mandates. One of the criteria that we listed in the statute is whether the area is considered economically distressed under the Public Works and Economic Development Act. Under this Act, a community or area within a larger political boundary is economically distressed when —

- the per capita income at 80 percent or less than national average,
- unemployment is 1 percent or more greater than national average, or
- there is an actual or threatened severe unemployment or economic adjustment.

This information is provided by the community and must be accepted unless the Secretary of Commerce determines it is inaccurate.

- Will EPA also incorporate this approach into your evaluation of affordability when taking enforcement action?

Response. The EPA is committed to implementing the Clean Water Act requirements in a sustainable manner, and will continue to work with permit holders toward our shared goals of clean water. The EPA's enforcement program encourages permit holders to submit any documentation that would create a more accurate and complete picture of their financial capability, which could include the type of information listed below. The EPA's "Financial Capability Assessment Framework for Municipal Clean Water Act Requirements" provides examples of information that may prove relevant in negotiating schedules.[1]

TECHNICAL ASSISTANCE TO STATES

Question 1. In EPA's fiscal year Budget Request, the Agency did not request any funds for the EPA technical assistance competitive grant program. As you know, this program provides small and rural communities with the training and technical assistance necessary to improve water quality and provide safe drinking water. Many communities count on this program to assist them in complying with Federal regulations when operating drinking and wastewater treatment facilities. These communities believe that is the most effective program to aid in compliance with the requirements of both the Clean Water Act and the Safe Drinking Water Act. In the past Congress has agreed and from fiscal year—fiscal year appropriated $12.7 million for the program. Given its success and importance to so many communities across the country, why is EPA is not requesting any funds to support this grant program in fiscal year 6?

Response. Answer: Assisting small and rural communities in compliance with water regulations is very much a priority for this Administration. The EPA's fiscal year budget requests $1.186 billion for the Drinking Water State Revolving Fund (DWSRF) program, which can be used to provide special assistance to systems serving 10,000 or fewer customers. For example, States are required to provide a minimum of 15 percent of the funds available for loan assistance to small systems to help address infrastructure needs. The DWSRF also allows states a 2 percent small system technical assistance set-aside to provide assistance to small and rural water systems. The 2 percent DWSRF set-aside is used by nearly every State to support their small systems and several states use these funds for non-profit State affiliates.

In fiscal year 6, the EPA is also requesting additional resources as part of the agency's infrastructure investment which will enable states to augment their roles and participation in building small drinking water system capabilities and partnerships. For example, an additional $9 million is requested to expand upon existing technical, managerial, and financial capability programs, and develop additional tools and partnerships to promote sound asset management, as well as strengthen State resources to engage in these activities. In addition, a $9 million increase is requested to provide technical assistance for small systems to plan and facilitate partnership, regionalization, or consolidation agreements. The EPA also is requesting an increase of $7.7 million in the Public Water System Supervision funding in order to enhance State and tribal efforts to provide increased operator training and technical assistance to small communities so they can acquire the knowledge and expertise needed to properly operate drinking water systems and therefore protect public health.

Question 2. You have requested $46 million and 13 new FTES for an unauthorized program to improve climate resilience for water and wastewater facilities. In contrast, you have requested only $5 million for fiscal year out of the EPM account to

[1] FCA Framework Memo: http://water.epa.gov/polwaste/npdes/cso/upload/municipal—fca—framework.pdf

set up the implementing the newly authorized Water Infrastructure Finance and Innovation Authority (WIFIA), but no money out of the STAG account to actually implement it. How can you explain the disparities in these requests? What does this say about your priorities?

Response. The $46 million and additional FTEs identified in the President's fiscal year budget, along with requests for the State Revolving Fund programs and preparation for WIFIA, reflect a priority to invest in our nation's infrastructure. Activities within the $46 million include:

• Water Infrastructure and Resilience Finance Center—Assist communities across the country improve their wastewater, drinking water, and stormwater systems, particularly through innovative financing and by building resilience to extreme weather events.

• Capacity Building—Expand upon existing technical, managerial, and financial capability programs, and develop additional tools and partnerships to promote sound asset management.

• Integrated Planning—Expand community assistance in developing integrated plans, and to provide support for a limited number of implementation projects.

• Small System Partnerships—Provide technical assistance for small systems to plan and facilitate partnerships, regionalization, or consolidation agreements. Disseminate best practices or model partnership efforts by states and towns.

• Full Cost Pricing—Provide technical assistance to communities on the adoption of pricing structures that cover a system's full capital and operations and maintenance costs.

Also, the Administration's request for continued WIFIA startup efforts in fiscal year will lay the groundwork for a WIFIA program that would provide additional infrastructure assistance.

NEW DEFINITION OF FLOOD PLAIN

Question On January 30, 2015, the President signed a new Executive Order (EO 13690) that changed the existing flood plain management policy that has been in effect since 1977. With these changes, the policy applies to all agencies and all Federal actions and flood plain is now defined as either the 500 year flood plain or a larger area based on climate modeling.

• Will this new definition affect the projects that states can fund using the State Revolving Loan Funds?

• Will this new definition affect the type, size, or location of infrastructure that EPA requires cities to build to treat wastewater or to address sewer overflows under enforcement agreements?

• Will this new definition affect the conditions attached to municipal stormwater permits?

• What was EPA's involvement in developing this Executive Order?

• What outreach efforts were made before signing this Executive Order to State and local governments?

Response. Executive Order 13690 (EO 13690), which amended Executive Order 11988 on Floodplain Management, gives agencies flexibility to select one of three approaches for establishing the flood elevation and hazard area they use in siting, design, and construction. First, agencies may use the elevation and flood hazard area that result from freeboard of 2 or 3 feet, depending on criticality. Second, agencies may also use the elevation and flood hazard area that result from a climate-informed science approach. Finally, agencies may use the area subject to flooding by the 0.2 percent annual chance flood. EO 13690 does not define the flood plain as "either the 500 year flood plain or a larger area based on climate modeling."

Following the development and issuance of the Final Revised Guidelines for EO 13690, which the public comment period recently closed (May 6), the EPA will begin the process for implementing EO 13690. Until that process is complete, it would be premature to respond to questions regarding effects on programs or projects.

The EPA participated in the interagency group that assisted in the development of the Executive Order and Draft Revised Guidelines. As one of the agencies in the interagency group, the EPA participated in engagement efforts with states, local governments, and other stakeholders regarding flood risk policy issues.

STORMWATER

Question EPA has announced that it has abandoned its plans to develop a national storm water rulemaking that would have tried to expand your authority to regulate not only pollutants, but also the actual flow of water. That is not surprising

given the fact that courts have made it clear that the Clean Water Act does not give EPA any authority to regulate water flows. However, it is my understanding that your agency is continuing to advance this agenda by regulating water flows in individual permits.

• Will you commit to me that your agency will use Clean Water Act permits to regulate the discharge of pollutants only and not the flow of water?

Response. The EPA and the States responsible for administering the National Pollutant Discharge Elimination System (NPDES) permits will continue to review and reissue Municipal Separate Storm Sewer System (MS4) permits under the authorities governing stormwater discharges in Section 402(p) of the Clean Water Act (CWA).

ATTORNEYS/WORKFORCE

Question 1. Administrator McCarthy, the President's budget request seeks an additional $10 million that would go to hire almost 40 additional attorneys to work at EPA. More than $3.5 million would go to hire 20 new attorneys who would be devoted to supporting the Clean Power Plan alone.

At a House committee hearing last week, you stated that these attorneys would not be "litigation attorneys" and instead would be used to help with reviewing permits and assisting states to set up their programs.

However, your own budget justification says these additional attorneys and needed because, "In addition, each EPA action is expected to be challenged in court, which will require skilled and experienced attorneys specialized in the Clean Air Act to devote significant resources to defense of these action."

• Which is it? Do you stand behind your recent statement to Congress, meaning the budget justification is incorrect? Or do you agree that you need to hire additional attorneys in part to defend these unlawful rules in court?

Response. The fiscal year President's budget requests 19.5 additional employees for legal counseling on a wide variety of EPA issues and 20 employees specifically for Clean Power Plan implementation. All of these additional employees would be provided to the EPA's Office of General Counsel for use in both EPA headquarters and the regional offices. Lawyers in the Office of General Counsel work closely with EPA program offices on rule development and implementation. They also review permits, counsel on State implementation plans and help address stakeholder concerns and questions. As such, with these employees, the EPA would provide significant benefits to our partners, stakeholders, and regulated communities.

Assisting the Department of Justice in defending the agency's actions is an important role for lawyers in the EPA's Office of General Counsel. Our lawyers have deep expertise in specific areas of law, and advise on all agency activities within that area of expertise. Most of the EPA's significant rules are challenged in court; often the regulated industry and environmental plaintiffs both challenge the same rule. It is in the interest of all stakeholders if the agency can get the rule right the first time, providing a robust explanation and record. This means a better final rule and less uncertainty.

The additional Clean Power Plan focused legal employees will work on the full range of important legal counseling services provided by the Office of General Counsel, including rule development, assisting the Department of Justice in defense, reviewing permits, and counseling on State implementation plans.

Question 2. The Budget justification goes on to say that additional legal resources will make EPA more responsive to states, industry, and citizens, and will make EPA's actions more defensible in court. Yet the budget request also says there are no performance measures for the agency's attorneys like there are for other programs.

• Why is that?

• Does this lack of staffing or accountability explain why, when it issued performance standards for new sources in September 2013, EPA seemed unaware of the Energy Power Act provision that prohibits the use of carbon capture projects receiving certain

• Federal funding from being used to show the technology had been adequately demonstrated?

• Shouldn't EPA attorneys and staff in the Air office have known about that provision before the rule was proposed?

• How are you going to ensure that these additional legal resources will be used effectively?

• Would these be term-limited positions, or permanent hires?

• Do the agency's attorneys—or any employees for that matter—keep track of their time, like attorneys in the private sector do or workers at a coal mine or factory would?

• Given the issues EPA has had with time and attendance problems, what is EPA doing to ensure that EPA staff are in fact doing the jobs they are being paid to do?

Response. The Office of General Counsel supports each of the agency's programs in achieving their goals and priorities. As such, OGC supports the accomplishment of the performance measures for every agency program. The additional legal counseling FTE in the President's proposal would result in the agency's ability to hire additional permanent attorneys in fiscal year 2016. These new attorneys would allow the agency to better serve our co-regulators and other stakeholders.

While OGC itself does not have quantitative measures, it has a very structured and systematic approach to its work. Each law office has a weekly or bi-weekly meeting to report to the General Counsel, and each office carefully tracks the cases and associated deadlines in its area of law. Each law office is similarly in close contact with the relevant media office, getting real-time feedback on both that office's needs and OGC lawyers' performance.

The EPA's September 2013 Proposed Carbon Pollution Standard for New Power Plant[1]] does not raise any accountability concerns. Any final standards the EPA issues will be based on sound science and will undergo thorough legal review to ensure they comply with all applicable laws and regulations. The EPA does not believe that the Energy Policy Act of 2005 precludes consideration of the projects the EPA has evaluated. The EPA has issued a Notice of Data Availability (NODA) that notes the availability of a Technical Support Document (TSD) in the rulemaking docket that details its proposed position on this issue. It explains, "EPA interprets these provisions to preclude EPA from relying solely on the experience of facilities that received EPAct05 assistance, but not to preclude EPA from relying on the experience of such facilities in conjunction with other information." The EPA based its proposed determination on a number of projects and other information including projects that did not receive any assistance under EPAct05. In addition, the agency extended the public comment period for January 2014 proposal by 60 days to allow adequate time for the public to review and comment on the contents of the NODA and TSD.

OGC uses a tracking system primarily to assist with workload management, to help ensure that all deadlines are met. In addition to this close tracking of substantive work, judicial deadlines, and client satisfaction, the time and attendance of OGC employees are subject to all agency accountability measures for time and attendance. Updated agencywide internal controls were implemented on September 21, 2014 to ensure compliance with time and attendance policies and regulations. The EPA made system adjustments to ensure accurate time and attendance recording, including elimination of default pay and mass approvals. The EPA established requirements for supervisors to monitor time and attendance reports, and clarified the time and attendance approvals of senior executives through an executive approval framework.

Question 3. Please describe the process and resources the Agency (both Headquarters and Regional Offices) currently uses to track litigation to which it is a party, as well as deadlines for regulatory or other EPA action that have been established in litigation settlements or court orders.

• What efforts are planned in fiscal year to improve this process and the public transparency of this tracking?

• What public notice and opportunity for comment and public participation does the Agency give to the public when a deadline established in a settlement or court order is revised or extended?

Response. The process the agency uses to track litigation starts with assigning the litigation to an attorney. The attorney assigned along with counsel from the Department of Justice, is responsible for tracking the litigation, and any associated deadlines or court-ordered schedules. As major deadlines or events approach, these are brought to the attention of the General Counsel through weekly or bi-weekly meetings. Where the agency agrees in settlement to a deadline for agency action, that deadline becomes a commitment of the relevant program office.

For both litigation and regulatory actions, there are a number of ways that agency provides information to the public. Below are examples of how information regarding litigation and regulatory actions are made available:

[1] For more information: http://www2.epa.gov/carbon-pollution-standards/2013-proposed-carbon-pollution-standard-new-power-plants

• Each Notice of Intent (NOI) to sue the EPA under an environmental statute is posted here: http://epa.gov/ogc/noi.html. (In response to stakeholder requests, the EPA has also begun posting complaints next to the related NOI.)

• When the EPA receives a petition for rulemaking, those are posted here: http://www2.epa.gov/aboutepa/petitions-rulemaking.

• The EPA publishes in the Federal Register any proposed settlement agreement under the Clean Air Act before finalizing. There is a 30-day open comment period on each of these proposed settlements. You can see an example here: https://Federalregister.gov/a/01–21342.

• Regulatory agendas are available in a few different ways, as explained on the agency's website. Available here: http://www2.epa.gov/laws-regulations/regulatory-agendas-and-regulatory-plans.

• The searchable regulatory plan is available at: http://www.reginfo.gov/public/do/eAgendaSimpleSearch. (These entries include deadlines such as those agreed to through settlement; for an example search RIN 2060-AM08).

Question 5. For its fiscal year budget proposal, EPA requested to remove the 50 person ceiling for hiring under Title 42. A March 5, 2015, EPA Inspector General Report found that EPA's Office of Research and Development did not always demonstrate the need to use Title 42 to recruit or retain 19 positions reviewed. In four cases reviewed, the IG found that employees were converted to Title 42 to perform the same position, yet paid a total $47,264 more in salary for performing the same job. The EPA OIG recommended that EPA improve transparency and its justification for the use of Title 42 appointments or reappointments, which could result in potential monetary benefits of $3.5 million. EPA did not agree with the OIG's recommendation. The OIG responded that EPA's alternate approach does not address the need to justify the need to use Title 42 authority or the need for more transparency in the decisions to use the Title 42 authority.

• Why did EPA request to remove the 50 person ceiling under Title 42 for fiscal year and not for fiscal year 6?

• Why did EPA disagree with the OIG's recommendations?

• How will the EPA address the need for greater transparency and justification for Title 42 hiring?

Response. As a result of congressional action in fiscal year 5, the Administration chose to not request any additional changes to its Title 42 authority in the fiscal year President's Budget at this time. It should be noted that as recently as 2014, the National Academy of Sciences strongly supported EPA's use of the Title 42 authority. EPA's Office of Research and Development (ORD) and the Office of Inspector General (OIG) reached an agreement on the corrective actions to be taken and EPA has completed these actions. The OIG has officially closed this audit. The OIG report found that ORD has a rigorous, in-depth process for hiring high-quality scientists and science leaders under its Title 42 authority. The Report found no instances of impropriety or mismanagement by EPA of its Title 42 authority and acknowledged ORD had detailed implementation guidance in place. The OIG also noted that EPA has undergone other favorable evaluations, such as a 2012 Government Accountability Office audit of EPA's Title 42 authority.

Further, the OIG report highlighted ORD's statements that Title 42 "allows the agency to maintain workforce flexibility and critical expertise in the face of emerging and rapidly changing scientific and technological approaches. The science leaders that ORD has recruited and retained using Title 42 are world-renowned experts in their field and are leading cutting-edge research programs in ORD to address the environmental issues of the 21st Century." ORD agreed to address the one OIG procedural recommendation contained in the report, which focused solely on perceptions of transparency.

To address the one OIG report recommendation, ORD revised its Title 42 Operations Manual to increase the transparency of ORD's justification to use Title 42 authority. The ORD Title 42 Operations Manual has been updated to reflect ORD's periodic reporting and use of Title 42 recruitment request memorandum. The OIG has now closed this audit.

HOMELAND SECURITY

Question 1. Administrator McCarthy, President Obama recently said that terrorism is less of a threat to the American people than climate change. Do you agree?

Response. Climate change and acts of terrorism are both issues of serious concern to the EPA. The EPA's homeland security budget helps the EPA to address important requirements that are intended to prepare the EPA to respond to and promote

recovery from significant emergencies, including acts of terrorism and natural disasters.

Question 2. Does the President's thinking explain why EPA's budget request has cut homeland security related funding in several important areas?

For example, the budget would cut more than $1 million from the Science and Technology account for work to treat contamination from chemical and radiological incidents (Page 131). The budget would also cut more than $2.5 million from the Superfund account reducing EPA's ability to detect threats and test and decontaminate sites.

• Why is EPA cutting back its capability to detect and respond to biological or radiological attacks?

Response. The EPA is maintaining its capability to detect and respond to biological or radiological attacks. Over the past years, the EPA has built, developed, and now maintains agency Homeland Security assets that provide critical technical expertise and support during nationally significant incidents including those which can involve chemical, biological, radiological, and nuclear (CBRN) agents. EPA also continues to provide support in addressing the science and technology needs for response to and recovery from biological and radiological incidents.

The reductions to the Solid Waste & Emergency Response program will not impact the agency's ability to respond to incidents. The reductions may affect field equipment maintenance and upgrades, such as planned upgrades to the Portable High-Throughput Integrated Laboratory Identification System (PHILIS) units. Additionally, there may be reduced agency participation in large-scale exercises that support internal and external coordination on Federal roles and responsibilities. The EPA will continue its coordination and integration efforts and its increased leverage of resources with our Federal partners to enable the EPA to meet its baseline requirements on Homeland Security Presidential Directives and Homeland Security mandates by following an all-hazards approach with emphasis on the most pressing capability gaps.

The fiscal year EPA's President's Budget request of $21.1 million for the Homeland Security Research Program (HSRP) will allow the agency to continue to conduct research that supports the agency in characterization of biological and radiological contamination and decontamination of indoor and outdoor areas as well as the management of the resulting waste during response to these incidents.

In addition, the President's fiscal year Budget requests increased funding for some of the needed operability upgrades to our radiation air monitoring system, RadNet.

Question 3. The budget for emergency preparedness is essentially stagnant (only a slight $200,000 increase due to higher fixed cost for rent and staff salaries).

• What does this mean in practice—fewer air monitoring flights, slower response times, increased risks to human health and the environment from a terrorist event?

Response. The EPA will continue its role in protecting human health and the environment from risks posed by a potential terrorist event, and the fiscal year President's budget proposal would not impact the agency's ability to respond to a terrorist event. The proposed budget for the Superfund Emergency Preparedness program adjusts resources for the National Response Team (NRT). The EPA will continue to maintain its significant role in the NRT, but will reduce contractor support for NRT committees and subcommittees.

Question 4. Recent scandals suggest that EPA has a "culture of complacency" among some supervisors and managers when it comes to time and attendance problems, computer usage, and property management.

• Given these concerns—and ongoing work by the Office of Inspector General—I am troubled to see the low priority that EPA places on screening job applicants and making sure its employees have been vetted and are suitable for their positions of trust.

• For example, the homeland security budget for conducting background checks for employees and contractors would be cut by $340,000—even though the John Beale episode has highlighted the need for improved background checks. Do you think this is the time for EPA to be cutting back on its process for doing background checks?

Response. The EPA continues to perform background investigations in accordance with the Office of Personnel and Management (OPM) guidelines. There are no planned resource cuts to background investigations for fiscal year 6. The reduction cited in the question reflects savings associated with other work in the Homeland Security: Protection of EPA Personnel and Infrastructure program. More specifically, the reduction reflects savings associated with transitioning the EPA Personnel Access and Security System (EPASS) from development into a State of operation and maintenance. EPASS manages the enrollment, printing, issuance, and lifecycle

of Personal Identity Verification (PIV) credentials as required by Homeland Security Presidential Directive 12 (HSPD–12).

Question 5. The IG has also raised concerns about the Office of Homeland Security and its interference with the IG's law enforcement work.

• How will this be resolved so it does not become a distraction to the Agency and impede EPA's homeland security mission?

Response. Over the past few months, the Office of Homeland Security (OHS) has worked collaboratively with the Office of Inspector General (OIG) to ensure that EPA's homeland security mission is strengthened through timely information sharing and threat management. OHS also has established a process for providing the OIG with access to any external law enforcement entity that requests assistance from OHS for EPA related counterintelligence or counter terrorism investigative activities. This process ensures that there continues to be no impediment to the OIG's ability to pursue any law enforcement actions or activities that fall within their jurisdiction.

GAO REPORTS

Question 1. The Government Accountability Office issued a report last year on problems with how EPA analyzes its regulations for economic impact, less burdensome alternatives, and uncertainties. GAO found that EPA's regulatory impact analysis (RIAs) do not clearly identify the costs of EPA's rules and the data EPA used in its analyses were often out of date and irrelevant.

For example, GAO found that for several high-profile clean air and water rules, EPA relied on employment data that was between 20 and 30 years old and from only four industrial sectors. The GAO report states, "Without additional information and improvements in its approach for estimating employment effects, EPA's RIAs may be limited in their usefulness for helping decisionmakers and the public understand the potential effects of the agency's regulations on employment."

That's a big problem—that EPA is making these incredibly significant regulatory decisions—and the American public, Congress, and even EPA itself do not know what the economic impacts or potential job losses will be.

• Is EPA continuing to rely on the outdated and limited employment data when analyzing the potential job impacts of its rules? If not, what is EPA relying on?

• How much of EPA's budget request will be going toward improving and updating the employment data that EPA uses in its economic analysis documents?

Response. The EPA no longer uses the data and study critically reviewed by GAO. Given the dearth of studies and models, the EPA does not use the same approach for employment analysis for every rule. As with other analyses in our RIAs, each employment analysis is tailored to the specifics of that regulation and reflects the degree to which reliable tools and data are available to quantify impacts. When conducting such analysis the EPA uses the best tools and data available for the relevant rulemaking. Often times, EPA conducts original "bottom up" studies that examine the employment used in specific industries and in the manufacturing and operation of pollution abatement equipment. In some cases, the EPA focuses on a qualitative discussion of the employment impacts both positive and negative and in other cases, it quantifies selected employment impacts. As the GAO acknowledges, the agency strives in all instances to transparently describe the strengths and weaknesses of the approach chosen by the agency. The EPA believes that these analyses, whether qualitative or quantitative, provide decisionmakers and the public with valuable information on the employment impacts of its rules and has worked hard to refine these analyses over time.

GAO's discussion of employment impact analysis focuses on one particular study that the EPA used to quantify employment effects in two of the seven rules reviewed by the GAO. It is important to recognize that this published study represented the best available peer-reviewed research at the time these RIA's were conducted and that GAO reported that the EPA's treatment transparently recognized the limitations of the study where it was applied. The EPA recognizes that there are limited tools provided in the peer-reviewed economics literature to quantify the small shifts in employment that might be attributable to environmental regulation and is continually working to improve our approaches.

It is difficult to assess how much of the budget request the EPA will be using to improve and update the employment data in our economic analysis documents. Partly this is because economists throughout the agency conduct employment analyses and use the best data available for their particular rules. In addition, analysis of employment impacts is one part of a broader analytic effort conducted for agency rules, so it is hard to isolate the costs of one aspect of the regulatory analyses.

The EPA is exploring alternative approaches in the relevant theoretical and empirical economics literature to apply new modeling approaches to quantify employment impacts. In October 2012, the agency convened a scientific workshop with academic economists to examine the theory and methods for understanding employment effects of environmental regulation. The EPA is in the process of updating its Guidelines for Preparing Economic Analyses to include revised guidance on assessing employment impacts from regulation. Finally, the EPA has announced the formation of a new Science Advisory Board panel to advise the agency on how best to model the economic impacts of environmental regulation, including approaches to capture employment effects. This panel plans to convene this summer. Commenters also are invited to provide information and data relevant to employment analysis during the notice and comment periods on rulemakings.

Question 2. The GAO report also found that EPA had cut corners in its economic analysis due to the short timeframes it had for issuing rules pursuant to court-ordered deadlines and litigation settlements.

• What criteria does EPA use when agreeing to a rulemaking deadline in a litigation settlement?

• How does EPA's obligation to conduct a robust analysis of a rule's economic impact factor into these court-ordered deadlines, or does it get short shrift in the discussions?

• Is part of the problem that laws like the Clean Air Act have unreasonable deadlines?

• Would you support attempts to give EPA additional time under the law to issue rules or update standards every 5 or 8 years as currently may be the case?

Response. Generally, EPA and the Department of Justice (DOJ) seek to settle cases brought against EPA if we believe the litigation risk is high and there is a resolution consistent with EPA authorities and in the public interest. The factors considered in determining whether to settle a particular matter include: the legal risks presented by the case, including both the probability and possible consequences of an adverse decision; and the comparative public policy implications of litigation versus settlement, including the resources required to litigate versus to take those actions called for by a settlement. These factors are applied in an evenhanded manner, without regard to the identity or type of the plaintiff or petitioner in the case.

The environmental statutes as enacted by Congress provide a myriad of regulatory actions that the EPA must take by certain deadlines. These requirements are commonly referred to as "mandatory duties" and the cases brought against the EPA alleging the Agency has failed to fulfill such duties are commonly referred to as "mandatory duty suits." Where the "mandatory duty" allegations are strongly grounded in statutory text, the EPA's litigating position is generally weaker, which impacts how the agency evaluates its settlement options.

While the decision to seek settlement is generally made jointly, DOJ typically takes the lead for the United States government in the development of a settlement strategy and in negotiating the settlement terms, and for EPA settlements, DOJ's Environment and Natural Resources Division must approve the decision to enter into a settlement agreement or consent decree.

In taking any action, the EPA is guided by applicable legal standards and requirements, as well as the relevant science and analysis. In mandatory duty lawsuits, seeking settlement allows the agency to negotiate for more time than it would expect to receive through litigation. Litigating these cases can be expensive litigation and result in a court-ordered schedule requiring agency action on an unfeasible timeline. By negotiating for an achievable deadline, the agency is able to invest more time in the analysis and decisionmaking process.

The majority of environmental lawsuits against the EPA are brought under the Clean Air Act. The Clean Air Act does have many mandatory duties with associated deadlines, which are the source of many of the cases we settle. However, before settling these cases, the proposed settlement agreement containing any deadlines goes out for public comment. Under Clean Air Act section 113(g), before finalizing a settlement agreement under the Clean Air Act or asking a court to enter a Clean Air Act consent decree, the EPA publishes in the Federal Register a notice seeking public comment on the proposed agreement and then considers any comments received.

The EPA has many duties and authorities under the various environmental statutes it administers. The agency works to protect human health and the environment by focusing on critical priorities while also endeavoring to meet recurring statutory obligations.

FACILITIES

Question Administrator McCarthy, EPA's budget justification says EPA is continuing to recalculate its facility and rent needs. It says that EPA plans to spend $1 million from the Science and Technology account to study further consolidation (Page 140) and that EPA intends to save $9.5 million from the EPM account from these efforts (Page 427).

• What plans if any does EPA have to close or relocate program, regional or lab offices or spaces across the country in fiscal year 6? When will affected offices be informed of their closure? Will the affected employees be given the opportunity to relocate or transfer to another duty station?

• How much has EPA spent in fiscal year and 2015 to relocate employees? How much does it expect to spend on relocation expenses in fiscal year 6?

Response. In EPA's fiscal year budget request, the agency requested $10 million to consolidate the Willamette Research Station and the Region 8 laboratory. Employees at the Willamette Research Station and the Region 8 laboratory have been informed of the agency's fiscal year request to consolidate their space. Neither consolidation requires employee relocation. The work being conducted at the Willamette Research Station will be moved to the Western Ecology Division's main facility in Corvallis. Employees from the Region 8 laboratory in Golden, CO will be moved to EPA's National Enforcement Investigations Center laboratory in nearby Lakewood, CO. In fiscal year and fiscal year consolidation activities were limited to office moves within local commuting areas and employee relocation was not required. In fiscal year 4, EPA spent $5.4 million to move the offices of approximately 500 employees from 1310 L Street to the agency's Federal Triangle Campus in Washington, DC. In fiscal year 5, the agency spent $196.4 thousand in employee relocation expenses associated with facility consolidation. The agency does not anticipate using additional resources for the remainder of fiscal year to move employees into new facilities.

SUPERFUND/HAZARDOUS WASTE

Question 1. The fiscal year budget shifts EPA's emphasis from well-established programs approved by Congress to ones that advance the President's Climate Action Plan.

• For example, the budget would cut almost $1 million and 5 FTEs from its RCRA corrective action program, which will reduce "EPA's technical support to State partners and may reduce the pace of cleanups including site-wide 'RCRA remedy construction' determinations." How will this reduction impact EPA's implementation of recommendations in the Government Accountability Office's 2011 report concerning RCRA corrective actions?

• How will EPA prioritize its work and support to states in response to the proposed reductions in funding?

• Will any sites or states that would have received support in order for EPA to meet its corrective action goals in the fiscal year 4–2018 Strategic Plan, no longer receive support due to the proposed reductions in funding?

• In another example, the fiscal year budget request would cut funding for the RCRA waste management program by $1.3 million and more than 9 FTEs, which according to EPA's budget justification "may delay activities such as conducting additional analysis to support non-hazardous secondary materials categorical rulemakings and responding to regulatory backlog petitions." Please identify how many "regulatory backlog petitions" EPA had at the start of fiscal year and the backlog time for each petition.

• How will this proposed reduction impact EPA's implementation of the final Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities rule, signed by EPA on December 19, 2014?

Question 2. Notably, the fiscal year budget proposed a $2.3 million increase, including an additional 4.2 FTEs, for the Sustainable Materials Management program to implement key aspects of the President's Climate Action Plan.

• The budget justification states EPA will explore the application of Sustainable Materials Management "approach to other high priority areas." What are these areas?

• The budget justification also states that EPA plans to hire 5 FTEs to serve as "Community Resource Coordinators for climate adaptation, sustainability, and communities work" who will "work as a cross-agency, multi-media team to facilitate access to EPA's programs and resources." Please explain whether these would be per-

manent or term-limited positions, the professional qualifications for these positions, and from what Headquarters or regional office such positions would be based.

• The budget request proposes the creation of a $1.3 million grant program "to support the EPA's investment in climate mitigation through waste program activities to reduce greenhouse gas emissions." Please describe the statutory authority for this program, the anticipated number of grants that would be funded in fiscal year 6, and a summary of the criteria EPA would use for grant awards.

Question 3. Concerns remain about the slow pace of Superfund cleanups. In fiscal year 4, EPA achieved construction completions at only 8 Superfund sites, an all-time low, with an enacted budget for Superfund cleanups at $555 million. In fiscal year 6, EPA is proposing to achieve construction completions at 13 sites with a budget request of $539 million. How many additional Superfund sites would EPA be able to clean up if the $214 million that the President has requested for greenhouse gas rules were put toward the Superfund program instead?

Responses. As GAO recommended, the EPA is assessing the remaining corrective action workload, evaluating the resource needs to meet these goals, and considering revising the goals. This reduction in corrective action resources will not delay the continued assessment of remaining workload and predictions for future progress. The reduction may, in the short-term, have an impact on EPA's ability to meet our site-wide remedy construction fiscal year and fiscal year targets.

• The EPA will continue to work closely with states to prioritize technical assistance and work sharing for facilities or work areas where there is the greatest need, and will continue to share program efficiencies to facilitate cleanup at corrective action facilities and polychorinated biphenyls (PCB) sites.

• The fiscal year President's Budget requested funding equal to the fiscal year enacted level for the Hazardous Waste Financial Assistance program which provides resources to our State partners to fulfill their RCRA obligations which includes corrective action activities. The proposed reductions to the RCRA Corrective Action program will not eliminate support to any specific State or facility, but will be distributed nationwide. The funding level allows for continued, although not fully maximized, progress on cleanups.

• Since 1998, the EPA has received 15 RCRA formal rulemaking petitions and EPA has responded completely to three of these (Coal Combustion Residuals, Saccharin, and Gasification). At the start of fiscal year 5, the EPA has 12 "regulatory backlog petitions." Of these 12 petitions, three are actively being addressed (two for Non-Hazardous Secondary Materials and one for Corrosivity); the others are under review. In addition, EPA receives approximately 30—40 "informal" requests for regulatory interpretations or assistance with specific emerging waste management situations over the course of a given year. These requests come from the regulated community, from states, citizens, and from foreign governments. Often these are complex, requiring the agency to obtain additional information about specific situations or industrial processes before being able to respond.

• The proposed reduction will not impact implementation of the final Coal Combustion Residuals Rule.

Within and outside of the Federal Government, the EPA has been working to reduce food loss and food waste through Sustainable Materials Management (SMM) approaches such as smarter purchasing and food donation. In addition, the residential and commercial building sector stands as an area where SMM principles can make a substantial impact with smart design choices, safer materials choices, and reuse and recycling of materials. Over the next several decades, billions of tons of concrete, steel, and wallboard will be required to construct, maintain, and operate our nation's buildings, roads and other infrastructure, resulting in substantial environmental impacts, including energy and petroleum consumption, use of non-renewable mineral resources, greenhouse gas emissions, expenditure of fresh water, and land and habitat use.

• The Community Resource Coordinator positions are intended to be permanent employees in the Regions. Each Region will receive 0.5 full-time equivalent employee dedicated to working as cross-agency, multi-media team members. The precise professional qualifications for the positions have not been finalized at this time. However, coordinators will be expected to have knowledge of and a firm grasp on sustainability concepts such as SMM, green infrastructure, smart growth, and brownfields. Further qualifications will include demonstrated experience regarding community support entities and mechanisms (i.e., the EPA's programs and other programs across the Federal spectrum that impact environmental outcomes).

• The statutory authority for the proposed $1.3 million grant program is the Solid Waste Disposal Act § 8001—Research, Demonstrations, Training, and Other Activities. The EPA estimates that approximately 8–13 grants would be funded in fiscal

year 6. These funds will focus on: increasing the recycling rates for containers and packaging; enhancing and expanding results-driven programs; working with the public and/or private sector to provide funding to assist states and local governments and non-governmental organizations (NGO's) focused on infrastructure development and providing technical assistance to recycling programs. Support in this program area will help to create new businesses and jobs in a sector that employs 1.1 million people at approximately 56,000 establishments, generating an annual payroll of nearly $37 billion, and more than $236 billion in annual revenues. Criteria for the grant awards would potentially include support of agency recycling goals, community/stakeholder needs, feasibility of project success, project benefits (e.g., policies, tools, job creation, economic and social benefits, among others), and the ability to leverage existing initiatives and partners. The EPA also will work with additional stakeholders to ensure consistent recycling guidance, identify gaps and recycling barriers, and transfer best practices. The reporting period for grants is anticipated to extend beyond 1 year, in order to measure changing recycling rates.

The Superfund Remedial program has made substantial progress in completing response work, as measured by the site-wide "construction completion" measure, though this is only one of a suite of measures used to gauge Superfund outcomes. As of the end of fiscal year 4, EPA had achieved construction completions at over 68 percent of the 1,706 Superfund sites on the National Priority List (NPL).

As part of the fiscal year budget request, the President has requested an increase in the Superfund Remedial program budget of more than $38 million and an increase in the Superfund Removal budget of more than $9 million. The EPA anticipates the increase in Remedial funding will enable the agency to start remedial action at up to 10 additional EPA funded site projects. It is difficult to assess how many Superfund sites could be completed with as much as $214 million in additional funding. Partly, this is because each site is different with unique site characteristics, so that site-by-site, cleanup costs would be expected to be very different. Some sites cost in the tens to hundreds of millions of dollars to complete. In addition, to move a site to completion, site investigation and studies, and remedy selection and design must be completed before starting and completing cleanup construction.

KEYSTONE

Question 1. Administrator McCarthy, in January of this year you stated that EPA believes current low oil prices are a short-term situation and will not affect how your Agency crafts new regulations.

- Do you still stand by that statement?
- Can you please explain to me why 3 weeks later EPA told the State Department that it should revisit its analysis of the Keystone XL pipeline with a new assumption that the current low oil prices are permanent?
- As a general rule, you ignore short-term oil prices when evaluating costs and benefits. But, politics appear to determine when you make an exception to that rule. How can you reconcile this inconsistency?

Question 12. The statement regarding current oil prices was a comment on consumer automobile buying habits, and was not intended to represent the agency's regulatory development process. Administrator McCarthy also noted that she did not expect that oil prices would continue to have "extreme fluctuation[s]."

The EPA's comment letter to the Department of State did not suggest an assumption that current low oil prices would be permanent. Instead, the EPA noted that given the importance of oil prices to the Department of State's market analysis and conclusions, and the recent large declines in oil prices and the uncertainty of oil price projections, we recommend that the additional low price scenario included in the Final EIS be given additional weight in considering potential environmental impacts of the project.

The EPA considers all relevant information when evaluating costs and benefits of its proposed regulations. With regard to our comments to the Department of State concerning the Keystone XL pipeline, the Department of State's Final Supplemental EIS identified the price of oil as a key and critical determinant of the effect of the pipeline on Canadian oil sand development and thus the environmental impacts of the project. The EPA's comments only recommended that they more fully consider the low oil price scenario when evaluating the environmental impacts of the project.

METHANE

Question 1. Administrator McCarthy, the Administration has acknowledged the great benefits that we are now enjoying as a result of the natural-gas renaissance in the US. In fact, the US is now the world's largest gas producer. As this was occurring, our nation's producers have been making great strides in reducing methane emissions thanks to investments in technology allowing us to produce more natural gas in a cleaner way. In fact, today, while natural gas production has increased 37 percent since 1990, methane from production has gone down by 25 percent. I am concerned as such by your January announcement regarding methane regulation.

• Why are you targeting such a steep 45 percent reduction in emissions from an industry that has already reduced its emissions significantly while increasing production? Moreover, the production sector represents only 0.4—1.4 percent of U.S. GHG emissions.

Question 2. In the Administration's January 14th release to reduce methane emissions from this industry, an assumption was given projecting that industry's methane emissions will be increasing by 25 percent—not decreasing as already shown.

Question 1. Can you explain this assumption and provide the specific data from which you've based these projections?

Question 3. Administrator McCarthy, I'm trying to understand EPA's rationale for pursuing another round of Clean Air Act regulations on natural gas production. This time the agency is directly targeting methane. I think it's important to note the industry's progress in reducing methane. Natural gas producers have reduced methane emissions by 25 percent since 1990, even as production has grown 37 percent.

A recent report by researchers at the University of Texas and the Environmental Defense Fund (EDF) found that methane emissions from the upstream portion of the supply chain are only 0.38 percent of production. That's about 10 percent lower than what the same research team found in a study released in September 2013. Studies by the National Renewable Energy Laboratory, U.N. IPCC, Massachusetts Institute of Technology, and many others reached similar conclusion: that methane emissions from natural gas production are declining, and quite low compared to other sources.

Moreover, we can't forget that methane is the main component of natural gas. Producers have every incentive to capture it and prevent leaks. The evidence I just cited shows this is exactly what they are doing.

The industry is only now implementing new source performance and MACT standards finalized in 2012, which target VOCs and sulfur dioxide, but also will help reduce methane. So Administrator, my question is: Why is EPA pursuing another round of mandates on the industry? What is the rationale for moving down this path?

Question 4. Administrator, EPA indicated it will develop new source performance standards for new and modified natural gas wells this summer. This action will be taken pursuant to Section 111(b) of the Clean Air Act, which covers new and modified sources. Some legal commentators believe that this action will provide the basis for regulations of existing wells under Section 111(d). What is EPA's legal view on this point? Once you finalize regulations under 111(b), are regulations for existing wells inevitable under 111(d)? Is EPA planning or thinking about regulation existing wells under 111(d)?

Response. Methane, the key constituent of natural gas, is a potent greenhouse gas with a global warming potential more than 25 times greater than that of carbon dioxide. Nearly 30 percent of methane emissions in the U.S. in 2012 came from oil production and the production, processing, transmission and distribution of natural gas. While methane emissions from the oil and gas industry have declined by more than 10 percent since 1990, they are projected to increase significantly over the next decade if additional steps are not taken to reduce emissions from this rapidly growing industry. EPA's strategy, which will use both voluntary and regulatory approaches, will help avoid this anticipated increase in methane emissions from new sources.

The January 14, 2015 announcement marked the beginning of the agency's process to develop proposed standards for methane and VOC emissions for new and modified sources in the oil and gas sector. As is the case with all of our regulatory actions, EPA will develop a robust regulatory impact analysis that will include, among other issues, a rigorous analysis of projected future emissions from this sector that would be avoided by the implementation of the proposed standards. To ensure the agency's projections are based on the very best data available, EPA's analysis will take into account additional information from industry, states, and other

stakeholders and will follow the time-tested methodologies used in all of our regulatory impact analyses. The agency's analysis will be issued along with a proposal this summer and will be available for public review and comment.

Methane emissions accounted for nearly 10 percent of U.S. greenhouse gas emissions in 2012, of which nearly 30 percent came from the production transmission and distribution of oil and natural gas. Emissions from the oil and gas sector are down 16 percent since 1990 and current data show significant reductions from certain parts of the sector, notably well completions. Nevertheless, emissions from the oil and gas sector are projected to rise more than 25 percent by 2025 without additional steps to lower them. For these reasons, a strategy for cutting methane emissions from the oil and gas sector is an important component of efforts to address climate change.

The steps announced are also a sound economic and public health strategy because reducing methane emissions means capturing valuable fuel that is otherwise wasted and reducing other harmful pollutants—a win for public health and the economy. Achieving the Administration's goal would save up to 180 billion cubic feet of natural gas in 2025, enough to heat more than 2 million homes for a year and continue to support businesses that manufacture and sell cost-effective technologies to identify, quantify, and reduce methane emissions.

On January 14, 2015, the EPA announced plans to set standards under 111(b) to address methane and VOC emissions from new and modified sources, develop new guidelines to assist states in reducing ozone-forming pollutants from existing oil and gas systems in areas that do not meet the ozone health standard and in states in the Ozone Transport Region, and work collaboratively with key stakeholders to make progress on voluntary efforts to reduce emissions from existing sources.

ENVIRONMENTAL EDUCATION

Question For its fiscal year budget proposal, EPA requested zero funds for its environmental education program; yet its fiscal year budget proposal requests funds albeit an increase in funds from $8.7 million enacted in fiscal year to $10.969 million.

• Why did EPA, after requesting zero funds for the program over the last couple years, request funds and an increase in funding for the program?

• EPA has recently identified climate change as a priority for environmental education grants under this program. These grants are used to educate elementary and secondary school students, train teachers, purchase textbooks, and develop curricula based on environmental issues EPA identifies as a priority. What performance measures are in place to ensure such curricula is based on the best available science?

Response. The recent establishment of the Office of Public Engagement and Environmental Education (OPEEE) with a career deputy to lead OEE is designed to provide leadership, management stability, and forward-thinking strategy to establish and implement a consistent vision for environmental education (EE) across the agency. Ensuring a centralized approach to EE and partnering the public engagement and EE functions within OA is intended to help EPA:

• place greater emphasis on EE as a tool for advancing priorities by providing leadership, technical expertise and coordination of agency efforts;

• enable EE to be more effectively and consistently used by the EPA's programs; and

• broaden the reach and scope of EE (through greater public engagement).

Reinstating the EE program project in fiscal year is a visible commitment to enhancing the agency's leadership role in educating and informing the public and encouraging environmentally beneficial attitudes and actions. A centralized EE program will allow the EPA to:

• improve internal EE capacity within program offices through greater provision of OEE expertise;

• support the National Environmental Education Foundation (NEEF) and other stakeholders to leverage their resources for greater stakeholder reach; and

• avoid significant administrative complexities associated with awarding grants under multiple authorities (under a decentralized approach) and ensure grants monitoring and compliance

This program has requested in fiscal year an increase to help meet the required staffing levels and corresponding funding requirements under the National Environmental Education Act. The request also reflects increased support for administration of EE grants; advancement of the frameworks and tools used for measuring EE impacts; development of a process to identify and address gaps and redundancies in

EE materials and programming within the agency; leveraging of EE efforts across the Federal Government; and development of the longer-term strategic direction for the program.

In order to be eligible for a grant under the EPA's Environmental Education (EE) Grant program, proposals must address at least one of the EPA's environmental themes and at least one EPA educational priority. The EE Grant Program does not assign order of importance or preference to those themes. According to the National Environmental Education Act (NEEA), grant funds can be used to support development and dissemination of curricula, educational materials, and training programs for teachers, plus the education of elementary and secondary students and other interested groups, including senior Americans in both formal and non-formal educational settings.

The annual grants are awarded through a competitive process, and applicable Federal guidelines and policies are followed for grant solicitations, proposal evaluation, and grant awards. The solicitations for EE grants includes a requirement that grantees collect and report applicable data as a condition to accepting a grant. Grantees are also required to submit a logic model with their initial proposal to identify short-, medium-and long-term educational and environmental outputs and outcomes of the project(s). As a further condition of eligibility, grantees must describe how they will evaluate the success in achieving the proposed project results and must submit a completed evaluation on the project's performance at the end of the project. In the application as well as in their progress reports, they must demonstrate the educational component of their program, including the best available science upon which it is based. By law, post-award baseline monitoring must be conducted on every EE grant, and at least every 6 months all grantees are required to report on the progress, accomplishments, and funding associated with the project.

URANIUM AND THORIUM MILL TAILINGS—RULEMAKING

Question 1. In January, the U.S. Environmental Protection Agency proposed "Health and Environmental Standards for Uranium and Thorium Mill Tailings (80 Fed. Reg. 4156). The agency maintains the rulemaking is necessary to reduce the risk of undetected excursions of pollutants from in situ uranium recovery operations into adjacent aquifers.

- Does the agency have any evidence that these operations have adversely impacted an adjacent aquifer? If so, please provide such data.
- Please explain why no such data is included in the rulemaking docket.
- If EPA has no such data, please explain the basis for proceeding with this rulemaking.

Response. The EPA, as well as the general public, have access to NRC data on ISR facilities. More information concerning in-situ recovery (ISR) wellfield baseline and restoration groundwater quality data collected from the NRC licensed ISR sites for regulatory purposes can be found at http://www.nrc.gov/info-finder/materials/uranium/. Generally the data is current through 2013 and shows both excursions and in at least one case, stability monitoring for as long as 10 years.

The current requirements at 40 CFR Part 192 address conventional uranium facilities but do not specifically address ISR operations. ISR operations are now the most common method for extracting uranium. In order to understand some of the reasons the EPA proposed the rule, it is helpful to understand the history related to ISR licensing and regulation. In 2006, after years of implementing the general requirements in 40 CFR Part 192 at ISR facilities, NRC said that the "manner of regulation [of ISR facilities] is both complex and unmanageable" and has led to an "inconsistent and ineffective regulatory program [for these types of facilities]." In 2007, NRC began developing new rules to address the issues at ISR facilities but stopped because the Atomic Energy Act (AEA), as amended by the Uranium Mill Tailings Radiation Control Act (UMTRCA), requires that the EPA promulgate generally applicable standards, which are then implemented and enforced by NRC.

In past and present efforts to implement the general requirements in 40 CFR Part 192 at ISR facilities, requirements vary from site to site rather than following a consistent, national approach for all ISR facilities. The proposal presents health or environmental standards tailored specifically to address the technologies and challenges associated with the most widely used method of uranium recovery.

The proposed standards will regulate byproduct materials produced by uranium ISR, with a primary focus on groundwater protection, restoration and stability. The proposed rule will reduce the risk of undetected excursions of pollutants into adjacent aquifers. This in turn will reduce the human health risks that could result from exposures to radionuclides in well water used for drinking or agriculture in

areas located down-gradient from an ISR In addition to avoiding human health impacts, the proposed rule has the potential to detect excursions sooner and thus enable a faster remedial response. Because plumes detected during long-term stability monitoring would be smaller, costs of remediation would be potentially much lower. The proposal would also lessen the likelihood of undocumented contamination of aquifers resulting in costly cleanup, potentially funded by the U.S. Government rather than the responsible party (e.g. the ISR facility). Citizens located near these ISR operations have commented that they are concerned about these facilities and have requested that EPA finalize this proposal. The intent of the Part 192 proposal is to establish requirements that will ensure the ISR facility that disturbs the groundwater must restore that groundwater to predetermined levels and ensure that the restoration is stable before leaving the site and terminating its NRC license.

Question 2. In the cost benefit analysis accompanying the rulemaking, the agency focuses almost exclusively on the increased costs that would be imposed by the proposed rule's new monitoring requirements, which could require facilities to conduct more than 30 additional years of groundwater monitoring. EPA fails to assess multiple other costs that would be associated with the rule, including the costs of maintaining licenses, permits, etc. for 30 years; claims maintenance fees owed to the Bureau of Land Management for facilities on public lands; costs to obtain and maintain surety for additional years; costs related to continuing leases with private surface holders; taxes; insurance; or the cost of maintaining equipment and facilities. Given the additional costs that would be imposed, it is likely that the ultimate cost would be several orders of magnitude higher than EPA calculated in their cost benefit analysis.

• Please explain why EPA chose to ignore these costs in its analysis.

• Does EPA plan to revise its cost benefit analysis to more comprehensively assess the costs of the rulemaking? If not, why not?

Response. License fees range from $35,400 to $40,000 per year, but drop to zero if only decommissioning is occurring. Financial assurance costs continue through decommissioning, but decline as more of the site is decommissioned. Throughout the life of an ISR operation, the costs associated with licensing and financial assurance would, in EPA's assessment, be unaffected by the proposed rule, until only one wellfield is still in operation or undergoing decommissioning. The longer duration of monitoring required would cause the firms to incur the costs associated with financial assurance for a longer period of time (potentially 30 years). However, as the number of wellfields in operation declines, and the amount of radioactive material onsite declines, the magnitude of the financial assurance required would decline proportionally. EPA thus believes that the additional costs associated with payment of license fees and financial assurance would be small relative to other incremental costs and thus we did not include them in our quantitative estimate of costs and impacts.

RESPONSES BY GINA MCCARTHY TO ADDITIONAL QUESTIONS FROM SENATOR WICKER

CARBON DIOXIDE

Question 1. As I hope you know, a one-sided focus on worst-case stories and scenarios is a poor foundation for sound environmental and economic policies. There is an extraordinary amount of uncertainty in climate science mainly because of the complex nature of the climate and climate models. Climate model predictions have wildly varying degrees of accuracy and many have estimates that failed to come to fruition. With so much uncertainty and unknown variables regarding the impacts of carbon dioxide on the world's oceans and environment how can you possibly accurately estimate the costs and benefits of your proposals? Considering you can't provide a quantifiable, measurable direct impact of these regulations on sea level rise and global temperatures, don't you think the other supposed benefits to society are equally uncertain and overstated?

Response. Actions taken to comply with the proposed guidelines will reduce emissions of CO_2 2 and other air pollutants, including SO_2 NO_x and directly emitted $PM_{2.5}$, from the electric power industry. States will make the ultimate determination as to how the emission guidelines are implemented. Thus, all costs and benefits reported for this action are illustrative estimates. The EPA has calculated illustrative costs and benefits in two ways: One based on an assumption of individual State plans and another based on an assumption that states will opt for multi-State plans. The illustrative costs and benefits are based upon compliance approaches

that reflect a range of measures consisting of improved operations at EGUs, dispatching lower-emitting EGUs and zero-emitting energy sources, and increasing levels of end-use energy efficiency. The annual compliance costs are estimated using the Integrated Planning Model (IPM) and include demand-side energy efficiency program and participant costs as well as monitoring, reporting and recordkeeping costs.

Question 2. With each and every climate regulation put forward by the administration, the supposed benefits of each regulation continue to get smaller and smaller and more imaginary while the costs to American taxpayers and the economy continue to grow. A sound environmental and economic policy would place amount of regulation, in this case carbon dioxide emissions, where the marginal benefits are equal to the marginal costs. It seems the opposite is true in the latest EPA budget proposal. While carbon dioxide emissions continue to rise across the globe, at what point will EPA begin to allocate their limited budgetary resources to other programs that have greater benefits to American taxpayers while imposing lower costs on them?

Response. By 2030, the Clean Power Plan proposal would cut carbon emission from the power sector by 30 percent nationwide below 2005 levels, which is equal to the emissions from powering more than half the homes in the United States for 1 year. These measures will avoid up to 6,600 premature deaths, up to 150,000 asthma attacks in children, and up to 490,000 missed work or school days providing up to $93 billion in climate and public health benefits, which far outweigh the costs of the plan.

Question 3. In the fiscal year budget request, EPA notes it will be finalizing rules for formaldehyde emissions in composite wood products. Why has EPA decided to regulate laminated products when the authorizing legislation gives you authority to exempt those products? The testing costs far exceed any benefit considering that studies submitted to EPA show that the value added process of finishing laminated products can reduce the emission profile of an already compliant platform.

Response. The Formaldehyde Standards for Composite Wood Products Act (TSCA Title VI), enacted by Congress in 2010, establishes formaldehyde emissions standards for hardwood plywood, particleboard, and medium density-fiberboard. Congress also provided the EPA with the authority to exempt some or all laminated products from the definition of hardwood plywood pursuant to a rulemaking under TSCA Title VI, which shall be promulgated "in a manner that ensures compliance with the [statutory] emission standards." The information available to the EPA at the time the regulations were proposed in June of 2013 did not indicate that laminated products would be in compliance with the emission standards, and therefore the agency did not propose an exemption for all laminated products from the proposed regulations. The agency did however, propose to exempt laminated products that are made with compliant cores and laminated with "no-added-formaldehyde" resins because we concluded that such exemptions would be consistent with the statutory directive.

As directed by the Act, the EPA is continuing to evaluate all available and relevant information from State authorities, industry, and other available sources to determine whether the definition of hardwood plywood should exempt engineered veneer or any laminated product. In an ongoing effort to reach out to potentially affected stakeholders, the EPA met and continues to meet with companies and trade associations that represent, among other members, producers of laminated products. As part of this effort, the EPA has specifically requested data on formaldehyde emissions from laminated products, as well as comments and information on the proposed definition of laminated products. The initial comment period for the implementing regulations was twice extended at the request of a number of industry stakeholders and closed on October 9, 2013. In spring 2014, the EPA provided an additional public comment period on the proposed rule and conducted a public meeting on laminated products to address issues of concern to stakeholders. In addition, the EPA has met regularly with the California Air Resources Board (CARB). The agency is working to develop an approach to laminated products that would address potentially significant formaldehyde emissions while recognizing industry concerns over testing costs and burdens, particularly for small businesses.

Question 4. With respect to the ongoing rulemaking on formaldehyde emissions in composite wood products, you recently stated that laminates could potentially be a "significant source of emissions." Does EPA have scientific data that validates that statement? Will you share it with the committee? Data submitted to the public record during the rulemaking shows that the value added process of finishing laminated products can reduce the emission profile of an already compliant platform.

Response. In developing the proposed laminated products provisions, the EPA consulted several sources of information, including a 2003 Composite Panel Association

technical bulletin on laminates, as well as information provided by small entity representatives to the Small Business Advocacy Review Panel held for the proposed regulations. During the public comment periods, the EPA received additional information, including test results that appear to confirm that the lamination process can increase formaldehyde emissions. The California Air Resources Board (CARB) submitted results from their testing of laminated products, which are available in the docket for this rulemaking at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT–2012–0018–0515 and are also attached. According to CARB, the results indicated that, in several instances, the laminated products emitted considerably more formaldehyde than was emitted by the cores, likely due to the urea-formaldehyde resin used to affix the veneer. In addition, CARB noted that, while most samples with no stain or finish had higher emissions than identical products with a stain, indicating that the application of stain can reduce formaldehyde off-gassing and decrease exposures to formaldehyde, a number of samples with a stain still emitted more formaldehyde than the cores.

Question 5. The academic and scientific communities are actively pursuing research into the magnitude of methane emissions from various sectors of the U.S. economy. With much of this research outstanding, why doesn't EPA wait to understand the major sources of methane emissions before promulgating regulation?

Response. Methane, the key constituent of natural gas, is a potent greenhouse gas with a global warming potential more than 25 times greater than that of carbon dioxide. Nearly 30 percent of methane emissions in the U.S. in 2012 came from oil production and the production, processing, transmission and distribution of natural gas. Methane emissions are projected to increase by about 25 percent over the next decade if additional steps are not taken to reduce emissions from this rapidly growing industry.

Question 6. EPA's announcement last month on methane regulation indicated that there was no intention to regulate existing sources in the oil and gas industry at this time, instead, the agency would allow for voluntary actions by industry for existing sources. Aren't the control technique guidelines, coupled with your pending ozone regulation essentially a defacto regulation of existing sources in the industry?

Response. The EPA will develop new guidelines to assist states in reducing ozone-forming pollutants from existing oil and gas systems in areas that do not meet the ozone health standard and in states in the Ozone Transport Region. These guidelines will also reduce methane emissions in these areas. The guidelines will help states that are developing clean air ozone plans by providing a ready-to-adopt control measure that they can include in those plans.

Senator INHOFE. Thank you very much.

We are going to have 6-minute rounds and use the early bird rule which we established when we changed things around here. I will begin and probably will not take all of my time because I want to reserve some in case some of my colleagues want to have more time.

The EPA is asking for, as I said in my opening statement, $3.5 million for additional attorneys and lawyers to defend their proposals. My question would be if the States requested a judicial stay of the rule after it is finalized to allow for legal challenges to the rule to be resolved, would the EPA object to that request for a stay?

Ms. MCCARTHY. We see no reason for a stay in the rule, Senator, but if you are looking at the lawyers we are asking for.

Senator INHOFE. I am talking about the existing source rule.

Ms. MCCARTHY. We are not interested in staying any of the rules, Senator. We don't think there is a reason for it. We are moving ahead to finalize those rules.

The lawyer issue is not related to our climate effort. It is related to regional and headquarters efforts to provide the resources we need to smoothly move through permits, to get our legal positions on our rules effectively identified and commented on.

Senator INHOFE. I understand your answer is no. Now I will ask the second part of that question. As soon as some of the States refuse to submit a SIP, a State program, or if the EPA denies the

State SIP, would the EPA consider withholding Federal highway funding or would you say no?

Ms. MCCARTHY. This is not a traditional State SIP under the national ambient air quality standards. There are other processes for us to work with States. Clearly our hope is that States will provide the necessary plans. If not, there will be a Federal system in place to allow us to move forward.

Senator INHOFE. For the benefit of some who may not be aware of why we have been talking so much up here, it seems like every hearing we have turns into a global warming hearing. One of the reasons people are talking about doing this through regulation is that ever since 2003 we have had four votes in the U.S. Senate to go ahead and do something, have some kind of cap and trade they are now talking about doing through regulation.

It was soundly defeated four times. Now the Obama administration is saying we will do through regulation what we were unable to do through legislation.

Ozone is a big deal for a lot of us. The 2008 implementation program, which planned for a 2008 ozone NAAQS was issued 2 weeks ago. I made the statement in my opening that there are a lot of States which have not complied with 2008, correct?

Ms. MCCARTHY. That is correct.

Senator INHOFE. Do you know how many States?

Ms. MCCARTHY. I do not know, sir, because we are in the early stages of implementing the 2008 standard.

Senator INHOFE. We have a standard of 75 ppb. A new standard they have tested down to 65 ppb and even 60 ppb. Even 65 ppb, in my State of Oklahoma, would put all 77 of our counties out of attainment. That is a very serious thing.

What is the justification for going ahead and moving toward this before we have had compliance with the 2008 regulations? What is your justification for that?

Ms. MCCARTHY. Actually, we are under a court order to move forward because the Clean Air Act enacted by Congress requires us to review these every 5 years and we are significantly behind.

The good news is this rule is simply looking at the level we need to achieve in order to protect public health and welfare. That is what we are going to be making a decision on.

Senator INHOFE. As opposed to moving on with that rule?

Ms. MCCARTHY. We don't have an option here. The Clean Air Act requires us to look at the science as it is updated every 5 years. The court has told us that is what it says over and over.

Senator INHOFE. That same court was there in 2008 when many States had not complied with that. That is my point. I don't see any logical reason we would move to a more stringent standard when we haven't complied with that.

I am going to save the remaining 2 minutes of my time. Senator Cardin?

Senator CARDIN. Thank you, Mr. Chairman. I appreciate it very much and appreciate this hearing.

Ms. McCarthy, it is always a pleasure to have you before the committee.

Senator INHOFE. I am going to interrupt you. She has been chairman for the last 8 years and I am just not used to this, so I won't recognize you. I will recognize Senator Boxer next.

Senator BOXER. To thoroughly confuse matters, I yield my time to Senator Cardin and will take mine later.

Senator CARDIN. Thank you, Senator Boxer and thank you, Mr. Chairman.

Mr. Chairman, I just want to make a point. Only in the U.S. Senate would getting a majority vote, 50 some votes, in favor of a proposal be characterized as soundly defeated.

My recollection is the cap and trade provision, to which you referred, got over 50 votes in the U.S. Senate. I just wanted to correct the record on that point. I am sure the public understands that a majority is not a majority in the U.S. Senate.

I want to compliment you on your budget as it relates to important priorities. I think the overall budget is a reasonable investment in the Environmental Protection Agency and I applaud the Administration for bringing that forward.

I think the emphasis on climate change as it relates to U.S. leadership that will have, I think, major dividends in global action which help the people of our Country, is exactly where we need to be. Your budget reflects those priorities.

I want to first start by saying I am very supportive of the priorities that you have set as it relates to the size of the EPA budget and the focus on issues that are critically important to our Country.

I want to ask you why you are recommending a reduction in the State Revolving Fund on clean water. I want to preface that by telling you I know the circumstances in Maryland and the circumstances around the Nation where water main breaks are a daily occurrence, where we had River Road in Montgomery County become a river threatening peoples' lives, where we have seen businesses shut down, where we have seen the Beltway shut down because of water main breaks. I visited Baltimore water main facilities and found water mains that are 100 years old and in desperate need of repair.

Our States are crying out for more resources in the State Revolving Fund. Can you explain to me the rationale for the recommendation on the State Revolving Fund?

Ms. MCCARTHY. Senator, there is no question that this is a level that is $50-some odd million below what was enacted last year. I will have to point out though it is $527 million above what the President requested last year. We certainly recognize there are significant challenges out there and are doing the best we can within a conservative and appropriately designed budget.

Senator CARDIN. I am going to let you finish your answer but it seems to me you are saying that you are depending on Congress to put in the right amount of money?

Ms. MCCARTHY. We have actually submitted a budget that is very close to what was enacted last year. We are trying to address the issue in a variety of different ways.

I am not suggesting that I wouldn't love to have lots of money to address these issues but difficult choices need to be made. I will point out that we are trying other very creative approaches to also

supplement the money that is available in SRF so that we can target SRF appropriately. Then we have the WIFIA Center that we are beginning to create this year.

I think the Water Infrastructure Resiliency Finance Center is also a very creative approach to try to address this challenge by building more public-private partnerships.

It is not that I don't think we could always spend more money and spend it effectively. I am suggesting that public sector dollars will not cover the need that is out there. We need to find very creative approaches and also attract private sector dollars into this venture because it matters to all of us.

Senator CARDIN. I agree with that. I agree that we are going to have to supplement the infrastructure financing by creative methods, whether it is WIFIA, tax credits or public-private partnerships. My Mayor, Stephanie Rawlings-Blake, suggested a separate trust fund for water infrastructure. We are going to have to do something for more.

You need a basic program that at least is there to provide the fundamental commitment by the Federal Government. The same thing is true, by the way, with highway transportation. We want our 6 year reauthorization but we also recognize we may have to supplement that with more infrastructure in creative ways.

Maybe my math is different than yours. We can do this later and get me the information. My staff tells me this is a 22 percent cut in the Clean Water State Revolving Fund, amounting to a transfer of $332 million.

Ms. MCCARTHY. I am sorry, I misunderstood. I thought you meant the entire fund. The Clean Water SRF is lower because we have shifted a lot of the additional resources to drinking water. As a whole, it is $2.302 billion we are proposing.

Senator CARDIN. The State Revolving Fund that deals with our wastewater treatment facilities are cut by 22 percent?

Ms. MCCARTHY. That is because the shift is going to drinking water for the first time in quite a while because the need on drinking water is even more severe than the need for wastewater at this point. I can show you, and certainly will provide your staff with the figures.

Senator CARDIN. We need modern drinking water for capacity but if we don't deal with wastewater treatment, we are going to have problems with clean water in our streams. I can assure you of that. It is a major source of pollution for our water bodies.

Ms. MCCARTHY. I totally agree with you. We would be able to utilize money effectively. This is, I think, a reasonable approach to start recognizing that at this point, drinking water has not been appropriately funded and that we need to make some shift in that fund. We are certainly able and willing to talk to folks about why we believe that is the case.

Senator CARDIN. We are half right and half wrong. Drinking water needs more, but you shouldn't be cutting the State Revolving Fund.

Senator INHOFE. Thank you.

Senator Wicker.

Senator WICKER. Thank you very much.

First of all, I would like to ask unanimous consent to enter into the record, an article, an op-ed, from the Wall Street Journal of September 19, 2014 by Steven E. Koonin, entitled Climate Science Is Not Settled.

Senator INHOFE. Without objection.

[The referenced information follows:]

Climate Science Is Not Settled
By Steven E. Koonin
Sept. 19, 2014 12:19 p.m. ET

The idea that "Climate science is settled" runs through today's popular and policy discussions. Unfortunately, that claim is misguided. It has not only distorted our public and policy debates on issues related to energy, greenhouse-gas emissions and the environment. But it also has inhibited the scientific and policy discussions that we need to have about our climate future.

My training as a computational physicist—together with a 40-year career of scientific research, advising and management in academia, government and the private sector—has afforded me an extended, up-close perspective on climate science. Detailed technical discussions during the past year with leading climate scientists have given me an even better sense of what we know, and don't know, about climate. I have come to appreciate the daunting scientific challenge of answering the questions that policy makers and the public are asking.

The crucial scientific question for policy isn't whether the climate is changing. That is a settled matter: The climate has always changed and always will. Geological and historical records show the occurrence of major climate shifts, sometimes over only a few decades. We know, for instance, that during the 20th century the Earth's global average surface temperature rose 1.4 degrees Fahrenheit.

Nor is the crucial question whether humans are influencing the climate. That is no hoax: There is little doubt in the scientific community that continually growing amounts of greenhouse gases in the atmosphere, due largely to carbon-dioxide emissions from the conventional use of fossil fuels, are influencing the climate. There is also little doubt that the carbon dioxide will persist in the atmosphere for several centuries. The impact today of human activity appears to be comparable to the intrinsic, natural variability of the climate system itself.

Rather, the crucial, unsettled scientific question for policy is, "How will the climate change over the next century under both natural and human influences?" Answers to that question at the global and regional levels, as well as to equally complex questions of how ecosystems and human activities will be affected, should inform our choices about energy and infrastructure.

But—here's the catch—those questions are the hardest ones to answer. They challenge, in a fundamental way, what science can tell us about future climates.

Even though human influences could have serious consequences for the climate, they are physically small in relation to the climate system as a whole. For example, human additions to carbon dioxide in the atmosphere by the middle of the 21st century are expected to directly shift the atmosphere's natural greenhouse effect by only 1% to 2%. Since the climate system is highly variable on its own, that smallness sets a very high bar for confidently projecting the consequences of human influences.

A second challenge to "knowing" future climate is today's poor understanding of the oceans. The oceans, which change over decades and centuries, hold most of the climate's heat and strongly

influence the atmosphere. Unfortunately, precise, comprehensive observations of the oceans are available only for the past few decades; the reliable record is still far too short to adequately understand how the oceans will change and how that will affect climate.

A third fundamental challenge arises from feedbacks that can dramatically amplify or mute the climate's response to human and natural influences. One important feedback, which is thought to approximately double the direct heating effect of carbon dioxide, involves water vapor, clouds and temperature.

But feedbacks are uncertain. They depend on the details of processes such as evaporation and the flow of radiation through clouds. They cannot be determined confidently from the basic laws of physics and chemistry, so they must be verified by precise, detailed observations that are, in many cases, not yet available.

Beyond these observational challenges are those posed by the complex computer models used to project future climate. These massive programs attempt to describe the dynamics and interactions of the various components of the Earth system—the atmosphere, the oceans, the land, the ice and the biosphere of living things. While some parts of the models rely on well-tested physical laws, other parts involve technically informed estimation. Computer modeling of complex systems is as much an art as a science.

For instance, global climate models describe the Earth on a grid that is currently limited by computer capabilities to a resolution of no finer than 60 miles. (The distance from New York City to Washington, D.C., is thus covered by only four grid cells.) But processes such as cloud formation, turbulence and rain all happen on much smaller scales. These critical processes then appear in the model only through adjustable assumptions that specify, for example, how the average cloud cover depends on a grid box's average temperature and humidity. In a given model, dozens of such assumptions must be adjusted ("tuned," in the jargon of modelers) to reproduce both current observations and imperfectly known historical records.

We often hear that there is a "scientific consensus" about climate change. But as far as the computer models go, there isn't a useful consensus at the level of detail relevant to assessing human influences. Since 1990, the United Nations Intergovernmental Panel on Climate Change, or IPCC, has periodically surveyed the state of climate science. Each successive report from that endeavor, with contributions from thousands of scientists around the world, has come to be seen as the definitive assessment of climate science at the time of its issue.

For the latest IPCC report (September 2013), its Working Group I, which focuses on physical science, uses an ensemble of some 55 different models. Although most of these models are tuned to reproduce the gross features of the Earth's climate, the marked differences in their details and projections reflect all of the limitations that I have described. For example:

• The models differ in their descriptions of the past century's global average surface temperature by more than three times the entire warming recorded during that time. Such mismatches are also present in many other basic climate factors, including rainfall, which is fundamental to the atmosphere's energy balance. As a result, the models give widely varying descriptions of the

climate's inner workings. Since they disagree so markedly, no more than one of them can be right.

• Although the Earth's average surface temperature rose sharply by 0.9 degree Fahrenheit during the last quarter of the 20th century, it has increased much more slowly for the past 16 years, even as the human contribution to atmospheric carbon dioxide has risen by some 25%. This surprising fact demonstrates directly that natural influences and variability are powerful enough to counteract the present warming influence exerted by human activity.

Yet the models famously fail to capture this slowing in the temperature rise. Several dozen different explanations for this failure have been offered, with ocean variability most likely playing a major role. But the whole episode continues to highlight the limits of our modeling.

• The models roughly describe the shrinking extent of Arctic sea ice observed over the past two decades, but they fail to describe the comparable growth of Antarctic sea ice, which is now at a record high.

• The models predict that the lower atmosphere in the tropics will absorb much of the heat of the warming atmosphere. But that "hot spot" has not been confidently observed, casting doubt on our understanding of the crucial feedback of water vapor on temperature.

• Even though the human influence on climate was much smaller in the past, the models do not account for the fact that the rate of global sea-level rise 70 years ago was as large as what we observe today—about one foot per century.

• A crucial measure of our knowledge of feedbacks is climate sensitivity—that is, the warming induced by a hypothetical doubling of carbon-dioxide concentration. Today's best estimate of the sensitivity (between 2.7 degrees Fahrenheit and 8.1 degrees Fahrenheit) is no different, and no more certain, than it was 30 years ago. And this is despite an heroic research effort costing billions of dollars.

These and many other open questions are in fact described in the IPCC research reports, although a detailed and knowledgeable reading is sometimes required to discern them. They are not "minor" issues to be "cleaned up" by further research. Rather, they are deficiencies that erode confidence in the computer projections. Work to resolve these shortcomings in climate models should be among the top priorities for climate research.

Yet a public official reading only the IPCC's "Summary for Policy Makers" would gain little sense of the extent or implications of these deficiencies. These are fundamental challenges to our understanding of human impacts on the climate, and they should not be dismissed with the mantra that "climate science is settled."

While the past two decades have seen progress in climate science, the field is not yet mature enough to usefully answer the difficult and important questions being asked of it. This decidedly unsettled state highlights what should be obvious: Understanding climate, at the level of detail relevant to human influences, is a very, very difficult problem.

We can and should take steps to make climate projections more useful over time. An international commitment to a sustained global climate observation system would generate an ever-lengthening record of more precise observations. And increasingly powerful computers can allow a better understanding of the uncertainties in our models, finer model grids and more sophisticated descriptions of the processes that occur within them. The science is urgent, since we could be caught flat-footed if our understanding does not improve more rapidly than the climate itself changes.

A transparent rigor would also be a welcome development, especially given the momentous political and policy decisions at stake. That could be supported by regular, independent, "red team" reviews to stress-test and challenge the projections by focusing on their deficiencies and uncertainties; that would certainly be the best practice of the scientific method. But because the natural climate changes over decades, it will take many years to get the data needed to confidently isolate and quantify the effects of human influences.

Policy makers and the public may wish for the comfort of certainty in their climate science. But I fear that rigidly promulgating the idea that climate science is "settled" (or is a "hoax") demeans and chills the scientific enterprise, retarding its progress in these important matters. Uncertainty is a prime mover and motivator of science and must be faced head-on. It should not be confined to hushed sidebar conversations at academic conferences.

Society's choices in the years ahead will necessarily be based on uncertain knowledge of future climates. That uncertainty need not be an excuse for inaction. There is well-justified prudence in accelerating the development of low-emissions technologies and in cost-effective energy-efficiency measures.

But climate strategies beyond such "no regrets" efforts carry costs, risks and questions of effectiveness, so nonscientific factors inevitably enter the decision. These include our tolerance for risk and the priorities that we assign to economic development, poverty reduction, environmental quality, and intergenerational and geographical equity.

Individuals and countries can legitimately disagree about these matters, so the discussion should not be about "believing" or "denying" the science. Despite the statements of numerous scientific societies, the scientific community cannot claim any special expertise in addressing issues related to humanity's deepest goals and values. The political and diplomatic spheres are best suited to debating and resolving such questions, and misrepresenting the current state of climate science does nothing to advance that effort.

Any serious discussion of the changing climate must begin by acknowledging not only the scientific certainties but also the uncertainties, especially in projecting the future. Recognizing those limits, rather than ignoring them, will lead to a more sober and ultimately more productive discussion of climate change and climate policies. To do otherwise is a great disservice to climate science itself.

Dr. Koonin was undersecretary for science in the Energy Department during President Barack Obama's first term and is currently director of the Center for Urban Science and Progress at

New York University. His previous positions include professor of theoretical physics and provost at Caltech, as well as chief scientist of BP , where his work focused on renewable and low-carbon energy technologies.

Senator WICKER. I would point out to our witness and also to the members of the committee that Steven E. Koonin, interestingly enough, was Under Secretary of Science in the Energy Department during President Obama's first term and is currently Director of the Center for Urban Science and Progress at New York University. Yet, he authors an essay entitled, Climate Science Is Not Settled.

I am going to read extensively from it in the time I have. Mr. Koonin starts by saying, "The idea that 'Climate science is settled' runs through today's popular and policy discussions. Unfortunately, that claim is misguided. "It has not only distorted our public and policy debates on issues related to energy, greenhouse-gas emissions and the environment, but it also has inhibited the scientific and policy discussions that we need to have about our climate future.

He sounds like you, Mr. Chairman. At this point, he says, "The crucial scientific question for policy isn't whether the climate is changing. That is a settled matter. The climate has always changed and always will."

The author also believes humans are influencing the climate, but he says, this, "The impact of human activity appears to be comparable to the intrinsic natural variability of the climate system itself. The crucial unsettled scientific question for policy is how will the climate change over the next century under both natural and human influences. Answers to that question at the global and regional levels as well as to the equally complex questions of how ecosystems and human activities will be affected should inform our choices about energy and infrastructure."

There is one other sentence that I will quote at this point. "Even though human influences could have serious consequences for the climate, they are physically small in relation to the climate system as a whole." I think that is a very interesting and balanced opinion piece raising doubts about the question of whether this is settled science.

I also would simply respond to what the Ranking Member said about deteriorating sea ice. I would point out to my colleagues that as a matter of fact, according to NOAA, indeed arctic ice in January of this year was 6.3 percent below the 20 year average from 1981–2010.

However, at the same moment, Antarctic sea ice is the largest on record, 44.6 percent above the 1981 to 2010 average. Deteriorating sea ice may be happening to 6.3 percent extent in the Arctic but it seems to be increasing by 44.6 percent in the Antarctic.

Director McCarthy, I noticed and would call to your attention that Congressman Whitfield in the House submitted questions on June 19, 2014 to EPA concerning the carbon dioxide regulation for power plants. He received a letter finally on February 11, 2015. I just wondered, Administrator McCarthy, if since that time you have a better answer to those questions. The questions concern power plants. Has EPA estimated the impact of this proposed CO_2 rule for existing power plants in terms of global mean temperature?

The answer includes this sentence, "Although EPA has not explicitly modeled the temperature impacts of this rule, the clean

power plant has an important and significant contribution to emission reductions." In other words, EPA cannot tell Congressman Whitfield, in answer to his question, to what extent is the temperature going to be impacted by this clean power rule.

Further, he asked, "Has EPA estimated the impact of the proposed CO_2 rule for existing power plants in terms of global mean sea level rise?" Again, the EPA was unable to answer his question: "The EPA has not explicitly modeled the sea level rise impacts of this rule."

I will tell you what is going to happen because of this rule to my State of Mississippi. It is going to be devastating to the economy. The Mississippi Energy Institute says, "The estimated cost to Mississippi ratepayers is $14 billion by 2030, not including fuel costs. Mississippi is projected under this power plan to experience the largest increase in electricity production costs of any State, a 177 percent increase."

I would say to my colleagues, and I would say to you, Administrator McCarthy, we know the negative effects on the hardworking people of my State in terms of how much money they are going to have to pay, but your agency is unable to say in a 6-month time in answer to a question submitted by the chairman of the subcommittee what impact, if any, it will have on global temperature and was unable to say what impact, if any the rule would have on sea level rise.

It seems to me the answer is, well, it is bound to help. We know it is going to increase electricity rates by 177 percent, cost jobs and make it harder for the people in my State, but we just think it is bound to help in some way although we cannot quantify that.

Thank you, Mr. Chairman.

Senator INHOFE. Thank you, Mr. Wicker.

Senator Boxer.

Senator BOXER. Thank you so much, Mr. Chairman.

I am going to ask unanimous consent to place into the record the series of votes that the Senate has taken regarding climate change. Is that OK with you?

Senator INHOFE. Without objection.

[The referenced information follows:]

Senate Climate Change Legislation
Vote History

October 30, 2003. **Vote 43-55.**
McCain-Lieberman "Climate Stewardship Act of 2003" (S. 139).
Roll Call Vote No. 420
Republicans: Chafee, Collins, Gregg, McCain, Snowe

June 22, 2005. **Vote 38-60.**
McCain Amendment 826 (to H.R. 6 "Energy Policy Act of 2005") to provide for a program to accelerate the reduction of greenhouse gas emissions in the United States.
Roll Call Vote No. 148
Republicans: Chaffee, Collins, Gregg, Lugar, McCain, Snowe

June 6, 2008. **Vote 48-36 (6 more absent Senators asked that their intentions to vote yes be entered into the record).**
Lieberman-Warner "Climate Security Act of 2008" (S. 2191).
Vote 11-8 in Senate Cmte. on Environment and Public Works (December 5, 2007).
Senate Report No. 110-337.
Amended version (S. 3036) voted on by Senate (June 6, 2008).
Roll Call Vote No. 145
Republicans: Collins, Dole, Martinez, Smith, Snowe, Sununu, Warner, McCain (by letter), Coleman (by letter).

November 5, 2009. **Vote 11-1.**
Kerry - Boxer "Clean Energy Jobs and American Power Act" (S. 1733).
Vote 11-1 in Senate Cmte. on Environment and Public Works.
Senate Report No. 111-121.

May 12, 2010. **Press Conference.**
Kerry-Lieberman Press Conference on Climate Change Effort.
http://www.kerry.senate.gov/press/release/?id=5e1dc216-ce17-4cc2-92e1-8321efc8240c

June 10, 2010. **Vote 47-53.**
Murkowski joint resolution disapproving a rule submitted by the Environmental Protection Agency relating to the endangerment finding and the cause or contribute findings for greenhouse gases under section 202(a) of the Clean Air Act.
Roll Call Vote No. 184

Senator INHOFE. I have the same list, I believe. If yours is different, then I would ask unanimous consent that next to yours, that is granted, I will have mine. Without objection, so ordered.

[The referenced information follows:]

CLIMATE VOTES

- 1997 Byrd Hagel 95-0 July 25, 1997
- 2003 McCain-Lieberman 43-55 Oct. 30, 2003
- 2005 McCain-Lieberman 38-60 June 22, 2005
- 2008 Warner-Lieberman 48-36 June 6, 2008
- 2009 Waxman-Markey Did not receive Senate vote
- 2010 Murkowski Endangerment Finding CRA 47-53 June 10, 2010
- 2011 Inhofe-McConnell-Upton Amendment 50-50 April 6, 2011 took away EPA ability to regulate GHG from power plants
- 2012 Inhofe Utility MACT 46-53 June 20, 2012
- 2013 Inhofe-Upton budget resolution amendment prohibiting GHG regulation 47-52 March 22, 2013

Senator BOXER. May I ask that I get back the 10 seconds that my friend stole from me?

Senator INHOFE. You have it.

Senator BOXER. Here is the deal. We started voting on climate change issues in 2003. We got our clocks cleaned in 2003 and 2005, absolutely true. In 2008, we had, absent Senators Collins, Martinez, Smith, Snowe, McCain and Coleman, by letter saying they were with us, that would have been 56 to 36 in favor of a cap and trade plan know as the Climate Security Act, Lieberman-Warner. We had 4 short of 60. We had a majority.

Then we had a Murkowski joint resolution to disapprove the ruling on the endangerment finding. That failed, 47 to 53.

Then on April 6, 2011, we had a 50 to 50 vote on the McConnell amendment to prohibit the Administrator of the Environmental Protection Agency from promulgating any regulation concerning climate. That failed.

Then we had an astounding vote. I voted with my chairman, 98 to 1, climate change is not a hoax, yes. That was really a huge admission.

Today, we hear from my friend, Ted Wicker. I take this out of context. I think what I heard you say was that there are scientists now that you respect saying that human activity does have an impact. You said it is offset by other things, but this is the first time I have ever heard you say that. In my mind, I think we are gaining ground, not fast enough for our grandkids, but we are gaining ground.

On the sea ice, I wanted to talk to my friend because I saw an amazing presentation by NOAA on what is happening to the ice. You are right about Antarctic versus Arctic, but there is just more ice, it is just that it is thinner. We will talk about that because I think that is a very important point you are making on the ice.

Back to you, Administrator McCarthy. The EPA's budget supports implementation of the President's Climate Action Plan by allocating funding for efforts to establish limits under the Clean Air Act on carbon pollution from cars, trucks and power plants.

All these actions consistent with the three Supreme Court decisions in Massachusetts v. EPA of 2007, American Electric Power v. Connecticut in 2011, and Utility Air Resources Group v. EPA of 2014, are your actions consistent with the Supreme Court decisions or is your rogue agency making up this stuff as you go along?

Ms. MCCARTHY. They are consistent with the decisions and laws that this body has passed.

Senator BOXER. Isn't it true that if you were not to move forward, you could be subjected to lawsuits by are families who are concerned about these issues?

Ms. MCCARTHY. I am quite sure.

Senator BOXER. EPA's Revolving Loan Program for drinking and wastewater infrastructure help to ensure the water we drink is safe and that our lakes and rivers are clean. This is a place where I think there is bipartisan concern about the budget.

We see a net cut of $53 million. Can you explain how EPA will ensure adequate investments in clean and drinking water given these cuts?

Ms. McCarthy. EPA believes that the total $2.302 billion investment in SRF which includes drinking water and clean water is a significant step forward. We certainly understand there may be interests in additional funding.

The absolute need of the drinking water supply that we have identified so far is $348 billion. On the clean water side, it is $298 billion in needed investment. We understand that these are issues that will take yearly significant investments.

The challenge we have is with our limited budget, we have a number of core functions in which we need to provide resources in order to protect public health and the environment.

Senator Boxer. You are saying you increased funding on one part of the clean water mission and you cut it on the other. Is that accurate?

Ms. McCarthy. We actually shifted funds away from the wastewater side and shifted it into the drinking water because there is some immediate need that we have identified, not that there isn't an immediate need in both categories.

Senator Boxer. My takeaway from this, I am not asking a question, it gets back to the 20 percent cut in EPA's budget that we have see over time is having an impact internally. In administering landmark laws like the Clean Water Act, it is important that Federal agencies follow the best available science.

Ms. McCarthy. Yes.

Senator Boxer. Can you expand on the science used to develop the clean water rule and how the rule reflects the best available science?

Ms. McCarthy. Thank you for raising this, Ranking Member.

The clean water rule is a rule the Supreme Court actually told us almost 6 years ago that we should do some more science around this so we could be clear about the waters that needed to be protected that were absolutely significant for drinking water and other functions we are relying on.

They told us to go back and look, which we did. We actually did a compilation of more than 1,000 studies that had been done and peer-reviewed. We worked with our Science Advisory Board so that could look at that compilation, look at the assessment and do a peer review.

We have done the science. We need to be able to reflect better in our rules what waters are necessary to protect under clean water. That is going to clarify issues that the States and this body, many of you, have been asking us to clarify for years. We are using sound, peer-reviewed science to do our job moving forward.

Senator Inhofe. Thank you, Senator Boxer.

Let me take the chairman's prerogative and ask if you want to respond to the last question Senator Wicker asked during his line of questioning?

Ms. McCarthy. There were many, sir. I understand that there are a vast minority of scientists who believe that the challenge of climate change isn't as significant as the majority.

Senator Wicker. Referring to the very last question with regard to what benefits are we going to receive from the clean power plant with regard to temperature and sea level which is what I thought was the whole point.

Ms. MCCARTHY. This issue was actually fairly well discussed by the Supreme Court. When they were looking at this issue, this is work and advice we followed, the Supreme Court said it was very clear that carbon pollution is a danger to public health and welfare and that efforts need to be underway to make progress.

The benefits that we are looking at are the benefits of strong domestic action that will, in and of itself, send a clear signal that we are doing what we can cost effectively and flexibly to make progress on carbon pollution.

It has already changed the international dynamic because climate change cannot be addressed without significant effective international efforts but we are going to do our part. That is the benefit of this rule.

To ask me whether a marathon can be accomplished without crossing the first mile, I would say you can't do it. While this won't get us to a cleaner, to address fully the issue of climate change, it gets us out of the gate, it gets us running and it provides the impetus and energy that we need to prove the actions we need to address climate change are both economically sound and are going to be providing us great national security and we are going to be able to move this ball forward internationally which is the forum for finally addressing climate change in the most comprehensive and cohesive way.

Senator WICKER. Twenty seconds, Mr. Chairman.

Senator INHOFE. Yes, out of my time.

Senator WICKER. I would simply observe the Supreme Court has a legalistic view of this but we have policy decisions to make as legislators and representatives of the taxpayers. It might be when all this is said and done we have the whole international community agreeing on what we should do, that this is going to prevent sea level from rising a quarter of an inch.

I might decide that is not worth a 177 percent increase in electric rates for my citizens in my State. It might be that they would conclude it is going to help by one degree globally. I might conclude that is just not worth the loss of jobs for Americans.

Senator INHOFE. My time is down to 1 minute now.

Senator Sullivan?

Senator SULLIVAN. Thank you, Mr. Chairman.

Administrator McCarthy, it is good to see you again.

Ms. MCCARTHY. You too.

Senator SULLIVAN. I always think it is important to get on the record at these hearings how important clean water is and clean air. As I have mentioned before, in Alaska, we have the most pristine environment in the world. Alaskans are really great about taking care of it.

As a matter of fact, I think we care about our environment a lot more than a lot of people in this town. We have a tremendously good record of taking care of that environment.

I think one of the things they are most concerned about is two interrelated themes that most Alaskans, I would say the vast majority, is concerned about. Your agency is not accountable. It is not accountable to the law. Most importantly, it is not accountable to the people where you are not listening to the people or the States. I will get into that in a minute.

Then you rush to get out rules which is of concern. Where we think you are trying to put out an agenda that is not based in the law to quickly get that agenda established before you leave office.

On accountability, I think there is a whole host of issues we can talk about but from my perspective, this is a really big issue for me. Accountability starts at the top. Last year, there was a glowing Wall Street Journal profile on you but some of us found it rather disturbing.

You were up in Alaska, honored by the Alaska Native people with gifts, which is a big deal in my State. You were quoted in the article about one of the gifts, which was a pen, that you threw the f—ing thing away, was your quote. A young girl gave you a jar of moose meat from Native people that you said, "could gag a maggot."

A lot of people saw that as a glowing article. Most people in Alaska saw it as an incredible disrespect to the people of my State. To me when the leader of an agency comes to a State and makes those kinds of statements to a national newspaper, it doesn't show that you are focused on serving the people you are required to serve.

Have you had the opportunity to make a comment on that, to apologize? If you would like to apologize here publicly, that would be fine.

Ms. MCCARTHY. I am happy to apologize for those remarks. I will tell you they were taken out of context but it doesn't matter because they hurt individual tribes I care about.

Senator SULLIVAN. They sure did. Thank you for apologizing.

Ms. MCCARTHY. No problem.

Senator SULLIVAN. The clean water rule, the "waters of the U.S." rule, is one of these issues that when you talk about no support, either in the law or the people, I think it is something that is happening right now.

My view is this is executive amnesty for water. Let me give you a reason why. In 2009, the EPA proposed expanding the clean water jurisdiction, is that true, through the Congress?

Ms. MCCARTHY. Yes.

Senator SULLIVAN. You did. It went nowhere in the Congress in terms of the bills that were submitted in 2009 to expand the clean water jurisdiction.

Ms. MCCARTHY. We never proposed such bills, sir.

Senator SULLIVAN. For the record, we can get the bills that were proposed, a letter from your predecessor on expanding the jurisdiction of the Clean Water Act.

When that happens and the Congress doesn't move on that, the Administration is not allowed to simply say, we are going to do it with a rule. That rule will expand the jurisdiction of the EPA in Alaska over our waters by approximately 40 percent, in a State that already has 60 percent of all waters in the United States in Alaska covered by the Clean Water Act.

In this last hearing, I asked for your legal opinion on where you got the legal authority. We still have not received that. Can you get that opinion to us?

Ms. MCCARTHY. Senator, I have been very clear. I have no authority to expand the jurisdiction of the Clean Water Act, nor am I proposing through a rulemaking to do that.

Senator SULLIVAN. There are a lot of people who disagree with that. We would like to see your legal opinion that gives you the authority to propose this rule.

Ms. MCCARTHY. I have no legal opinion to support that position. I am not doing that.

Senator SULLIVAN. Don't you do legal analysis of the rules you propose?

Ms. MCCARTHY. We do legal analysis of our rules. We do not expand through our rulemaking the jurisdiction under the rule. I implement.

Senator SULLIVAN. That is the big issue right now. You said you didn't do that in your clean air issue and, a lot of States sued. The recent Supreme Court came out and said you did exactly that, you violated the Constitution.

There are not a lot of people who believe what you are saying in terms of the authority. You have not done a legal analysis on "the waters of the U.S." and whether you have the legal authority? You have no legal analysis on this?

Ms. MCCARTHY. We have certainly done a legal analysis in the proposed rule and we will explain it in the final as well after looking at comments, but I have never claimed that the agency can expand the jurisdiction of the law.

Senator SULLIVAN. You cannot. That is why we need a legal opinion that says you are not doing that when many people think you are doing that. You have no legal analysis on "the waters of the U.S." right now?

Ms. MCCARTHY. No. We clearly are looking at staying within the boundaries of the Clean Water Act legally and using science to implement it appropriately as the Supreme Court told us we should do. That is what this rule is all about.

Senator SULLIVAN. Mr. Chairman, if I may, I think in the last hearing, I asked for the legal analysis that you said your agency undertook that says that "the waters of the U.S.," the regulation you have, is a legitimate agency function because it is based in statute.

You said you were going to provide that. We have not seen that.

Ms. MCCARTHY. I am happy to provide you the actual clean water rule that we proposed. It does include a legal analysis of what we are supposed to do, what we were told by the Supreme Court, the boundaries of the law, and explain why we are well within those boundaries in following that advice.

Senator INHOFE. Thank you, Senator Sullivan.

Senator Whitehouse?

Senator WHITEHOUSE. Thank you, Mr. Chairman.

Welcome, Administrator. How are you?

Ms. MCCARTHY. I am well, Senator. How are you?

Senator WHITEHOUSE. I am well, thank you.

Could you comment for a bit on EPA's track record in terms of the cost of regulation? We come at this question with things like the U.S. Chamber of Commerce's statement that proposed existing power plant regulation will cost the economy 224,000 jobs and $289 billion in high electric costs through 2030. That got replayed by colleagues of mine pretty extensively.

Upon examination, it earned a PolitiFact false and it earned four Pinocchios from the Washington Post Fact Checker. We have had your predecessors, both Republican and Democrat, here describing over and over as environmental rules have come up, how there has developed a more or less standardized industry response which is to exaggerate the costs, deny the benefits and try to cast doubt about the problem.

What is your view? Let us start with the Clean Air Act. How has EPA's enforcement of the Clean Air Act worked to the benefit or peril of the American people?

Ms. McCARTHY. Overall, the Clean Air Act has resulted in 70 percent reduced air pollution, while the GDP has tripled. We have looked at all of our major rules and followed all of the economic procedures we are supposed to follow, the best science that we can.

Time and time again, we actually over project the costs, so our rules are even more cost effective than we have projected. That is not a surprise to people who see how we follow the rules and our transparency. Time and time again, we know we hear the same arguments over and over again every time we propose a rule.

Every single time, I have never seen those lack of benefits come through or those excess costs be realized. This Congress has given us requirements to continue to look at cost benefit but also to do a 20-year study of the Clean Air Act and how those benefits have been realized. The benefits have far exceeded even the individual benefits we estimated for each of those individual rules.

It is a tremendous opportunity to improve public health and protect the environment. We are going to continue to implement it effectively and cost effectively.

Senator WHITEHOUSE. Over and over again, the American people have been economic winners as well as public health winners because of EPA regulations?

Ms. McCARTHY. We have shown that we identify for people what the public health goals have to be to keep themselves and their families safe. It sparks innovation, it grows jobs, it helps us maintain a robust economy and it keeps our lifestyle that we are so used to in this Country available to everyone.

It is part and parcel of how we have grown the economy in this Country. I am sure hoping that continues.

Senator WHITEHOUSE. The question of carbon pollution continues to be debated. As you said, the debate is getting increasingly one-sided as an amazing majority of scientists and every single major scientific organization in the Country comes down on the side of the importance of coping with carbon pollution.

In addition to your obligation to follow the best available science, which you do in this, you also have an obligation to follow the law. The Supreme Court has spoken quite clearly to the question of carbon pollution, has it not?

Ms. McCARTHY. Quite a few times, yes.

Senator WHITEHOUSE. Using those words, defining carbon emissions as a pollutant, correct?

Ms. McCARTHY. They have also indicated that EPA's science, I cannot quote it directly but the word outstanding comes to my mind. They vilified that we have done everything we could on the science side and we have proven our case.

Senator WHITEHOUSE. I think it is important to note the history we began with because it casts a spotlight on whether or not we really have a legitimate discrepancy in scientific opinion or whether this is simply the rollout of a repeat performance that has happened over and over again whenever an industry has faced a new regulation to protect the public health in which they create artificial doubt with a stable of basically kept scientists.

I think it is important that we bear that in mind and that the public keep an eye on that as well. Would you agree there is a difference between a legitimate, scientific debate and this campaign of doubt casting that has pre-existed the fight over carbon? It goes all the way back to whether tobacco was safe or not. The tobacco industry was the great proponent and inventor of this theory, was it not?

Ms. MCCARTHY. Yes, and I am certainly aware that the wealth of science we have that shows that climate change is real, it is happening, and it is a threat. Humans are causing the majority of that threat. It is supported by the majority of scientists and frankly, the public in the U.S. at this point as well. They are concerned. The impacts are already being felt.

Climate change is not a religion or a belief system. It is a science fact and challenges us to move forward with the actions we need to do to protect future generations.

Senator WHITEHOUSE. Thank you, Mr. Chairman.

Senator INHOFE. Thank you, Senator Whitehouse.

Next we will hear from Senator Sessions but first, I do have my last remaining minute of which I am going to give 45 seconds to Senator Sullivan. Let me just quote one of the imminent scientists of the many, many scientists who believe this, Richard Lindzen, from MIT who made the statement that "controlling carbon is a bureaucrat's dream. If you control carbon, you control life." Many, many scientists out there agree with that.

Senator, if you finish your line of thinking there, you may have 45 seconds.

Senator SULLIVAN. Thank you, Mr. Chairman.

I just want to wrap up the discussion on the issue of the legality of your actions. There are a lot of people in Alaska, and I think throughout the Country, who are doubting the legal basis for which your agency is acting.

Mr. Chairman, for the record, I would like to submit a Wall Street Journal editorial called, A Constitutional Tutorial for Obama, the President and EPA do not possess an heralded power to rewrite laws, and more recently, a Wall Street Journal op-ed from Harvard professor, Laurence Tribe, The Clean Power Act is Unconstitutional, where Laurence Tribe says, "Frustration with congressional inaction cannot justify throwing the Constitution overboard to rescue this lawless EPA proposal."

[The referenced information follows:]

THE WALL STREET JOURNAL.

REVIEW & OUTLOOK

A Constitutional Tutorial for Obama

The President doesn't possess 'an unheralded power' to rewrite laws.

Updated June 24, 2014 3:52 p.m. ET

The Obama Administration's abuse of executive power is emerging as this Supreme Court term's defining theme, and on Monday the Justices applied some basic constitutional law to the White House's anticarbon agenda.

In *Utility Air Regulatory Group v. EPA*, the Justices feed several major climate regulations into the wood chipper. "When an agency claims to discover in a long-extant statute an unheralded power to regulate a significant portion of the American economy," the majority observes, "we typically greet its announcement with a measure of skepticism."

EPA

The ruling amounts to an overdue correction to *Massachusetts v. EPA*, the 5-4 ruling in 2007 that held greenhouse gases can be "pollutants" under clean air laws that were written decades before the carbon panic. That decision wrongly rewrote the Clean Air Act, but it was also always narrower than liberals made it out to be and never the license for policy rewrites that became the EPA's interpretation.

The problem for the agency is that the Clean Air Act sets precise emissions thresholds for "major sources" of a given pollutant, defined as more than either 100 or 250 tons annually. Congress had in mind traditional industrial byproducts like SOX or ozone, but the ceilings make no sense for ubiquitous carbon. Any CO_2 rule would thus reach well beyond power plants and factories to millions of small carbon sources like hospitals, grocery stores, shopping centers, farms and churches, with penalties of $37,500 per day for violations.

To obey the law as written, the EPA estimated, permit applications under one program would have climbed to 6.1 million a year from 15,000 today, while administrative costs in another would have exploded to $1.5 billion from $12 million. The agency conceded that such a regime would be "unrecognizable" to Congress. Yet in 2009 the EPA regulated anyway and asserted unilateral power to "tailor" the law. It baldly increased the thresholds by as much as a thousandfold to avoid having to supervise elementary schools the same as cement mixers.

Amid a tangle of partial concurrences and dissents, Justice Antonin Scalia wrote the controlling 5-4 opinion striking down this tailoring as illegal. He writes that it is "patently unreasonable—not to say outrageous—for EPA to insist on seizing expansive power that it admits the statute is not designed to grant."

RELATED VIDEO

Justice Scalia catches the EPA climateers selectively citing statutes, claiming that they are compelled to regulate by the Clean Air Act but uncompelled to abide by its text. The act is "not a command to regulate," and neither is *Mass. v. EPA*, he reiterates. More to the point, "An agency has no power to 'tailor' legislation to bureaucratic policy goals by rewriting unambiguous statutory terms."

Even better, Justice Scalia's opinion explicitly defends the structure of the Constitution. Blessing the EPA's tailoring rule would be "a severe blow to the Constitution's separation of powers" where Congress enacts laws and the President enforces them, he writes. This remedial civics lesson ought to be unnecessary but with the Obama crowd it's essential. "We are not willing to stand on the dock and wave goodbye as EPA embarks on this multiyear voyage of discovery" that ignores the will of Congress, Justice Scalia writes.

The Court did still preserve 7-2 the *Mass. v. EPA* prerogative to regulate carbon in other contexts, such as requiring new or substantially modified power sources to install "best available control technology." But the ruling says this authority is not "unbounded," which suggests the Court is warning EPA to tread carefully when exercising "extravagant statutory power over the national economy."

That could include the rules for existing power sources that the EPA rolled out earlier this month. They are grounded in an obscure catch-all clause of the Clean Air Act that wasn't before the Court in Monday's case. Section 111(d) runs only a few hundred words, yet the EPA is claiming unprecedented authority to command the states to create cap-and-tax programs or otherwise ration energy use. A less willful Administration would heed this warning and restrain its ambitions, but this one refuses, so the High Court will have to keep issuing Constitution 101 tutorials.

In any other Administration, such a Supreme Court smackdown on so important a regulation would also invite more media scrutiny of executive overreach. When the 2008 *Boumediene* decision gave terrorists the right to make habeas corpus challenges to their detention, the story was that the High Court was reining in a power-mad President.

Mr. Obama's regulatory abuses are far more corrosive to the Constitution than anything George W. Bush did on war powers, but the press corps has barely noticed. Maybe it will start now that the Supreme Court is calling out President Obama's lawbreaking.

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Senator SULLIVAN. I would like to wrap up with one final question. What is the rush on "the waters of the U.S." regulation? You are expediting it. Isn't it true that OMB allowed you to expedite this because they said it wasn't a major rule? You are expediting this rule when 35 States have said they oppose it and over 1 million comments have not been placed online on this rule. It seems to me that you are rushing this.

Again, we would like to see the legal basis for you moving outside the normal procedures for the timeline of a rule that is going to impact dramatic parts of the Country and huge parts of my State.

Ms. MCCARTHY. Very quickly, first of all, the reason we are moving forward with this rule is we are in no rush. In fact, the questions began in 2001. We are moving it forward. We actually have been requested by States, by industries, by farming and ranching groups to move forward with the rulemaking to provide clarity. We are moving for our constituencies, the people who are confused and need answers.

We have not had 35 States tell us. There have been individuals representing various constituencies in States or different offices in States who have commented, but we have received over 1 million comments and 87.1 percent of those comments we have counted so far—we are only missing 4,000—are supportive of this rule. Let me repeat, 87.1 percent of those one plus million are supportive of this rule.

Senator INHOFE. Thank you.

Senator Sessions?

Senator SESSIONS. Thank you, Mr. Chairman.

As a member of the Budget Committee and somewhat familiar with the Budget Control Act which contained the growth of spending, I think EPA this year should be flat spending or at least no more than 2.5 percent increase. You are proposing a 6 percent increase. Where does the money come from? Are you proposing to break the limitations?

Ms. MCCARTHY. It is part of the President's proposal which is not going to buy into the bad policy of sequestration, but he has designed a budget that can accommodate this.

Senator SESSIONS. The inflation rate in the United States is about 2 percent, so you want to have a three times the inflation rate increase in spending. I would suggest that when we go to our States, the group we have most complaints about from our constituency, highway people, whether it is our farmers, our energy people, is the Environmental Protection Agency. It is an extraordinary overreach.

You apparently are unaware of the pushback that is occurring in the real world. I just want to tell you I am not inclined to increase your funding 6 percent a buck. Now you say we have a crisis and there are dangers out there.

In an article by Mr. Lumbergh, who testified before the Budget Committee from the Copenhagen Institute, along with Dr. Pioki from Colorado, "We have had fewer droughts in recent years." Do you dispute that?

Ms. MCCARTHY. I don't know in what context he is making statements like that, but I certainly can tell you about the droughts that are happening today.

Senator SESSIONS. No, no, I am not arguing to you today that you are wrong about global warming because we have a cold spell. I am asking you what are the worldwide data about whether or not we are having fewer or less droughts.

Ms. MCCARTHY. I will be happy to provide it, but I certainly am aware that droughts are becoming more extreme and frequent.

Senator SESSIONS. You are aware that the IPCC has found that moisture content of the soil is, if anything, slightly greater than it has been over the last decade in their report. Are you aware of that?

Ms. MCCARTHY. I don't know what you are referring to, Senator, but I am happy to respond.

Senator SESSIONS. You need to know because you are asking this economy to sustain tremendous costs and you don't know whether or not the soil worldwide is more or less moist?

Ms. MCCARTHY. I don't know where your cost figures are coming from.

Senator SESSIONS. I am quoting the IPCC. What about hurricanes? We had more or less hurricanes in the last decade?

Ms. MCCARTHY. There have been more frequent hurricanes and more intense. In terms of landing, those hurricanes on land, I cannot answer that question. It is a very complicated issue.

Senator SESSIONS. It is not complicated on how many landed. We have had dramatic reduction in the number. We have gone a decade without a Class III or above hurricane.

Ms. MCCARTHY. The scientists are not really considering that number to be significant because the subset is so small that you are looking at, you are taking issues in science out of context.

Senator SESSIONS. Are you asserting that you have evidence that we have greater hurricanes around the world in the last decade than the previous decade?

Ms. MCCARTHY. I am asserting that I have plenty of evidence, factual evidence from scientists who know this issue that climate change is happening, it is real, and it is happening now.

Senator SESSIONS. Of course the climate is changing, Ms. McCarthy. You have been saying we have more storms. Will you submit within a few days, it shouldn't take long, a showing that we have had more storms in the last decade?

Ms. MCCARTHY. When you say "we," what are we talking about, the U.S.?

Senator SESSIONS. The world.

Ms. MCCARTHY. I am happy to submit the full breadth of science that we have behind climate. We have submitted it and will submitted it again.

Senator SESSIONS. Would you acknowledge that over the last 18 years, the increase in temperature has been very little and that it is well below, 90 percent below most of the environmental models that show how fast temperature would increase?

Ms. MCCARTHY. No, I would not agree with that. A 1-degree temperature is significant.

Senator SESSIONS. I am asking below the models or above the models?

Ms. MCCARTHY. I do not know what the models are actually predicting that you are referring to. There are many models and sometimes it is actually going faster and sometimes slightly slower than the model predicts, but on the whole, it makes no difference to the validity and the robustness of climate science that is telling us that we are facing an absolute challenge that we must address both environmentally and economically from a national security perspective, and for EPA, from a public health perspective.

Senator SESSIONS. Carbon pollution, CO2, is really not a pollutant. It is a plant food and it does not harm anybody except that it might include temperature increases.

Let me ask you one more time, just give me this answer. If you take the average for the models predicting how fast the temperature would increase or is the temperature in fact increasing less than that or more than that?

Ms. MCCARTHY. I cannot answer that question specifically.

Senator SESSIONS. Mr. Chairman, I would say this is a stunning development, that the head of the Environment Protection Agency, who should know more than anybody else in the world, who is imposing hundreds of billions of dollars in costs to prevent climate and temperature increases, doesn't know whether their projections have been all along.

Ms. MCCARTHY. Whose projections? What models, sir?

Senator SESSIONS. Where do you get the information that the temperature is increasing? Isn't it from climate models produced by scientists around the world that projected certain increases as the actual temperature increased at that rate?

Ms. MCCARTHY. It depends on what you are looking at. In the timeframe of climate, which is trends, absolutely, positively.

Senator SESSIONS. Would you submit to me a written document that explains how you believe the models have been proven correct and whether or not, I will ask this specific question, had it increased less than projected or more than projected?

Ms. MCCARTHY. I would be happy to provide you the information. My concern is you are not looking at climate in the kind of trend lines that climate determines. Sometimes you were asking us did we get it right last year, did we get it right the prior 4 years, instead of looking at this as climate demands. This isn't weather patterns. This is a partitive time. If you look at the last century, we have had changes in our climate that we should not have seen over a span of 1,000 years.

Senator INHOFE. I am sure that Senator Sessions is looking forward to getting your written document.

We wanted to hear from Senator Markey but we have a unanimous consent request by Senator Vitter.

Senator VITTER. Actually, Mr. Chairman, I will pass and try to stay around. Thank you.

Senator INHOFE. Senator Markey.

Senator MARKEY. Thank you.

Senator Sessions, they have a big stunning development in Massachusetts. It is that temperatures off the coast of Massachusetts and the Atlantic have been measured at 20 degrees above normal.

What is happening is this Arctic vortex is being sent down in larger amounts than ever seen before as Anchorage has almost no snow on its grounds, leads to this cold air lingering longer over Massachusetts and then hitting this 20 degree warmer than normal Atlantic Ocean which then leads to more moisture and more precipitation which then leads to us breaking the record for the most snow in history.

That is not weather; that is climate. There is a distinction between these things. The reason we know things are changing off the coast of Massachusetts is NOAA, NASA and predecessor agencies have been using thermometers since the 1880's to actually take the temperature of the water and the air. They just write it down each year.

They do that all around the world, actually. Scientists all around the world keep these temperatures.

The reason we know it is happening is that people have been using thermometers over all these years. It is not a more sophisticated technology, it is exactly the same technology, probably costs more but it is the same exact device.

We are now suffering from that in Massachusetts. It is climate. There is an intensity, an extra level of effect that it creates.

I would like to point out that in the op-ed of Steven Koonin, that Senator Wicker put in the record, there was one sentence he left out. That sentence says, "Uncertainty need not be an excuse for inaction." I applaud the EPA for all of its great work. I thank you, Madam Administrator, for what you have done on this issue.

I would like to move the renewable energy component of your clean power plant rules and ask, as you finalize these rules, will you be incorporating up to date renewable costs so what is truly achievable is reflected?

Ms. MCCARTHY. Yes, sir, we will.

Senator MARKEY. The renewable fuels standard is another policy where technology and innovation can help reduce carbon pollution. Last year, facilities with almost 60 million gallons of cellulosic ethanol fuel per year capacity on line. Another 30 million gallons per year of facility was set up this year.

To continue that growth and investment, the advanced biofuels industry needs policy certainty. Will the upcoming renewable fuels standard proposal reflect developments in cellulosic and advanced biofuels and support their growth in the future as was the intent of the 2007 legislative language?

Ms. MCCARTHY. Yes, sir.

Senator MARKEY. Can you elaborate a little?

Ms. MCCARTHY. I think the challenge for us has been the requirement to annually look at these budgets. We are looking at ways in which we can send longer term signals to the market so that advancements like cellulosic can really find investment opportunity on a longer term basis that they need to continue to grow.

Senator MARKEY. I was the co-author of that language in 2007. Then it was cellulosic but then we went almost immediately into a recession which hurt that industry.

Ms. MCCARTHY. It has really taken off.

Senator MARKEY. It did not get its initial shot but in normal economic conditions, we are quite confident it will be successful.

I want to turn to EPA's work to keep our water clean. Between 1979 and 2001, about 15 football fields were the wetlands that feed into the historic Buzzards Bay in Massachusetts were cleaned of all vegetation and pollutants with high levels of fertilizer and pesticides that contaminated the waters that feed into the Bay. It was all done without notification or permitting.

The EPA tried to take action against the polluters using its Clean Water Act authority but more than 15 years later, the case is still not resolved and the wetlands have never been restored.

The reason this case remains in limbo is that the Supreme Court was unable to make up its mind about whether wetlands are bodies of water that fall under the Clean Water Act's jurisdiction.

Rather than perpetuate the uncertainty that the Supreme Court created, EPA responded to requests from religious organizations, small businesses, public health groups, sportsmen's associations and State leaders to craft a definition of which types of water bodies can be subject to enforcement under the Clean Water Act and which cannot.

Isn't it true that the EPA, as it reviews more than 1,200 peer-reviewed, scientific papers and other data, established a Scientific Advisory Board of 26 independent scientists to review the EPA's work, reached out to stakeholders in every single State and reviewed more than 1 million comments on the proposed rule?

Ms. MCCARTHY. That is true.

Senator MARKEY. Isn't it true that more than 30 Republican Senators and House members publicly called on EPA to write a rule instead of just issuing guidance like EPA initially planned to do?

Ms. MCCARTHY. That is true.

Senator MARKEY. Isn't it true that when this rule is finalized, it will actually cover fewer water bodies than was the case under policies that were promulgated by the Reagan administration and it will permanently remove types of bodies of water from being subject to EPA's authority under the Clean Water Act?

Ms. MCCARTHY. That is correct.

Senator MARKEY. It seems that common-sense, scientifically based policy is being put on the books and we thank you so much for doing that.

Thank you, Mr. Chairman.

Senator INHOFE. Thank you, Senator Markey.

Senator Capito?

Senator CAPITO. Thank you.

Thank you, Madam Administrator. I appreciate your coming before the committee today.

I want to say at the onset, I think, in a bipartisan way, we have asked questions about the technical assistance issues through the Safe Drinking Water and the Clean Water Acts.

It does maximize resources to a lot of localities, municipalities and it is very important to all of us no matter how big or small your State is.

You know I am from the State of West Virginia. We have had numerous conversations. As one of my colleagues said, I would say in the State of West Virginia, if I hear disagreements, which I hear quite a few, but EPA is always right at the epicenter because of

the impact of the regulatory environment we have had because we are so heavily reliant on coal as our power source.

I would like to ask this question. You have in your remarks that the President's budget calls for a $4 billion Clean Power State Incentive Fund. The way I am reading this, that is a legislative prerogative, correct? That exists outside your budget?

Ms. MCCARTHY. That is not included in our budget.

Senator CAPITO. That has to be passed here in Congress before that would ever be funded?

Ms. MCCARTHY. That is correct.

Senator CAPITO. I am not going to waste a lot of time on that one because I don't think that is going to go. Although I will say, at cross purposes there, in your remarks, you say it helps with the financing for renewable and low income communities, but in the analysis by the committee, the bipartisan analysis, the quote says this would be to give grants to States that go beyond the clean power plan?

Ms. MCCARTHY. We actually have other opportunities in our budget that speak to the issues I was referring to.

Senator CAPITO. I would say if we are going to talk about economics and environment, if $4 billion, about 50 percent of what you are asking for today, the EPA and the President believe that is something that will help meet the demands of this new clean power plan. That tells me how explosively expensive something like this would be across the Country. Would that be a safe statement?

Ms. MCCARTHY. I don't believe so, Senator. I think it is appropriate to look at the proposal that EPA put on the table because we believe it was flexible in terms of individual States and where they are overall in terms of our ability to continue to keep a reliable and cost effective energy system.

We think the goals are achievable for individual States. The standards were set and the overall rule will be very cost effective.

Senator CAPITO. If the Administration wants an additional $4 billion in mandatory spending, in my view—we can move on after this. I would like to say my own DEP has said EPA comments "on the 111(d) proposal notes with the finesse of a bull in a china shop, EPA intends to assert itself broadly into the new regulatory arenas that impact all areas of the Nation's economy."

If we are looking at the impacts of the clean power rule and weaving a balance, you all have talked about this a lot with me and I have a lot of frustrations at home about it. Of those dollars you are committing to this, how much of those dollars are actually used to model the economics?

We have heard a lot about the science. What about the economic effects, the job loss, communities that basically are going to be abandoned in my State because of the poor communities, the rise, 170 percent and that may be high, of 170 percent for that low income person in West Virginia, that senior and their electric bill where they are already at the end of their rope trying to meet their monthly obligations?

How much time, effort and money do you spend to analyze that effect when you are putting together one of these regulations?

Ms. MCCARTHY. I am happy to try to see if we can decipher that for you.

Senator CAPITO. If you could quantify that for me, I would appreciate it.

Ms. MCCARTHY. I am happy to do that. If you look at the way in which we designed our proposal, if you look at what we are asking in terms of additional resources on climate, you will see we are asking for $57.7 million, $25 million of which is technical assistance grants going to States so they can help them with their plans. In excess of $25 million is to help actually provide technical assistance to be able to work on this issue.

You will see that we are providing in the core of our budget the funding we believe we need to implement the plan and help States implement the plan.

Senator CAPITO. I understand. Additionally, even though it is a legislative priority, the Administration obviously feels an extra $4 billion in mandatory spending is going to be what is necessary for the States to meet these challenges.

Let me ask about ozone real quick because again I think there are big economic impacts there. The rule you said went forward in 2008, the previous, and now we are moving to a new standard. This is ozone?

Ms. MCCARTHY. Ozone, yes.

Senator CAPITO. We know there are still many States and counties not in compliance. The President withdrew this in 2011, the same proposal, is that correct, to not move forward. The $90 billion price tag was something he was really unable to move forward.

Do you believe the economy has changed so much that this $90 billion price tag is now sustainable and whatever would be on top of the new ozone regulations?

Ms. MCCARTHY. The way this works, let me explain. The rule being implemented will ask States to look at cost effective opportunities for reducing pollutants that contribute to ozone. We are setting a health protective standard.

The rule we are looking at or the standard we are setting now is actually going to be based on air quality in 2014, 2016, and States will get to 2030 to actually in some cases achieve that. National rules already in place will actually get us most of the way to complying with that more rigorous standard if and when the decision is made to change that standard.

This is not a stop and start process. It is a continued discussion and cost effective actions to us getting at the levels of protection for public health.

Senator CAPITO. My misunderstanding might be that it was a previous rule that was supposed to meet certain standards. I am interpreting it as a new rule that is moving you to different standards. You are telling me it is sort of a continued rule.

Ms. MCCARTHY. It is and has been continuing for 20 years and States have been able to manage through this. Everything you do to comply with the 2008 will provide you a strong foundation to actually achieve what we are proposing.

The exciting thing about these standards is if we decide to reduce the standard to 70, only nine counties in the U.S. outside of California are predicted to actually be out of attainment by 2025.

National rules already on the books are going to get us a significant way there. It may actually get us outside of California and

give us the ability to be in attainment almost throughout the entire Country.

Senator INHOFE. We will recognize Senator Rounds. Senator Rounds, would you yield for a unanimous consent request from Senator Vitter?

Senator ROUNDS. I will.

Senator VITTER. Thank you, Senator.

Very briefly, I just have a UC request to submit to Ms. McCarthy, for the record, my questions, which are on existing source performance standards and economic analysis.

Senator INHOFE. Without objection.

Senator VITTER. Thank you.

Senator INHOFE. Senator Rounds.

Senator ROUNDS. Thank you, Mr. Chairman.

Administrator McCarthy, I suspect this is something like going to a dental appointment in terms of coming in here and sitting down.

Earlier, you had an opportunity to discuss a little, and I sensed the frustration, with regard to the waters of the United States rules and the comments made. I want to correct it because, if not, we will come back later on and correct it.

The Corps of Engineers basically issued the request. On February 11, Assistant Secretary Darcy told the House Appropriations Committee members that 37 percent of the comments on the proposed "waters of the United States" rule were in favor of the rule and 58 percent were opposed and that others were neutral.

On February 26, you told the House Appropriations Committee members that 87 percent of the comments were positive and said "all they," meaning the Corps, "had completed was a review of 2 percent of the comments and you weren't sure which 2 percent they chose." You said you feel badly there is confusion. You suggested maybe the Corps should review their numbers. Today, you issued a similar suggestion.

I suspect that although there have been over 1 million comments made, it seems there has also been discussion and there are only about 20,000 of the million that would be considered unique and substantive in terms of comments. It also appears in discussions that these were the comments the Corps had reviewed.

I want to clear up any confusion. When you talk about the substantive comments that have been made which appear to be about 20,000, I don't know there is much disagreement on that.

Out of the 20,000, 7,400 were unique and substantive comments that supported the rule. When you talked about 87 percent of the comments were positive, you were talking about the mass campaigns and the duplicative comments also received in addition to the 20,000 substantive and unique comments that had been there.

Also in that 20,000, there were approximately 11,600 of these substantive comments that were in opposition to the rule. Am I accurate in my assessment?

Ms. MCCARTHY. I don't have that exact figure, sir.

Senator ROUNDS. I am trying to clear up that while I think you were using numbers different from the Corps of Engineers, the Corps was talking about the substantive comments and you were

looking at the gross number of total comments that have come in overall?

Ms. MCCARTHY. I would have to refer to the Corps for that. I don't know, sir. I think the point I am really trying to make is we have probably done a bit of disservice saying what is opposed and what isn't opposed.

It is important to know that people find this rule important and obviously to get it right. We do as well. Every comment is meaningful to us and we look at all of them. It is important for us to do what the science and the law say and to explain ourselves. We need to do the best job we can in the final to have that done.

Senator ROUNDS. I do agree with you that this is critical. I think this has some far reaching impacts in terms of individuals who before may very well not have to have permitting in order to do the same jobs they were doing before.

I think it is so important that when we start talking about waters of the United States, I think this is a major rule. Although there maybe some discussion or disagreement in terms of the definitions of what a major rule is, there is Executive Order 12866 directing all Federal agencies to assess economic effects of economically significant rules. I do think this is one of those rules.

These rules will have a material adverse effect on any sector of the economy such as productivity, competition or jobs. In August 2014, a GAO study reported your agency was writing and implementing regulations based on information that considered the effects of regulations on employment for the years 1979–1991. This was in 2014.

Additionally, the study was limited to four industrial sectors. As a result, the regulations EPA was crafting for the United States were finalized with the assumptions that the United States economy 20–30 years ago was the same as it is today and involved only four industrial sectors. That is simply not correct today.

The Bureau of Labor statistics breaks down the manufacturing sector into approximately two dozen industries and this does not include other sectors such as retail, hospitality or tourism.

I understand you are no longer using the outdated data when writing regulations but you are required under this Executive Order to consider economic effects whenever you are writing a major rule.

The EPA is in the process of finalizing the clean power plant rules and the NOx ozone rules as well, which is predicted to be one of the most expensive regulations in the EPA's history.

I am curious. What economic factors and how updated are they that you use when you look at any one of these three rules today? How up to date are your economic numbers? What guidelines are you using today?

Ms. MCCARTHY. I am happy to provide you information on this but EPA, I believe, does a great job in keeping up with the economics we need in order to provide the American public a really good understanding of what the costs and benefits are of our rules.

I think we do an excellent job. There is always work going on and we try to update as much as we can, but I think we are up to date in what we are doing. I would be happy to share that information with you.

Senator ROUNDS. Would you provide the committee the current data you are using when you did each of these three rules, please?

Ms. MCCARTHY. Of course. There is something called the Regulatory Impact Analysis that goes with these rules. All of the methods, methodologies and data is contained in that.

Senator ROUNDS. I hear you say, and we would like to get, since you are not using the old data, you have updated the data, the most current data that you have to indicate the impact on the economy that all three of these rules would have.

Ms. MCCARTHY. I will make sure we provide that information to you, Senator.

Senator ROUNDS. Thank you very much. I appreciate it.

Senator INHOFE. Thank you, Senator Rounds.

We will leave the record open for 24 hours because there are things that both Senator Boxer and I want to submit for the record, questions for the record and also clarifications for the record.

Senator BOXER. Mr. Chairman, can I make an inquiry?

Senator INHOFE. Yes.

Senator BOXER. I asked if I could have a second round and you said, no, I could not. I don't ever remember my ever stopping from a second round. I ask unanimous consent that I have a second round to make some points at this time.

Senator INHOFE. I object.

Senator BOXER. Then I ask unanimous consent that I be allowed to place documents in the record.

Senator INHOFE. We have already done that.

Senator BOXER. No, I want to say what they are. I ask unanimous consent that Senator Markey's first statement be submitted to the record.

Senator INHOFE. Without objection.

[The referenced information follows:]

STATEMENT OF HON. EDWARD J. MARKEY, U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Administrator McCarthy, under your leadership the EPA has been working on common-sense policies to continue the gains in clean air, clean water and public health that our country has made during the last 40 years. Thank you for being here today to answer questions about how our country can maintain that progress and continue to move forward.

Being from Boston, there is no denying that we've had a weird winter. Arctic air that usually hangs out in Alaska has instead been in New England. When that cold air meets the record warm water in the Atlantic, the result is extraordinary snowfall. Snow that our friends in the western US would love to have as they look at the small snowpack on their mountains and wonder where winter went this year.

These weird winters are what scientists have predicted would happen as the levels of carbon pollution buildup in our atmosphere from burning fossil fuels.

In the United States, power plants are a major producer of carbon pollution and the EPA is working on standards to reduce pollution from them. I want to see you finalize the strongest Clean Power Plan possible. Getting the renewable energy component of it right will be critical.

Wind and solar electricity generation has seen extraordinary growth in the United States in the last decade. And with that growth, costs have fallen dramatically.

And once the Clean Power Plan is finalized those cost savings will continue even as we cut dangerous carbon pollution.

Senator BOXER. I ask unanimous consent that the National Climate Assessment which was voted on by the Senate 100 to 0 be put in the record that shows that climate change is going to harm human health.

Senator INHOFE. Without objection.
[The referenced information follows:]

U.S. Senate Roll Call Votes 101st Congress - 2nd Session

as compiled through Senate LIS by the Senate Bill Clerk under the direction of the Secretary of the Senate

Vote Summary

Question: On Passage of the Bill (S. 169)

Vote Number:	5	**Vote Date:**	February 6, 1990, 02:16 PM
Required For Majority:	1/2	**Vote Result:**	Bill Passed

Measure Number: S. 169 (National Global Change Research Act of 1989)

Measure Title: A bill to amend the National Science and Technology Policy, Organization, and Priorities Act of 1976 in order to provide for improved coordination of national scientific research efforts and to provide for a national plan to improve scientific understanding of the Earth system and the effect of changes in that system on climate and human well-being.

Vote Counts: YEAs 100

NAYs 0

Vote Summary By Senator Name By Vote Position By Home State

Alphabetical by Senator Name

Adams (D-WA), **Yea**
Armstrong (R-CO), **Yea**
Baucus (D-MT), **Yea**
Bentsen (D-TX), **Yea**
Biden (D-DE), **Yea**
Bingaman (D-NM), **Yea**
Bond (R-MO), **Yea**
Boren (D-OK), **Yea**
Boschwitz (R-MN), **Yea**
Bradley (D-NJ), **Yea**
Breaux (D-LA), **Yea**
Bryan (D-NV), **Yea**
Bumpers (D-AR), **Yea**
Burdick (D-ND), **Yea**
Burns (R-MT), **Yea**
Byrd (D-WV), **Yea**
Chafee (R-RI), **Yea**
Coats (R-IN), **Yea**
Cochran (R-MS), **Yea**
Cohen (R-ME), **Yea**
Conrad (D-ND), **Yea**
Cranston (D-CA), **Yea**
D'Amato (R-NY), **Yea**
Danforth (R-MO), **Yea**
Daschle (D-SD), **Yea**
DeConcini (D-AZ), **Yea**
Dixon (D-IL), **Yea**
Dodd (D-CT), **Yea**
Dole (R-KS), **Yea**
Domenici (R-NM), **Yea**
Durenberger (R-MN),**Yea**
Exon (D-NE), **Yea**
Ford (D-KY), **Yea**
Fowler (D-GA), **Yea**
Garn (R-UT), **Yea**
Glenn (D-OH), **Yea**
Gore (D-TN), **Yea**
Gorton (R-WA), **Yea**
Graham (D-FL), **Yea**
Gramm (R-TX), **Yea**
Grassley (R-IA), **Yea**
Harkin (D-IA), **Yea**
Hatch (R-UT), **Yea**
Hatfield (R-OR), **Yea**
Heflin (D-AL), **Yea**
Heinz (R-PA), **Yea**
Helms (R-NC), **Yea**
Hollings (D-SC), **Yea**
Humphrey (R-NH), **Yea**
Inouye (D-HI), **Yea**
Jeffords (R-VT), **Yea**
Johnston (D-LA), **Yea**
Kassebaum (R-KS), **Yea**
Kasten (R-WI), **Yea**
Kennedy (D-MA), **Yea**
Kerrey (D-NE), **Yea**
Kerry (D-MA), **Yea**
Kohl (D-WI), **Yea**
Lautenberg (D-NJ), **Yea**
Leahy (D-VT), **Yea**
Levin (D-MI), **Yea**
Lieberman (D-CT), **Yea**
Lott (R-MS), **Yea**
Lugar (R-IN), **Yea**
Mack (R-FL), **Yea**
Matsunaga (D-HI), **Yea**
McCain (R-AZ), **Yea**
McClure (R-ID), **Yea**
McConnell (R-KY), **Yea**
Metzenbaum (D-OH),**Yea**
Mikulski (D-MD), **Yea**
Mitchell (D-ME), **Yea**
Moynihan (D-NY), **Yea**
Murkowski (R-AK), **Yea**
Nickles (R-OK), **Yea**
Nunn (D-GA), **Yea**
Packwood (R-OR), **Yea**
Pell (D-RI), **Yea**
Pressler (R-SD), **Yea**
Pryor (D-AR), **Yea**
Reid (D-NV), **Yea**
Riegle (D-MI), **Yea**
Robb (D-VA), **Yea**
Rockefeller (D-WV), **Yea**
Roth (R-DE), **Yea**
Rudman (R-NH), **Yea**
Sanford (D-NC), **Yea**
Sarbanes (D-MD), **Yea**
Sasser (D-TN), **Yea**
Shelby (D-AL), **Yea**
Simon (D-IL), **Yea**
Simpson (R-WY), **Yea**
Specter (R-PA), **Yea**
Stevens (R-AK), **Yea**
Symms (R-ID), **Yea**
Thurmond (R-SC), **Yea**
Wallop (R-WY), **Yea**
Warner (R-VA), **Yea**
Wilson (R-CA), **Yea**
Wirth (D-CO), **Yea**

Vote Summary By Senator Name By Vote Position By Home State

Grouped By Vote Position

YEAs ---100

Adams (D-WA)
Armstrong (R-CO)
Baucus (D-MT)
Bentsen (D-TX)
Biden (D-DE)
Bingaman (D-NM)
Bond (R-MO)
Boren (D-OK)
Boschwitz (R-MN)
Bradley (D-NJ)
Breaux (D-LA)
Bryan (D-NV)
Bumpers (D-AR)
Burdick (D-ND)
Burns (R-MT)
Byrd (D-WV)
Chafee (R-RI)
Coats (R-IN)
Cochran (R-MS)
Cohen (R-ME)
Conrad (D-ND)
Cranston (D-CA)
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Ford (D-KY)
Fowler (D-GA)
Garn (R-UT)
Glenn (D-OH)
Gore (D-TN)
Gorton (R-WA)
Graham (D-FL)
Gramm (R-TX)
Grassley (R-IA)
Harkin (D-IA)
Hatch (R-UT)
Hatfield (R-OR)
Heflin (D-AL)
Heinz (R-PA)
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Lieberman (D-CT)
Lott (R-MS)
Lugar (R-IN)
Mack (R-FL)
Matsunaga (D-HI)
McCain (R-AZ)
McClure (R-ID)

Senator BOXER. I have put in the record two documents that show how climate change is fueling our California drought.

Senator INHOFE. Without objection.

[The referenced information follows:]

PNAS

Anthropogenic warming has increased drought risk in California

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Edited by Jane Lubchenco, Oregon State University, Corvallis, OR, and approved January 30, 2015 (received for review November 22, 2014)

California is currently in the midst of a record-setting drought. The drought began in 2012 and now includes the lowest calendar-year and 12-mo precipitation, the highest annual temperature, and the most extreme drought indicators on record. The extremely warm and dry conditions have led to acute water shortages, groundwater overdraft, critically low streamflow, and enhanced wildfire risk. Analyzing historical climate observations from California, we find that precipitation deficits in California were more than twice as likely to yield drought years if they occurred when conditions were warm. We find that although there has not been a substantial change in the probability of either negative or moderately negative precipitation anomalies in recent decades, the occurrence of drought years has been greater in the past two decades than in the preceding century. In addition, the probability that precipitation deficits co-occur with warm conditions and the probability that precipitation deficits produce drought have both increased. Climate model experiments with and without anthropogenic forcings reveal that human activities have increased the probability that dry precipitation years are also warm. Further, a large ensemble of climate model realizations reveals that additional global warming over the next few decades is very likely to create ~100% probability that any annual-scale dry period is also extremely warm. We therefore conclude that anthropogenic warming is increasing the probability of co-occurring warm–dry conditions like those that have created the acute human and ecosystem impacts associated with the "exceptional" 2012–2014 drought in California.

drought | climate extremes | climate change detection | event attribution | CMIP5

The state of California is the largest contributor to the economic and agricultural activity of the United States, accounting for a greater share of population (12%) (1), gross domestic product (12%) (2), and cash farm receipts (11%) (3) than any other state. California also includes a diverse array of marine and terrestrial ecosystems that span a wide range of climatic tolerances and together encompass a global biodiversity "hotspot" (4). These human and natural systems face a complex web of competing demands for freshwater (5). The state's agricultural sector accounts for 77% of California water use (5), and hydroelectric power provides more than 9% of the state's electricity (6). Because the majority of California's precipitation occurs far from its urban centers and primary agricultural zones, California maintains a vast and complex water management, storage, and distribution/conveyance infrastructure that has been the focus of nearly constant legislative, legal, and political battles (5). As a result, many riverine ecosystems depend on mandated "environmental flows" released by upstream dams, which become a point of contention during critically dry periods (5).

California is currently in the midst of a multiyear drought (7). The event encompasses the lowest calendar-year and 12-mo precipitation on record (8), and almost every month between December 2011 and September 2014 exhibited multiple indicators of drought (Fig. S1). The proximal cause of the precipitation deficits was the recurring poleward deflection of the cool-season storm track by a region of persistently high atmospheric pressure, which steered Pacific storms away from California over consecutive seasons (8–11). Although the extremely persistent high pressure is at least a century-scale occurrence (8), anthropogenic global warming has very likely increased the probability of such conditions (8, 9).

Despite insights into the causes and historical context of precipitation deficits (8–11), the influence of historical temperature changes on the probability of individual droughts has—until recently—received less attention (12–14). Although precipitation deficits are a prerequisite for the moisture deficits that constitute "drought" (by any definition) (15), elevated temperatures can greatly amplify evaporative demand, thereby increasing overall drought intensity and impact (16, 17). Temperature is especially important in California, where water storage and distribution systems are critically dependent on winter/spring snowpack, and excess demand is typically met by groundwater withdrawal (18–20). The impacts of runoff and soil moisture deficits associated with warm temperatures can be acute, including enhanced wildfire risk (21), land subsidence from excessive groundwater withdrawals (22), decreased hydropower production (23), and damage to habitat of vulnerable riparian species (24).

Recent work suggests that the aggregate combination of extremely high temperatures and very low precipitation during the 2012–2014 event is the most severe in over a millennium (12). Given the known influence of temperature on drought, the fact that the 2012–2014 record drought severity has co-occurred with record statewide warmth (7) raises the question of whether long-term warming has altered the probability that precipitation deficits yield extreme drought in California.

SUSTAINABILITY SCIENCE

Significance

California ranks first in the United States in population, economic activity, and agricultural value. The state is currently experiencing a record-setting drought, which has led to acute water shortages, groundwater overdraft, critically low streamflow, and enhanced wildfire risk. Our analyses show that California has historically been more likely to experience drought if precipitation deficits co-occur with warm conditions and that such confluences have increased in recent decades, leading to increases in the fraction of low-precipitation years that yield drought. In addition, we find that human emissions have increased the probability that low-precipitation years are also warm, suggesting that anthropogenic warming is increasing the probability of the co-occurring warm–dry conditions that have created the current California drought.

Author contributions: N.S.D., D.L.S., and D.T. designed research, performed research, contributed new reagents/analytic tools, analyzed data, and wrote the paper.

The authors declare no conflict of interest.

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Results

We analyze the "Palmer" drought metrics available from the US National Climatic Data Center (NCDC) (25). The NCDC Palmer metrics are based on the Palmer Drought Severity Index (PDSI), which uses monthly precipitation and temperature to calculate moisture balance using a simple "supply-and-demand" model (26) (*Materials and Methods*). We focus on the Palmer Modified Drought Index (PMDI), which moderates transitions between wet and dry periods (compared with the PDSI) (27). However, we note that the long-term time series of the PMDI is similar to that of other Palmer drought indicators, particularly at the annual scale (Figs. S1 and S2).

Because multiple drought indicators reached historic lows in July 2014 (Figs. S1–S3), we initially focus on statewide PMDI, temperature, and precipitation averaged over the August–July 12-mo period. We find that years with a negative PMDI anomaly exceeding −1.0 SDs (hereafter "1-SD drought") have occurred approximately twice as often in the past two decades as in the preceding century (six events in 1995–2014 = 30% of years; 14 events in 1896–1994 = 14% of years) (Fig. 1*A* and Fig. S4). This increase in the occurrence of 1-SD drought years has taken place without a substantial change in the probability of negative precipitation anomalies (53% in 1896–2014 and 55% in 1995–2014) (Figs. 1*B* and 2 *A* and *B*). Rather, the observed doubling of the occurrence of 1-SD drought years has coincided with a doubling of the frequency with which a negative precipitation year produces a 1-SD drought, with 55% of negative precipitation years in 1995–2014 co-occurring with a −1.0 SD PMDI anomaly, compared with 27% in 1896–1994 (Fig. 1 *A* and *B*).

Most 1-SD drought years have occurred when conditions were both dry (precipitation anomaly < 0) and warm (temperature anomaly > 0), including 15 of 20 1-SD drought years during 1896–2014 (Fig. 2*A* and Fig. S4) and 6 of 6 during 1995–2014 (Fig. 2*B* and Fig. S4). Similarly, negative precipitation anomalies are much more likely to produce 1-SD drought if they co-occur with a positive temperature anomaly. For example, of the 63 negative precipitation years during 1896–2014, 15 of the 32 warm–dry years (47%) produced 1-SD drought, compared with only 5 of the 31 cool–dry years (16%) (Fig. 2*A*). (During 1896–1994, 41% of warm–dry years produced 1-SD droughts, compared with 17% of cool–dry years.) The probability that a negative precipitation anomaly co-occurs with a positive temperature anomaly has increased recently, with warm–dry years occurring more than twice as often in the past two decades (91%) as in the preceding century (42%) (Fig. 1*B*).

All 20 August–July 12-mo periods that exhibited a −1.0 SD PMDI anomaly also exhibited a −0.5 SD precipitation anomaly (Fig. 1*B* and 2*E*), suggesting that moderately low precipitation is prerequisite for a 1-SD drought year. However, the occurrence of −0.5 SD precipitation anomalies has not increased in recent years (40% in 1896–2014 and 40% in 1995–2014) (Fig. 2 *A* and *B*). Rather, these moderate precipitation deficits have been far more likely to produce 1-SD drought when they occur in a warm year. For example, during 1896–2014, 1-SD drought occurred in 15 of the 28 years (54%) that exhibited both a −0.5 SD precipitation anomaly and a positive temperature anomaly, but in only 5 of the 20 years (25%) that exhibited a −0.5 SD precipitation anomaly and a negative temperature anomaly (Fig. 2*A*). During 1995–2014, 6 of the 8 moderately dry years produced 1-SD drought (Fig. 1*A*), with all 6 occurring in years in which the precipitation anomaly exceeded −0.5 SD and the temperature anomaly exceeded 0.5 SD (Fig. 1*C*).

Taken together, the observed record from California suggests that (*i*) precipitation deficits are more likely to yield 1-SD PMDI droughts if they occur when conditions are warm and (*ii*) the occurrence of 1-SD PMDI droughts, the probability of precipitation deficits producing 1-SD PMDI droughts, and the probability of precipitation deficits co-occurring with warm conditions have all been greater in the past two decades than in the preceding century.

These increases in drought risk have occurred despite a lack of substantial change in the occurrence of low or moderately low precipitation years (Figs. 1*B* and 2 *A* and *B*). In contrast, statewide warming (Fig. 1*C*) has led to a substantial increase in warm conditions, with 80% of years in 1995–2014 exhibiting a positive temperature anomaly (Fig. 2*B*), compared with 45% of years in 1896–2014 (Fig. 2*A*). As a result, whereas 58% of moderately dry years were warm during 1896–2014 (Fig. 2*A*) and 50% were warm during 1896–1994, 100% of the 8 moderately dry years in 1995–2014 co-occurred with a positive temperature anomaly (Fig. 2*B*). The observed statewide warming (Fig. 1*C*) has therefore substantially increased the probability that when moderate precipitation deficits occur, they occur during warm years.

The recent statewide warming clearly occurs in climate model simulations that include both natural and human forcings ("Historical" experiment), but not in simulations that include only natural forcings ("Natural" experiment) (Fig. 3*B*). In particular, the Historical and Natural temperatures are found to be different at the 0.001 significance level during the most recent 20-, 30-, and 40-y periods of the historical simulations (using the block bootstrap resampling applied in ref. 28). In contrast, although the Historical experiment exhibits a slightly higher mean annual precipitation (0.023 significance level), there is no statistically

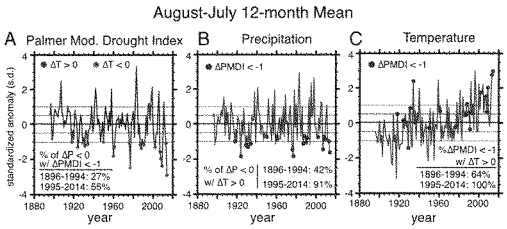

Fig. 1. Historical time series of drought (*A*), precipitation (*B*), and temperature (*C*) in California. Values are calculated for the August–July 12-mo mean in each year of the observed record, beginning in August 1895. In each year, the standardized anomaly is expressed as the magnitude of the anomaly from the long-term annual mean, divided by the SD of the detrended historical annual anomaly time series. The PMDI is used as the primary drought indicator, although the other Palmer indicators exhibit similar historical time series (Figs. S1 and S2). Circles show the years in which the PMDI exhibited a negative anomaly exceeding −1.0 SDs, which are referred to as 1-SD drought years in the text.

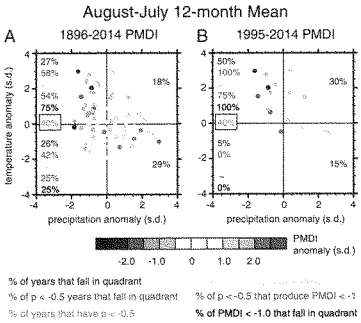

Fig. 2. Historical occurrence of drought, precipitation, and temperature in California. Standardized anomalies are shown for each August–July 12-mo period in the historical record (calculated as in Fig. 1). Anomalies are shown for the full historical record (*A*) and for the most recent two decades (*B*). Percentage values show the percentage of years meeting different precipitation and drought criteria that fall in each quadrant of the temperature–precipitation space. The respective criteria are identified by different colors of text.

significant difference in probability of a −0.5 SD precipitation anomaly (Fig. 3 *A* and *C*). However, the Historical experiment exhibits greater probability of a −0.5 SD precipitation anomaly co-occurring with a positive temperature anomaly (0.001 significance level) (Fig. 3*D*), suggesting that human forcing has caused the observed increase in probability that moderately dry precipitation years are also warm.

The fact that the occurrence of warm and moderately dry years approaches that of moderately dry years in the last decades of the Historical experiment (Fig. 3 *B* and *C*) and that 91% of negative precipitation years in 1995–2014 co-occurred with warm anomalies (Fig. 1*B*) suggests possible emergence of a regime in which nearly all dry years co-occur with warm conditions. We assess this possibility using an ensemble of 30 realizations of a single global climate model [the National Center for Atmospheric Research (NCAR) Community Earth System Model (CESM1) Large Ensemble experiment ("LENS")] (29) (*Materials and Methods*). Before ~1980, the simulated probability of a warm–dry year is approximately half that of a dry year (Fig. 4*B*), similar to observations (Figs. 1*B* and 2). However, the simulated probability of a warm–dry year becomes equal to that of a dry year by ~2030 of RCP8.5. Likewise, the probabilities of co-occurring 0.5, 1.0 and 1.5 SD warm–dry anomalies become approximately equal to those of 0.5, 1.0, and 1.5 SD dry anomalies (respectively) by ~2030 (Fig. 4*B*).

The probability of co-occurring extremely warm and extremely dry conditions (1.5 SD anomaly) remains greatly elevated throughout the 21st century (Fig. 4*B*). In addition, the number of multiyear periods in which a −0.5 SD precipitation anomaly co-occurs with a 0.5 SD temperature anomaly more than doubles between the Historical and RCP8.5 experiments (Fig. 4*A*). We find similar results using a 12-mo moving average (Fig. 4*C*). As with the August–July 12-mo mean (Fig. 4*B*), the probability of a dry year is approximately twice the probability of a warm–dry year for all 12-mo periods before ~1980 (Fig. 4*C*). However, the occurrence of warm years (including +1.5 SD temperature anomalies) increases after ~1980, reaching 1.0 by ~2030. This increase implies a transition to a permanent condition of ~100% risk that any negative—or extremely negative—12-mo precipitation anomaly is also extremely warm.

The overall occurrence of dry years declines after ~2040 (Fig. 4*C*). However, the occurrence of extreme 12-mo precipitation deficits (−1.5 SD) is greater in 2006–2080 than in 1920–2005 (<0.03 significance level). This detectable increase in extremely low-precipitation years adds to the effect of rising temperatures and contributes to the increasing occurrence of extremely warm–dry 12-mo periods during the 21st century.

All four 3-mo seasons likewise show higher probability of co-occurring 1.5 SD warm–dry anomalies after ~1980, with the probability of an extremely warm–dry season equaling that of an extremely dry season by ~2030 for spring, summer, and autumn, and by ~2060 for winter (Fig. 4*D*). In addition, the probability of a −1.5 SD precipitation anomaly increases in spring ($P < 0.001$) and autumn ($P = 0.01$) in 2006–2080 relative to 1920–2005, with spring occurrence increasing by ~75% and autumn occurrence increasing by ~44%—which represents a substantial and statistically significant increase in the risk of extremely low-precipitation events at both margins of California's wet season. In contrast, there is no statistically significant difference in the probability of a −1.5 SD precipitation anomaly for winter.

Discussion

A recent report by Seager et al. (30) found no significant long-term trend in cool-season precipitation in California during the 20th and early 21st centuries, which is consistent with our

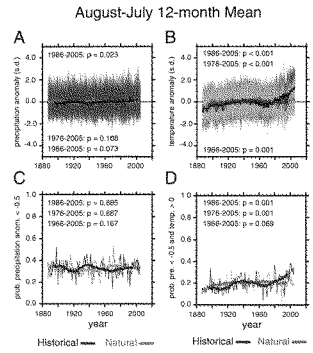

Fig. 3. Influence of anthropogenic forcing on the probability of warm–dry years in California. Temperature and precipitation values are calculated for the August–July 12-mo mean in each year of the CMIP5 Historical and Natural forcing experiments (*Materials and Methods*). The *Top* panels (*A* and *B*) show the time series of ensemble-mean standardized temperature and precipitation anomalies. The *Bottom* panels (*C* and *D*) show the unconditional probability (across the ensemble) that the annual precipitation anomaly is less than −0.5 SDs, and the conditional probability that both the annual precipitation anomaly is less than −0.5 SDs and the temperature anomaly is greater than 0. The bold curves show the 20-y running mean of each annual time series. The CMIP5 Historical and Natural forcing experiments were run until the year 2005. *P* values are shown for the difference between the Historical and Natural experiments for the most recent 20-y (1986–2005; gray band), 30-y (1976–2005), and 40-y (1966–2005) periods of the CMIP5 protocol. *P* values are calculated using the block bootstrap resampling approach of ref. 28 (*Materials and Methods*).

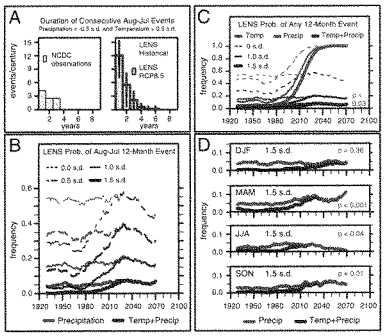

Fig. 4. Projected changes in the probability of co-occurring warm–dry conditions in the 21st century. (*A*) Histogram of the frequency of occurrence of consecutive August–July 12-mo periods in which the 12-mo precipitation anomaly is less than −0.5 SDs and the 12-mo temperature anomaly is at least 0.5 SDs, in historical observations and the LENS large ensemble experiment. (*B*) The probability that a negative 12-mo precipitation anomaly and a positive 12-mo temperature anomaly equal to or exceeding a given magnitude occur in the same August–July 12-mo period, for varying severity of anomalies. (*C*) The probability that a negative precipitation anomaly and a positive temperature anomaly equal to or exceeding a given magnitude occur in the same 12-mo period, for all possible 12-mo periods (using a 12-mo running mean; see *Materials and Methods*), for varying severity of anomalies. (*D*) The unconditional probability of a −1.5 SD seasonal precipitation anomaly (blue curve) and the conditional probability that a −1.5 SD seasonal precipitation anomaly occurs in conjunction with a 1.5 SD seasonal temperature anomaly (red curve), for each of the four 3-mo seasons. Time series show the 20-y running mean of each annual time series. *P* values are shown for the difference in occurrence of −1.5 SD precipitation anomalies between the Historical period (1920–2005) and the RCP8.5 period (2006–2080).

findings. Further, under a scenario of strongly elevated greenhouse forcing, Neelin et al. (31) found a modest increase in California mean December–January–February (DJF) precipitation associated with a local eastward extension of the mean subtropical jet stream west of California. However, considerable evidence (8–11, 31–33) simultaneously suggests that the response of northeastern Pacific atmospheric circulation to anthropogenic warming is likely to be complex and spatiotemporally inhomogeneous, and that changes in the atmospheric mean state may not be reflective of changes in the risk of extreme events (including atmospheric configurations conducive to precipitation extremes). Although there is clearly value in understanding possible changes in precipitation, our results highlight the fact that efforts to understand drought without examining the role of temperature miss a critical contributor to drought risk. Indeed, our results show that even in the absence of trends in mean precipitation—or trends in the occurrence of extremely low-precipitation events—the risk of severe drought in California has already increased due to extremely warm conditions induced by anthropogenic global warming.

We note that the interplay between the existence of a well-defined summer dry period and the historical prevalence of a substantial high-elevation snowpack may create particular susceptibility to temperature-driven increases in drought duration and/or intensity in California. In regions where precipitation exhibits a distinct seasonal cycle, recovery from preexisting drought conditions is unlikely during the characteristic yearly dry spell (34). Because California's dry season occurs during the warm summer months, soil moisture loss through evapotranspiration (ET) is typically high—meaning that soil moisture deficits that exist at the beginning of the dry season are exacerbated by the warm conditions that develop during the dry season, as occurred during the summers of 2013 and 2014 (7).

Further, California's seasonal snowpack (which resides almost entirely in the Sierra Nevada Mountains) provides a critical source of runoff during the low-precipitation spring and summer months. Trends toward earlier runoff in the Sierra Nevada have already been detected in observations (e.g., ref. 35), and continued global warming is likely to result in earlier snowmelt and increased rain-to-snow ratios (35, 36). As a result, the peaks in California's snowmelt and surface runoff are likely to be more pronounced and to occur earlier in the calendar year (35, 36), increasing the duration of the warm-season low-runoff period (36) and potentially reducing montane surface soil moisture (37). Although these hydrological changes could potentially increase soil water availability in previously snow-covered regions during the cool low-ET season (34), this effect would likely be outweighed by the influence of warming temperatures (and decreased runoff) during the warm high-ET season (36, 38), as well as by the increasing occurrence of consecutive years with low precipitation and high temperature (Fig. 4*A*).

The increasing risk of consecutive warm–dry years (Fig. 4*A*) raises the possibility of extended drought periods such as those found in the paleoclimate record (14, 39, 40). Recent work suggests that record warmth could have made the current event the most severe annual-scale drought of the past millennium (12). However, numerous paleoclimate records also suggest that the region has experienced multidecadal periods in which most years were in a drought state (14, 39, 41, 42), albeit less acute than the current California event (12, 39, 41). Although multidecadal ocean variability was a primary cause of the megadroughts of the last millenium (41), the emergence of a condition in which there is ~100% probability of an extremely warm year (Fig. 4) substantially increases the risk of prolonged drought conditions in the region (14, 39, 40).

A number of caveats should be considered. For example, ours is an implicit approach that analyzes the temperature and precipitation conditions that have historically occurred with low PMDI years, but does not explicitly explore the physical processes that produce drought. The impact of increasing temperatures on the processes governing runoff, baseflow, groundwater, soil moisture, and land-atmosphere evaporative feedbacks over both the historical period and in response to further global warming remains a critical uncertainty (43). Likewise, our analyses of anthropogenic forcing rely on global climate models that do not resolve the topographic complexity that strongly influences California's precipitation and temperature. Further investigation using high-resolution modeling approaches that better resolve the boundary conditions and fine-scale physical processes (44–46) and/or using analyses that focus on the underlying large-scale climate dynamics of individual extreme events (8) could help to overcome the limitations of simulated precipitation and temperature in the current generation of global climate models.

Conclusions

Our results suggest that anthropogenic warming has increased the probability of the co-occurring temperature and precipitation conditions that have historically led to drought in California. In addition, continued global warming is likely to cause a transition to a regime in which essentially every seasonal, annual, and multiannual precipitation deficit co-occurs with historically warm conditions. The current warm–dry event in California—as well as historical observations of previous seasonal, annual, and multiannual warm–dry events—suggests such a regime would substantially increase the risk of severe impacts on human and natural systems. For example, the projected increase in extremely

low precipitation and extremely high temperature during spring and autumn has substantial implications for snowpack water storage, wildfire risk, and terrestrial ecosystems (47). Likewise, the projected increase in annual and multiannual warm–dry periods implies increasing risk of the acute water shortages, critical groundwater overdraft, and species extinction potential that have been experienced during the 2012–2014 drought (5, 20).

California's human population (38.33 million as of 2013) has increased by nearly 72% since the much-remembered 1976–1977 drought (1). Gains in urban and agricultural water use efficiency have offset this rapid increase in the number of water users to the extent that overall water demand is nearly the same in 2013 as it was in 1977 (5). As a result, California's per capita water use has declined in recent decades, meaning that additional short-term water conservation in response to acute shortages during drought conditions has become increasingly challenging. Although a variety of opportunities exist to manage drought risk through long-term changes in water policy, management, and infrastructure (5), our results strongly suggest that global warming is already increasing the probability of conditions that have historically created high-impact drought in California.

Materials and Methods

We use historical time series of observed California statewide temperature, precipitation, and drought data from the National Oceanic and Atmospheric Administration's NCDC (7). The data are from the NCDC "nClimDiv" divisional temperature–precipitation–drought database, available at monthly time resolution from January 1895 to the present (7, 25). The NCDC nClimDiv database includes temperature, precipitation, and multiple Palmer drought indicators, aggregated at statewide and substate climate division levels for the United States. The available Palmer drought indicators include PDSI, the Palmer Hydrological Drought Index (PHDI), and PMDI.

PMDI and PHDI are variants of PDSI (25–27, 48, 49). PDSI is an index that measures the severity of wet and dry anomalies (26). The NCDC nClimDiv PDSI calculation is reported at the monthly scale, based on monthly temperature and precipitation (49). Together, the monthly temperature and precipitation values are used to compute the net moisture balance, based on a simple supply-and-demand model that uses potential evapotranspiration (PET) calculated using the Thornthwaite method. Calculated PET values can be very different when using other methods (e.g., Penman–Monteith), with the Thornthwaite method's dependence on surface temperature creating the potential for overestimation of PET (e.g., ref. 43). However, it has been found that the choice of methods in the calculation of PET does not critically influence the outcome of historical PDSI estimates in the vicinity of California (15, 43, 50). In contrast, the sensitivity of the PET calculation to large increases in temperature could make the PDSI inappropriate for calculating the response of drought to high levels of greenhouse forcing (15). As a result, we analyze the NCDC Palmer indicators in conjunction with observed temperature and precipitation data for the historical period, but we do not calculate the Palmer indicators for the future (for future projections of the PDSI, refer to refs. 15 and 40).

Because the PDSI is based on recent temperature and precipitation conditions (and does not include human demand for water), it is considered an indicator of "meterological" drought (25). The PDSI calculates "wet," "dry," and "transition" indices, using the wet or dry index when the probability is 100% and the transition index when the probability is less than 100% (26). Because the PMDI always calculates a probability-weighted average of the wet and dry indices (27), the PDSI and PMDI will give equal values in periods that are clearly wet or dry, but the PMDI will yield smoother transitions between wet and dry periods (25). In this work, we use the PMDI as our primary drought indicator, although we note that the long-term time series of the PMDI is similar to that of the PDSI and PHDI, particularly at the annual scale considered here (Figs. S1 and S2).

We analyze global climate model simulations from phase 5 of the Coupled Model Intercomparison Project (CMIP5) (51). We compare two of the CMIP5 multimodel historical experiments (which were run through 2005): (*i*) the Historical experiment, in which the climate models are prescribed both anthropogenic and nonanthropogenic historical climate forcings, and (*ii*) the Natural experiment, in which the climate models are prescribed only the nonanthropogenic historical climate forcings. We analyze those realizations for which both temperature and precipitation were available from both experiments at the time of data acquisition. We calculate the temperature and precipitation values over the state of California at each model's native resolution using all grid points that overlap with the geographical borders of California, as defined by a high-resolution shapefile (vector digital data obtained from the US Geological Survey via the National Weather Service at www.nws.noaa.gov/geodata/catalog/national/html/us_state.htm).

We also analyze NCAR's large ensemble ("LENS") climate model experiment (29). The LENS experiment includes 30 realizations of the NCAR CESM1. This large single-model experiment enables quantification of the uncertainty arising from internal climate system variability. Although the calculation of this "irreducible" uncertainty likely varies between climate models, it exists independent of uncertainty arising from model structure, model parameter values, and climate forcing pathway. At the time of acquisition, LENS results were available for 1920–2005 in the Historical experiment and 2006–2080 in the RCP8.5 (Representative Concentration Pathway) experiment. The four RCPs are mostly indistinguishable over the first half of the 21st century (52). RCP8.5 has the highest forcing in the second half of the 21st century and reaches ~4 °C of global warming by the year 2100 (52).

Given that the ongoing California drought encompasses the most extreme 12-mo precipitation deficit on record (8) and that both temperature and many drought indicators reached their most extreme historical values for California in July 2014 (7) (Fig. 1 and Figs. S1 and S2), we use the 12-mo August–July period as one period of analysis. However, because severe conditions can manifest at both multiannual and subannual timescales, we also analyze the probability of occurrence of co-occurring warm and dry conditions for multiannual periods, for all possible 12-mo periods, and for the winter (DJF), spring (March–April–May), summer (June–July–August), and autumn (September–October–November) seasons.

We use the monthly-mean time series from NCDC to calculate observed time series of statewide 12-mo values of temperature, precipitation, and PMDI. Likewise, we use the monthly-mean time series from CMIP5 and LENS to calculate simulated time series of statewide 12-mo and seasonal values of temperature and precipitation. From the time series of annual-mean values for each observed or simulated realization, we calculate (*i*) the baseline mean value over the length of the record, (*ii*) the annual anomaly from the baseline mean value, (*iii*) the SD of the detrended baseline annual anomaly time series, and (*iv*) the ratio of each individual annual anomaly value to the SD of the detrended baseline annual anomaly time series. (For the 21st-century simulations, we use the Historical simulation as the baseline.) Our time series of standardized values are thereby derived from the time series of 12-mo annual (or 3-mo seasonal) mean anomaly values that occur in each year.

For the multiannual analysis, we calculate consecutive occurrences of August–July 12-mo values. For the analysis of all possible 12-mo periods, we generate the annual time series of each 12-mo period (January–December, February–January, etc.) using a 12-mo running mean. For the seasonal analysis, we generate the time series by calculating the mean of the respective 3-mo season in each year.

We quantify the statistical significance of differences in the populations of different time periods using the block bootstrap resampling approach of ref. 28. For the CMIP5 Historical and Natural ensembles, we compare the populations of the August–July values in the two experiments for the 1986–2005, 1976–2005, and 1966–2005 periods. For the LENS seasonal analysis, we compare the respective populations of DJF, March–April–May, June–July–August, and September–October–November values in the 1920–2005 and 2006–2080 periods. For the LENS 12-mo analysis, we compare the populations of 12-mo values in the 1920–2005 and 2006–2080 periods, testing block lengths up to 16 to account for temporal autocorrelation out to 16 mo for the 12-mo running mean data. (Autocorrelations beyond 16 mo are found to be negligible.)

Throughout the text, we consider drought to be those years in which negative 12-mo PMDI anomalies exceed −1.0 SDs of the historical interannual PMDI variability. We stress that this value is indicative of the variability of the annual (12-mo) PMDI, rather than of the monthly values (compare Fig. 1 and Figs. S1 and S2). We consider "moderate" temperature and precipitation anomalies to be those that exceed 0.5 SDs ("0.5 SD") and "extreme" temperature and precipitation anomalies to be those that exceed 1.5 SDs ("1.5 SD").

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Los Angeles Times
Science Now
Discoveries from the world of science and medicine

Scientists explain how climate change helps fuel California drought

By BETTINA BOXALL

MARCH 2, 2015, 9:32 PM

Climate change is increasing the risk of severe drought in California by causing warm periods and dry periods to overlap more often, according to a new study.

Rising temperatures resulting from increased greenhouse gas emissions mean warm and dry periods are coinciding more frequently, the study authors say. And that is amplifying the effects of low precipitation.

"The key for drought stress is not just how much precipitation there is," said Noah Diffenbaugh, the paper's lead author and an associate professor at Stanford University's School of Earth, Energy and Environmental Sciences. "Temperature is an important influence on the water available in California."

Higher temperatures decrease soil moisture, increase evaporation and intensify California's annual dry season. All of these accentuate the impacts of below-normal precipitation.

So Diffenbaugh and two other Stanford researchers analyzed historical climate data for the state to see when warm years coincided with dry years. They found that warm-dry years have occurred more than twice as often in the last two decades than they did in the preceding century.

And it appears that the situation is set to get worse. A continuing rise in global temperatures — fueled in part by human activity — will greatly increase the chances that dry periods are accompanied by warm conditions, the team predicted. That's what has happened during the state's current drought, now entering its fourth year and by some measures the worst on record.

"Our results highlight the fact that efforts to understand drought without examining the role of temperature miss a critical contributor to drought risk," wrote the authors, whose work was published Monday in the Proceedings of the National Academy of Sciences.

Whether climate change – whatever its cause – has played a role in the California drought is a matter of debate. A report published last fall by the Bulletin of the American Meteorological Society concluded that there is no definitive link.

That report included the work of 20 research teams that explored the causes of 16 extreme weather events recorded around the world in 2013. Diffenbaugh and Stanford graduate student Daniel Swain, a co-author of the PNAS study, contributed a paper that said the type of stubborn high-pressure system that persistently pushed storms north of the state is more likely to occur with climate change, suggesting a link to global warming.

But other scientists who contributed to the meteorological society report disagreed, attributing the drought to natural variability. They wrote there was "no appreciable long-term change in the risk for dry climate extremes over California since the late 19th century."

In the PNAS study, Diffenbaugh, Swain and Stanford graduate student Danielle Touma note that California's average precipitation has not appreciably declined over the last century. Indeed, climate models suggest that winter precipitation in much of the state could modestly increase this century.

But rising temperatures caused by human activities are nonetheless increasing drought risk, they wrote.

"The emergence of a condition in which there is ~100% probability of an extremely warm year substantially increases the risk of prolonged drought conditions in the region," they concluded. "Our results strongly suggest that global warming is already increasing the probability of conditions that have historically created high-impact drought in California."

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Senator BOXER. I ask unanimous consent to put in the record a Washington Post article, The Remote Alaskan Village that Needs to Be Relocated Due to Climate Change.

Senator INHOFE. Without objection.

[The referenced information follows:]

The Washington Post

Energy and Environment

The remote Alaskan village that needs to be relocated due to climate change

By Chris Mooney

KIVALINA, ALASKA — This tiny and isolated town of 400 cannot be reached by road. It lies on a fragile barrier island along the Chukchi Sea, 83 miles above the Arctic circle. And for generations, the Iñupiat people of the region have hunted gigantic bowhead whales from camps atop the sea ice that stretches out from the town's icy shores.

But in recent years, climate change has thinned the ice so much that it has become too dangerous to hunt the whales. Soon, the U.S. government says, it may be too dangerous to live here at all, with less sea ice to protect the barrier island from powerful waves that wash across the village.

"Global warming has caused us so much problems," said Joseph Swan, Sr., a Kivalina elder, at a town meeting last week. The ice "does not freeze like it used to. It used to be like 10 to 8 feet thick, way out in the ocean."

The question now facing the town, the state of Alaska, and the nation is whether to move the people of Kivalina to a safer location nearby, either inland or further down the coast — and who would pay upwards of a hundred million dollars to do it. It's a question already facing Kivalina and a handful of other native Alaskan villages, and in the coming decades could apply to numerous other towns along U.S. coastlines. Here, climate change is less a

future threat and more a daily force, felt in drastic changes to weather, loss of traditional means of sustenance like whale hunting, and the literal vanishing of land.

"We have a whole bunch of infrastructure that we need to move, that the government should be moving themselves," said Colleen Swan, who sits on the City Council and also works in disaster preparedness for the community. "I would like to live without having to worry about having to evacuate, or having to run."

The role the U.S. government will play is still an open question. Interior secretary Sally Jewell came to Kivalina last week to highlight the problems facing the town, and President Obama has proposed $50.4 million in federal spending to help Native American communities grapple with climate change. Yet that is less than half of what's estimated to be needed to relocate Kivalina alone.

Congress, controlled by Republicans skeptical of federal spending and interventions to stem climate change, may not approve even that. While it is not clear how congressional Republicans will respond to this budget request, in the past they have objected to climate-related initiatives, for instance the administration's recent pledge to spend up to $3 billion to help other nations adapt to climate change.

"The President's climate change agenda has only siphoned precious taxpayer dollars away from the real problems facing the American people," said Sen. James M. Inhofe (R-Okl.) late last year.

One of Alaska's Republican senators, Lisa Murkowski, says she doesn't trust the administration's moves on Kivalina.

"Senator Murkowski acknowledges the impacts of climate change on Alaska's coastal communities and believes that the federal government should step up its relief role, but she does not want Alaska's rural communities used merely as political talking points," said

her spokesman Matthew Felling. But Murkowski does support using federal dollars to help Alaska native communities protect their communities and even relocate if that's what's they choose to do, he said.

For the Obama administration, the problem is lack of funding. "While we do not expect that funding of this scale could support actual relocation, it could be used to support long-term resilience planning, planning that could consider relocation as determined by the community as well as other actions and approaches," said Jessica Kershaw, Interior Press Secretary.

Other funding then might have to come from other sources, a problem that is sure to rear its head more frequently, first in the Arctic — where climate change is stark and rapid — but later as it increasingly affects coastal cities around the country and world. At least one climate relocation is now complete abroad — the small village of Vunidogoloa, in Fiji, was relocated inland last year by the Fiji government.

"There's no government agency that has the responsibility to relocate a community, nor the funding to do it," says Robin Bronen, a director of the Alaska Immigration Justice Project, a human rights group, and a senior research scientist at the University of Alaska Fairbanks. "It means that for communities like Kivalina, they don't know what steps they need to take to get which government agencies involved."

If it is not getting enough resources, Kivalina is at least getting more attention. Last week, Sally Jewell made the first visit to the town by an interior secretary in its 110 year history.

"Your story will help the world understand what's happening right here," said Jewell at a town meeting in the basketball court of Kivalina's only school, a day before announcing $8 million in funding to help native communities adjust. "It will help us make the case for climate change in the U.S. Congress. It will help us bring the kind of resources that we have to bring to bear for people like you, and for people in other parts of the world that

live in coastal communities that are at high risk."

Residents of Kivalina suggest the U.S. government may have a special responsibility to relocate them — after all, they say, it helped put them there over a century ago. A 1906 Interior Department report records that $50,000 was appropriated for the "education of natives in Alaska," leading to the construction of 26 schools, including one at Kivalina.

As one historian notes, the establishment of government schools led to the "consolidation" of previously mobile hunting and fishing communities in larger, stationary villages, like Kivalina.

Today, the town consists of some 85 homes, as well as two water tanks, an airstrip, a post office, and its largest building, the school. Recently the town's only general store burned down, leaving a large mess of tangled metal and wood. A complete wolfskin hangs outside one home; towards the frozen beach, a group of sled dogs tied to tethers. Elsewhere, a jettisoned car is half buried in snow. The villagers live in cramped conditions without running water in most buildings, and have to haul their own trash and sewage to dump sites.

For Kivalina, the risk is all about the thinning Arctic sea ice — a phenomenon plainly visible from the sky. Along much of the coast, open water was visible just offshore, instead of being fully covered by seasonal sea ice, as is more typical of mid-February in the area.

The scenery reflected what multiple scientific assessments have found about the changing Arctic. It is warming at "twice the rate of anywhere else on Earth," according to a 2014 National Oceanic and Atmospheric Administration report. One reason is a climate "feedback" in which rising temperatures melt the ice. Then, the loss of highly reflective sea ice exposes darker ocean water beneath. The darker sea absorbs more solar radiation – retaining more heat and leading to still more ice melt.

Arctic sea ice has been declining markedly over the past few decades, which also means that sturdy, so-called "multiyear" ice — which builds up its bulk over many seasons — is being replaced with ice that is "younger," having formed much more recently. Young ice is thinner and more fragile. Arctic sea ice extent in January was at its third lowest level on record for that month, according to the National Snow and Ice Data Center, and especially low in the Bering Sea south of Kivalina.

Along with the ice goes the stability of the tiny barrier island itself. Weak sea ice in February presages a longer summer and fall season without protective ice along the shore. And that lengthening ice free period – it has increased from 3 months to "as much as 5 months" one report found — is when Kivalina is vulnerable to fall sea storms, which can hurl large waves at the town. Without sea ice to mute their force, the waves can strip away the island's very existence through erosion.

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"As we grew up, we've never seen the water come over the village, but in the last 10 years, it came over the village at least three times," Millie Hawley, president of the Native Village of Kivalina, said last week in a meeting with Jewell.

For well over a decade, experts analyzing Kivalina's situation have called it untenable. In 2003, the Government Accountability Office said that Kivalina was in "imminent danger" from erosion and from getting over-washed in a storm. "It has long been apparent that the island would eventually succumb to natural forces, and that the village would have to be moved," wrote the U.S. Army Corps of Engineers in 2006. In a later 2009 report, the GAO added that no federal agency was taking the lead in addressing threats to Kivalina and other Alaskan native villages, even though everyone could see a potential disaster coming.

A rock erosion barrier, constructed by the U.S. Army Corps of Engineers to buy the town some time, may have prevented the worst during a powerful winter cyclone in November

2011, which tore down doors and drove waters against the barrier. But the Corps — and everyone in Kivalina — knows that's only a temporary solution. Kivalina's villagers have voted to move along the coast a mile to the south, but the Corps has questioned its stability as well.

In the meantime, Kivalina remains torn between tradition and a deeply uncertain future. The struggle is symbolized by two massive whalebone arches — formed from the ribs of bowhead whales caught by villagers more than two decades ago — that lie at the entrance to the town from the airstrip.

"This is in some ways such an unprecedented problem, and a lot of our national policies for disaster have to do with after a disaster occurs," says Christine Shearer, a researcher who wrote a book about Kivalina and now works for CoalSwarm, which shares information about coal plants. "But with climate change, it's really about: We need to prepare for what's coming."

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The Obama administration wants to make Arctic drilling 'safe.' Is that possible?

Why climate scientists are right about how hot the planet is going to get

Chris Mooney reports on science and the environment.

Senator BOXER. I ask unanimous consent to put in the record the peer-reviewed study that shows warmer temperatures equal bigger snow storms.

Senator INHOFE. Without objection.

[The referenced information follows:]

Climate Change Impacts in the United States

CHAPTER 9
HUMAN HEALTH

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On the Web: http://nca2014.globalchange.gov/report/sectors/human-health

INFORMATION DRAWN FROM THIS CHAPTER IS INCLUDED IN THE HIGHLIGHTS REPORT AND IS IDENTIFIED BY THIS ICON

9 HUMAN HEALTH

Key Messages

1. **Climate change threatens human health and well-being in many ways, including impacts from increased extreme weather events, wildfire, decreased air quality, threats to mental health, and illnesses transmitted by food, water, and disease-carriers such as mosquitoes and ticks. Some of these health impacts are already underway in the United States.**

2. **Climate change will, absent other changes, amplify some of the existing health threats the nation now faces. Certain people and communities are especially vulnerable, including children, the elderly, the sick, the poor, and some communities of color.**

3. **Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As threats increase, our ability to adapt to future changes may be limited.**

4. **Responding to climate change provides opportunities to improve human health and well-being across many sectors, including energy, agriculture, and transportation. Many of these strategies offer a variety of benefits, protecting people while combating climate change and providing other societal benefits.**

Climate change, together with other natural and human-made health stressors, influences human health and disease in numerous ways. Some existing health threats will intensify and new health threats will emerge. Not everyone is equally at risk. Important considerations include age, economic resources, and location. Preventive and adaptive actions, such as setting up extreme weather early warning systems and improving water infrastructure, can reduce the severity of these impacts, but there are limits to the effectiveness of such actions in the face of some projected climate change threats.

Climate change presents a global public health problem, with serious health impacts predicted to manifest in varying ways in different parts of the world. Public health in the U.S. can be affected by disruptions of physical, biological, and ecological systems, including disturbances originating in the U.S. and elsewhere. Health effects of these disruptions include increased respiratory and cardiovascular disease, injuries and premature deaths related to extreme weather events, changes in the prevalence and geographical distribution of food- and waterborne illnesses and other infectious diseases, and threats to mental health.

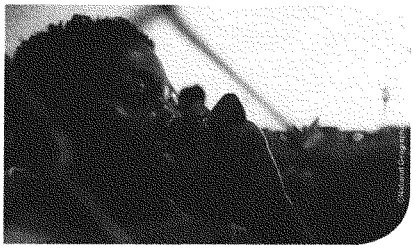
Key weather and climate drivers of health impacts include increasingly frequent, intense, and longer-lasting extreme heat, which worsens drought, wildfire, and air pollution risks; increasingly frequent extreme precipitation, intense storms, and changes in precipitation patterns that lead to drought and ecosystem changes (Ch. 2: Our Changing Climate); and rising sea levels that intensify coastal flooding and storm surge (Ch. 25: Coasts). Key drivers of vulnerability include the attributes of certain groups (age, socioeconomic status, race, current level of health – see Ch. 12: Indigenous Peoples for examples of health impacts on vulnerable populations) and of place (floodplains, coastal zones, and urban areas), as well as the resilience of critical public health infrastructure. Multi-stressor situations, such as impacts on vulnerable populations following natural disasters that also damage the social and physical infrastructure necessary for resilience and emergency response, are particularly important to consider when preparing for the impacts of climate change on human health.

Key Message 1: Wide-ranging Health Impacts

Climate change threatens human health and well-being in many ways, including impacts from increased extreme weather events, wildfire, decreased air quality, threats to mental health, and illnesses transmitted by food, water, and disease-carriers such as mosquitoes and ticks. Some of these health impacts are already underway in the United States.

Air Pollution

Climate change is projected to harm human health by increasing ground-level ozone and/or particulate matter air pollution in some locations. Ground-level ozone (a key component of smog) is associated with many health problems, such as diminished lung function, increased hospital admissions and emergency room visits for asthma, and increases in premature deaths.[1,2,3] Factors that affect ozone formation include heat, concentrations of precursor chemicals, and methane emissions, while particulate matter concentrations are affected by wildfire emissions and air stagnation episodes, among other factors.[4,5] By increasing these different factors, climate change is projected to lead to increased concentration of ozone and particulate matter in some regions.[6,7,8,9] Increases in global temperatures could cause associated increases in premature deaths related to worsened ozone and particle pollution. Estimates made assuming no change in regulatory controls or population characteristics have ranged from 1,000 to 4,300 additional premature deaths nationally per year by 2050 from combined ozone and particle health effects.[10,11] There is less



certainty in the responses of airborne particles to climate change than there is about the response of ozone. Health-related costs of the current effects of ozone air pollution exceeding national standards have been estimated at $6.5 billion (in 2008 U.S. dollars) nationwide, based on a U.S. assessment of health impacts from ozone levels during 2000 to 2002.[12,13]

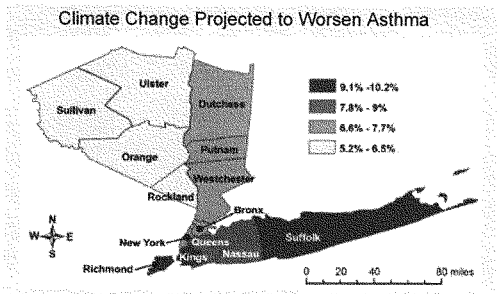


Figure 9.1. Projected increases in temperature, changes in wind patterns, and ecosystem changes will all affect future ground-level ozone concentrations. Climate projections using an increasing emissions scenario (A2) suggest that ozone concentrations in the New York metropolitan region will increase because of future climate change. This figure shows the estimated increase in ozone-related emergency room visits for children in New York in the 2020s (compared to the mid-1990s) resulting from climate change related increases in ozone concentrations. The results from this modeling exercise are shown as a percent change in visits specifically attributed to ozone exposure. For example, the 10.2% increase in Suffolk County represents five additional emergency room visits that could be attributed to increased ozone exposure over the baseline of 46 ozone-related visits from the mid-1990s. In 2010, an estimated 25.7 million Americans had asthma, which has become a problem in every state. (Figure source: Sheffield et al. 2011[14]).

Allergens

Climate change, resulting in more frost-free days and warmer seasonal air temperatures, can contribute to shifts in flowering time and pollen initiation from allergenic plant species, and increased CO_2 by itself can elevate production of plant-based allergens.[14,15,16,17,18,19] Higher pollen concentrations and longer pollen seasons can increase allergic sensitizations and asthma episodes,[20,21,22] and diminish productive work and school days.[19,22,23] Simultaneous exposure to toxic air pollutants can worsen allergic responses.[24,25,26] Extreme rainfall and rising temperatures can also foster indoor air quality problems, including the growth of indoor fungi and molds, with increases in respiratory and asthma-related conditions.[27] Asthma prevalence (the percentage of people who have ever been diagnosed with asthma and still have asthma) increased nationwide from 7.3% in 2001 to 8.4% in 2010. Asthma visits in primary care settings, emergency room visits, and hospitalizations were all stable from 2001 to 2009, and asthma death rates per 1,000 persons with asthma declined from 2001 to 2009.[28] To the extent that increased pollen exposures occur, patients and their physicians will face increased challenges in maintaining adequate asthma control.

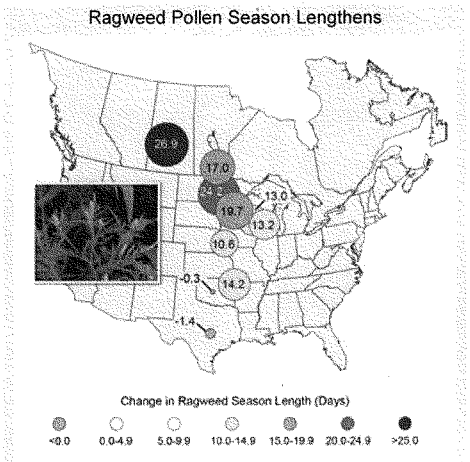


Figure 9.2. Ragweed pollen season length has increased in central North America between 1995 and 2011 by as much as 11 to 27 days in parts of the U.S. and Canada in response to rising temperatures. Increases in the length of this allergenic pollen season are correlated with increases in the number of days before the first frost. As shown in the figure, the largest increases have been observed in northern cities. (Data updated from Ziska et al. 2011[19]; Photo credit: Lewis Ziska, USDA).

Wildfires

Climate change is currently increasing the vulnerability of many forests to wildfire. Climate change is projected to increase the frequency of wildfire in certain regions of the United States (Ch. 7: Forests).[17,29] Long periods of record high temperatures are associated with droughts that contribute to dry conditions and drive wildfires in some areas.[30] Wildfire smoke contains particulate matter, carbon monoxide, nitrogen oxides, and various volatile organic compounds (which are ozone precursors)[31] and can significantly reduce air quality, both locally and in areas downwind of fires.[32,33] Smoke exposure increases respiratory and cardiovascular hospitalizations, emergency department visits, and medication dispensations for asthma, bronchitis, chest pain, chronic obstructive pulmonary disease (commonly known by its acronym, COPD), respiratory infections, and medical visits for lung illnesses.[32,34,35] It has been associated with hundreds of thousands of deaths annually, in an assessment of the global health risks from landscape fire smoke.[32,34,36,37] Future climate change is projected to increase wildfire risks and associated emissions, with harmful impacts on health.[17,38,39,40]

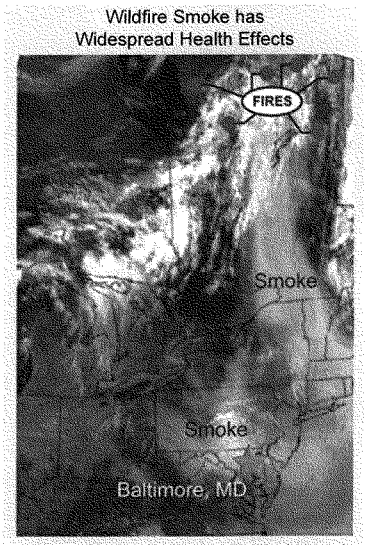


Figure 9.3. Wildfires, which are projected to increase in some regions due to climate change, have health impacts that can extend hundreds of miles. Shown here, forest fires in Quebec, Canada, during July 2002 (red circles) resulted in up to a 30-fold increase in airborne fine particle concentrations in Baltimore, Maryland, a city nearly a thousand miles downwind. These fine particles, which are extremely harmful to human health, not only affect outdoor air quality, but also penetrate indoors, increasing the long-distance effects of fires on health.[41] An average of 6.4 million acres burned in U.S. wildfires each year between 2000 and 2010, with 9.5 and 9.1 million acres burned in 2006 and 2012, respectively.[42] Total global deaths from the effects of landscape fire smoke have been estimated at 260,000 to 600,000 annually between the years 1997 and 2006.[37] (Figure source: Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on the Terra satellite, Land Rapid Response Team, NASA/GSFC).

Temperature Extremes

Extreme heat events have long threatened public health in the United States.[43,44,45] Many cities, including St. Louis, Philadelphia, Chicago, and Cincinnati, have suffered dramatic increases in death rates during heat waves. Deaths result from heat stroke and related conditions,[44,45,46] but also from cardiovascular disease, respiratory disease, and cerebrovascular disease.[47,48] Heat waves are also associated with increased hospital admissions for cardiovascular, kidney, and respiratory disorders.[48,49,50] Extreme summer heat is increasing in the United States (Ch. 2: Our Changing Climate, Key Message 7),[51] and climate projections indicate that extreme heat events will be more frequent and intense in coming decades (Ch. 2: Our Changing Climate, Key Message 7).[2,52,53,54]

Some of the risks of heat-related sickness and death have diminished in recent decades, possibly due to better forecasting, heat-health early warning systems, and/or increased access to air conditioning for the U.S. population.[55] However, extreme heat events remain a cause of preventable death nationwide. Urban heat islands, combined with an aging population and increased urbanization, are projected to increase the vulnerability of urban populations to heat-related health impacts in the future (Ch. 11: Urban).[56,57,58]

Milder winters resulting from a warming climate can reduce illness, injuries, and deaths associated with cold and snow. Vulnerability to winter weather depends on many non-climate factors, including housing, age, and baseline health.[59] While deaths and injuries related to extreme cold events are projected to decline due to climate change, these reductions are not expected to compensate for the increase in heat-related deaths.[60,61]

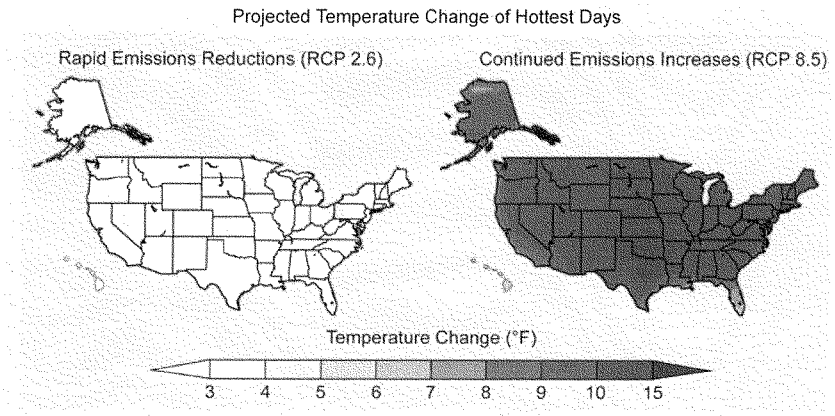


Figure 9.4. The maps show projected increases in the average temperature on the hottest days by late this century (2081-2100) relative to 1986-2005 under a scenario that assumes a rapid reduction in heat-trapping gases (RCP 2.6) and a scenario that assumes continued increases in these gases (RCP 8.5). The hottest days are those so hot they occur only once in 20 years. Across most of the continental United States, those days will be about 10°F to 15°F hotter in the future under the higher emissions scenario. (Figure source: NOAA NCDC / CICS-NC).

Precipitation Extremes: Heavy Rainfall, Flooding, and Droughts

The frequency of heavy precipitation events has already increased for the nation as a whole, and is projected to increase in all U.S. regions (Ch. 2: Our Changing Climate).[54,62] Increases in both extreme precipitation and total precipitation have contributed to increases in severe flooding events in certain regions (see Ch. 2: Our Changing Climate, Figure 2.21). Floods are the second deadliest of all weather-related hazards in the United States, accounting for approximately 98 deaths per year,[63] most due to drowning.[64] Flash floods (see Ch. 3: Water, "Flood Factors and Flood Types") and flooding associated with tropical storms result in the highest number of deaths.[63]

In addition to the immediate health hazards associated with extreme precipitation events when flooding occurs, other hazards can often appear once a storm event has passed. Elevated waterborne disease outbreaks have been reported in the weeks

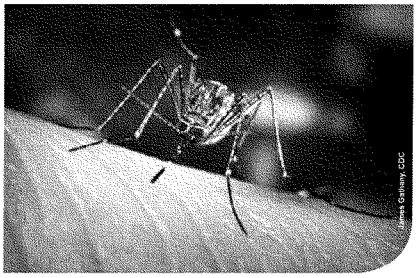
following heavy rainfall,[65] although other variables may affect these associations.[66] Water intrusion into buildings can result in mold contamination that manifests later, leading to indoor air quality problems. Buildings damaged during hurricanes are especially susceptible to water intrusion. Populations living in damp indoor environments experience increased prevalence of asthma and other upper respiratory tract symptoms, such as coughing and wheezing[67] as well as lower respiratory tract infections such as pneumonia, Respiratory Syncytial Virus (RSV), and RSV pneumonia (see Figure 9.7).[68]

At the opposite end of precipitation extremes, drought also poses risks to public health and safety.[69] Drought conditions may increase the environmental exposure to a broad set of health hazards including wildfires, dust storms, extreme heat events, flash flooding, degraded water quality, and reduced water quantity. Dust storms associated with drought conditions contribute to degraded air quality due to particulates and have been associated with increased incidence of Coccidioidomycosis (Valley fever), a fungal pathogen, in Arizona and California.[70]

Disease Carried by Vectors

Climate is one of the factors that influence the distribution of diseases borne by vectors (such as fleas, ticks, and mosquitoes, which spread pathogens that cause illness).[71,72,73,74,75,76,77,78] The geographic and seasonal distribution of vector populations, and the diseases they can carry, depend not only on climate but also on land use, socioeconomic and cultural factors, pest control, access to health care, and human responses to disease risk, among other factors.[72,73,79,80,81] Daily, seasonal, or year-to-year climate variability can sometimes result in vector/pathogen adaptation and shifts or expansions in their geographic ranges.[73,74,81] Such shifts can alter disease incidence depending on vector-host interaction, host immunity, and pathogen evolution.[71] North Americans are currently at risk from numerous vector-borne diseases, including Lyme,[75,82,83,84] dengue fever,[85] West Nile virus,[86] Rocky Mountain spotted fever,[87] plague, and tularemia.[88] Vector-borne pathogens not currently found in the United States, such as chikungunya, Chagas disease, and Rift Valley fever viruses, are also threats. Climate change effects on the geographical distribution and incidence of vector-borne diseases in other countries where these diseases are already found can also affect North Americans, especially as a result of increasing trade with, and travel to, tropical and subtropical areas.[74,81] Whether climate change in the U.S. will increase the chances of domestically acquiring diseases such as dengue fever is uncertain, due to vector-control efforts and lifestyle factors, such as time spent indoors, that reduce human-insect contact.

Infectious disease transmission is sensitive to local, small-scale differences in weather, human modification of the landscape, the diversity of animal hosts,[83] and human behavior that affects vector-human contact, among other factors. There is a need for finer-scale, long-term studies to help quantify the relationships among weather variables, vector range, and vector-borne pathogen occurrence, the consequences of shifting distributions of vectors and pathogens, and the impacts on human behavior. Enhanced vector surveillance and human disease tracking are needed to address these concerns.



The *Culex tarsalis* mosquito is a vector that transmits West Nile Virus.

Transmission Cycle of Lyme Disease

The development and survival of blacklegged ticks, their animal hosts, and the Lyme disease bacterium, *Borrelia burgdorferi*, are strongly influenced by climatic factors, especially temperature, precipitation, and humidity. Potential impacts of climate change on the transmission of Lyme disease include: 1) changes in the geographic distribution of the disease due to the increase in favorable habitat for ticks to survive off their hosts;[89] 2) a lengthened transmission season due to earlier onset of higher temperatures in the spring and later onset of cold and frost; 3) higher tick densities leading to greater risk in areas where the disease is currently observed, due to milder winters and potentially larger rodent host populations; and 4) changes in human behaviors, including increased time outdoors, which may increase the risk of exposure to infected ticks.

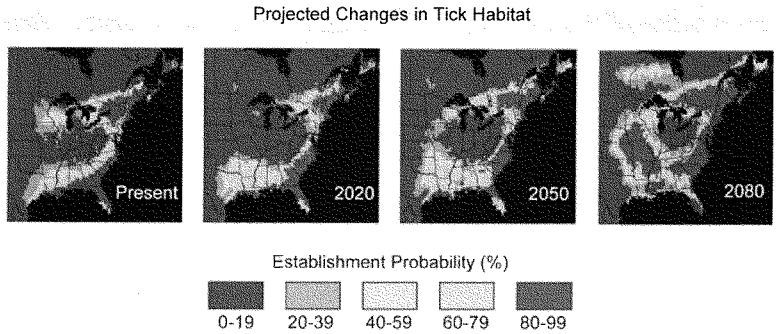


Figure 9.5. The maps show the current and projected probability of establishment of tick populations (*Ixodes scapularis*) that transmit Lyme disease. Projections are shown for 2020, 2050, and 2080. The projected expansion of tick habitat includes much of the eastern half of the country by 2080. For some areas around the Gulf Coast, the probability of tick population establishment is projected to decrease by 2080. (Figure source: adapted from Brownstein et al. 2005[90]).

Food- and Waterborne Diarrheal Disease

Diarrheal disease is a major public health issue in developing countries and, while not generally increasing in the United States, remains a persistent concern nonetheless. Exposure to a variety of pathogens in water and food causes diarrheal disease. Air and water temperatures, precipitation patterns, extreme rainfall events, and seasonal variations are all known to affect disease transmission.[65,91,92] In the United States, children and the elderly are most vulnerable to serious outcomes, and those exposed to inadequately or untreated groundwater will be among those most affected.

In general, diarrheal diseases including Salmonellosis and Campylobacteriosis are more common when temperatures are higher,[93,94] though patterns differ by place and pathogen. Diarrheal diseases have also been found to occur more frequently in conjunction with both unusually high and low precipitation.[95] Sporadic increases in streamflow rates, often preceded by rapid snowmelt[96] and changes in water treatment,[97] have also been shown to precede outbreaks. Risks of waterborne illness and beach closures resulting from changes in the magnitude of recent precipitation (within the past 24 hours) and in lake temperature are expected to increase in the Great Lakes region due to projected climate change.[98,99]

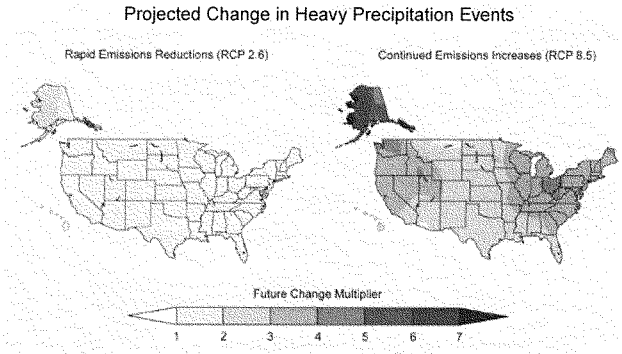


Figure 9.6. Maps show the increase in frequency of extreme daily precipitation events (a daily amount that now occurs just once in 20 years) by the later part of this century (2081-2100) compared to the latter part of the last century (1981-2000). Such extreme events are projected to occur more frequently everywhere in the United States. Under a rapid emissions reduction scenario (RCP 2.6), these events would occur nearly twice as often. For a scenario assuming continued increases in emissions (RCP 8.5), these events would occur up to five times as often. (Figure source: NOAA NCDC / CICS-NC).

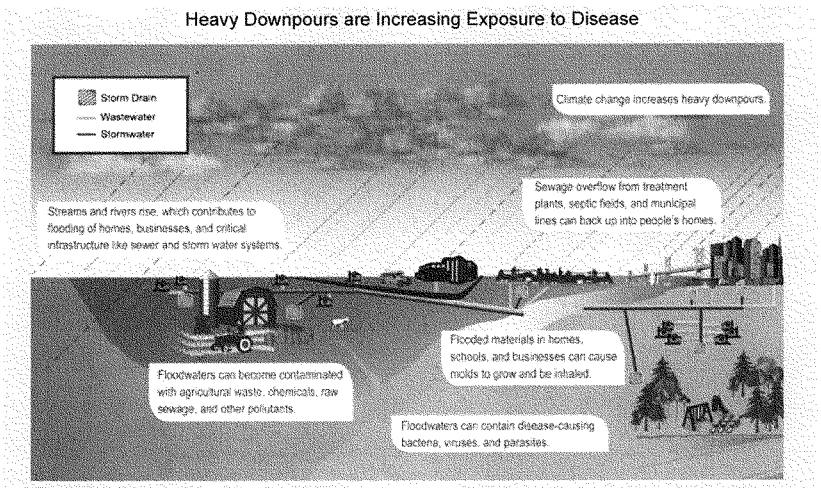


Figure 9.7. Heavy downpours, which are increasing in the United States, have contributed to increases in heavy flood events (Ch. 2: Our Changing Climate, Key Message 6). The figure above illustrates how people can become exposed to waterborne diseases. Human exposures to waterborne diseases can occur via drinking water, as well as recreational waters.[100,101,102,103] (Figure source: NOAA NCDC / CICS-NC).

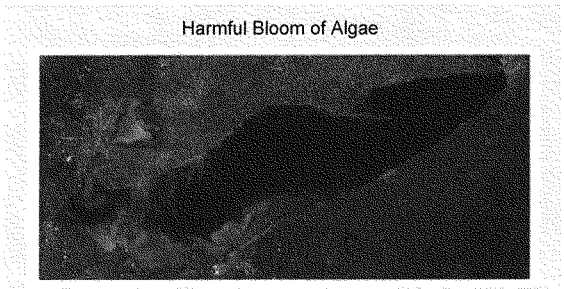


Figure 9.8. Remote sensing color image of harmful algal bloom in Lake Erie on October 9, 2011. The bright green areas have high concentrations of algae, which can be harmful to human health. The frequency and range of harmful blooms of algae are increasing.[102,103] Because algal blooms are closely related to climate factors, projected changes in climate could affect algal blooms and lead to increases in water- and food-borne exposures and subsequent cases of illness.[103] Other factors related to increases in harmful algal blooms include shifts in ocean conditions such as excess nutrient inputs.[101,102,103] (Figure source: NASA Earth Observatory[104]).

Food Security

Globally, climate change is expected to threaten food production and certain aspects of food quality, as well as food prices and distribution systems. Many crop yields are predicted to decline due to the combined effects of changes in rainfall, severe weather events, and increasing competition from weeds and pests on crop plants (Ch. 6: Agriculture, Key Message 6).[105,106] Livestock and fish production is also projected to decline.[107] Prices are expected to rise in response to declining food production and associated trends such as increasingly expensive petroleum (used for agricultural inputs such as pesticides and fertilizers).[108]

While the U.S. will be less affected than some other countries,[109,110] the nation will not be immune. Health can be affected in several ways. First, Americans with particular dietary patterns, such as Alaska Natives, will confront shortages of key foods (Ch. 12: Indigenous Peoples, Key Message 1).[111] Second, food insecurity increases with rising food prices.[112] In such situations, people cope by turning to nutrient-poor but calorie-rich foods, and/or they endure hunger, with consequences ranging from micronutrient malnutrition to obesity.[113] Third, the nutritional value of some foods is projected to decline. Elevated atmospheric CO_2 is associated with decreased plant nitrogen concentration, and therefore decreased protein, in many crops, such as barley, sorghum, and soy.[114] The nutrient content of crops is also projected to decline if soil nitrogen levels are suboptimal, with reduced levels of nutrients such as calcium, iron, zinc, vitamins, and sugars, although this effect is alleviated if sufficient nitrogen is supplied.[115] Fourth, farmers are expected to need to use more herbicides and pesticides because of increased growth of pests[116] and weeds[117] as well as decreased effectiveness[118] and duration[119] of some of these chemicals (Ch. 6: Agriculture). Farmers, farmworkers, and consumers will thus sustain increased exposure to these substances and their residues, which can be toxic. These climate change impacts on the nutritional value of food exist within a larger context in which other factors, such as agricultural practices, food distribution systems, and consumer food choices, also play key roles. Adaptation activities can reduce the health-related impacts of some of the anticipated food security challenges (Ch. 6: Agriculture).

Mental Health and Stress-related Disorders

Mental illness is one of the major causes of suffering in the United States, and extreme weather events can affect mental health in several ways.[120,121,122,123] First, following disasters, mental health problems increase, both among people with no history of mental illness, and those at risk – a phenomenon known as "common reactions to abnormal events." These reactions may be short-lived or, in some cases, long-lasting.[124] For example, research demonstrated high levels of anxiety and post-traumatic stress disorder among people affected by Hurricane Katrina,[125] and similar observations have followed floods[126] and heat waves.[127] Some evidence suggests wildfires have similar effects.[128] All of these events are increasingly fueled by climate change (see Ch. 2: Our Changing Climate). Other health consequences of intensely stressful exposures are also a concern, such as adverse birth outcomes including pre-term birth, low birth weight, and maternal complications.[129] Second, some patients with mental illness are especially susceptible to heat.[130] Suicide rates vary with weather,[131] rising with high temperatures,[132] suggesting potential climate change impacts on depression and other mental illnesses. Dementia is a risk factor for hospitalization and death during heat waves.[127,133] Patients with severe mental illness such as schizophrenia are at risk during hot weather because their medications may interfere with temperature regulation or even directly cause hyperthermia.[134] Additional potential mental health impacts, less well understood, include the possible distress associated with environmental degradation[135] and displacement,[136] and the anxiety and despair that knowledge of climate change might elicit in some people (Ch. 12: Indigenous Peoples, Key Message 5).[122]

Key Message 2: Most Vulnerable at Most Risk

Climate change will, absent other changes, amplify some of the existing health threats the nation now faces. Certain people and communities are especially vulnerable, including children, the elderly, the sick, the poor, and some communities of color.

Climate change will increase the risk of climate-related illness and death for a number of vulnerable groups in the United States, as when Hurricane Katrina devastated New Orleans in 2005. Children, primarily because of physiological and developmental factors, will disproportionately suffer from the effects of heat waves,[47] air pollution, infectious illness, and trauma resulting from extreme weather events.[14,16,18,22,138,139,140,141] The country's older population also could be harmed more as the climate changes. Older people are at much higher risk of dying during extreme heat events.[45,47,139,142] Pre-existing health conditions also make older adults susceptible to cardiac and respiratory impacts of air pollution[26] and to more severe consequences from infectious diseases;[143] limited mobility among older adults can also increase flood-related health risks.[144] Lim-

ited resources and an already high burden of chronic health conditions, including heart disease, obesity, and diabetes, will place the poor at higher risk of health impacts from climate change than higher income groups.[26,47] Potential increases in food cost and limited availability of some foods will exacerbate current dietary inequalities and have significant health ramifications for the poorer segments of our population (Ch. 12: Indigenous Peoples, Key Message 1).[110,145]

Climate change will disproportionately affect low-income communities and some communities of color (Ch. 12: Indigenous Peoples, Key Message 2),[139,149,151,152,153,154,155,156,157] raising environmental justice concerns. Existing health disparities[153,158,159] and other inequities[160,161] increase vulnerability. Climate change related issues that have an equity component include heat waves, air quality, and extreme weather and climate events. For example, Hurricane Katrina demonstrated how vulnerable certain groups of people were to extreme weather events, because many low-income and of-color New Orleans residents were killed, injured, or had difficulty evacuating and recovering from the storm.[154,155,156,161,162,163,164]

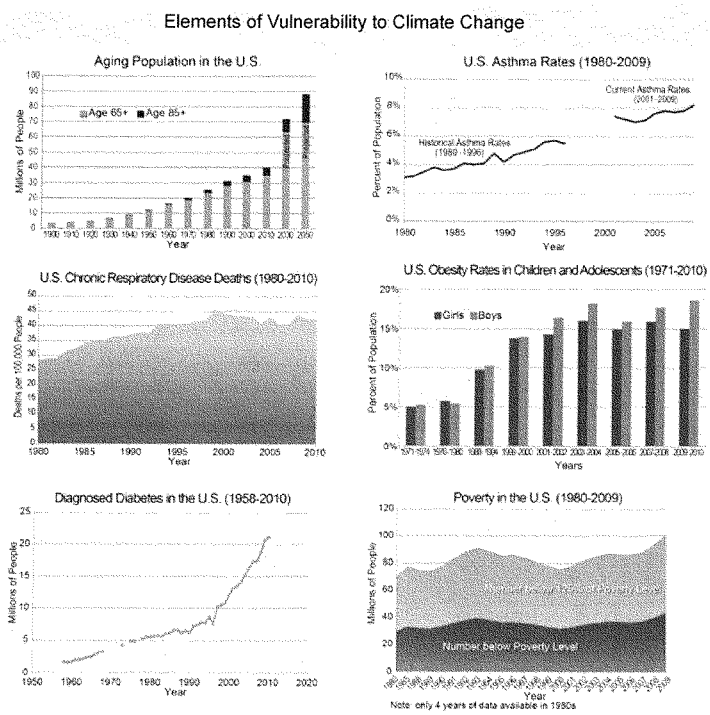


Figure 9.9. A variety of factors can increase the vulnerability of a specific demographic group to health effects due to climate change. For example, older adults are more vulnerable to heat stress because their bodies are less able to regulate their temperature. Overall population growth is projected to continue to at least 2050, with older adults comprising an increasing proportion of the population. Similarly, there are an increasing number of people who are obese and have diabetes, heart disease, or asthma, which makes them more vulnerable to a range of climate-related health impacts. Their numbers are also rising. The poor are less able to afford the kinds of measures that can protect them from and treat them for various health impacts. (Data from CDC; Health E-Stat; U.S. Census Bureau 2010, 2012; and Akinbami et al. 2011[137]).

Societal system failures during extreme events

We have already seen multiple system failures during an extreme weather event in the United States, as when Hurricane Katrina struck New Orleans.[146] Infrastructure and evacuation failures and collapse of critical response services during a storm is one example of multiple system failures. Another example is a loss of electrical power during a heat wave or wildfires, which can reduce food and water safety.[147] Air conditioning has helped reduce illness and death due to extreme heat,[148] but if power is lost, everyone is vulnerable. By their nature, such events can exceed our capacity to respond.[79] In succession, these events severely deplete our resources needed to respond, from the individual to the national scale, but disproportionately affect the most vulnerable populations.[149]

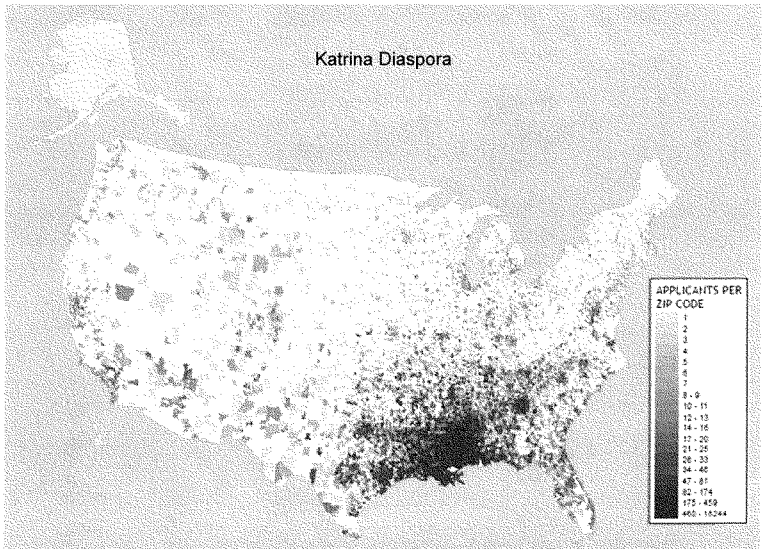


Figure 9.10. This map illustrates the national scope of the dispersion of displaced people from Hurricane Katrina. It shows the location by zip code of the 800,000 displaced Louisiana residents who requested federal emergency assistance. The evacuees ended up dispersed across the entire nation, illustrating the wide-ranging impacts that can flow from extreme weather events, such as those that are projected to increase in frequency and/or intensity as climate continues to change (Ch. 2: Our Changing Climate, Key Message 8). (Figure source: Kent 2006[150]).

Multiple climate stressors and health

Climate change impacts add to the *cumulative* stresses currently faced by vulnerable populations including children, the elderly, the poor, some communities of color, and people with chronic illnesses. These populations, and others living in certain places such as cities, floodplains, and coastlines, are more vulnerable not only to extreme events but also to ongoing, persistent climate-related threats. These threats include poor air quality, heat, drought, flooding, and mental health stress. Over time, the accumulation of these stresses will be increasingly harmful to these populations.

Key Message 3: Prevention Provides Protection

Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As threats increase, our ability to adapt to future changes may be limited.

Prevention is a central tenet of public health. Many conditions that are difficult and costly to treat when a patient gets to the doctor could be prevented before they occur at a fraction of the cost. Similarly, many of the larger health impacts associated with climate change can be prevented through early action at significantly lower cost than dealing with them after they occur.[153,165] Early preventive interventions, such as early warnings for extreme weather, can be particularly cost-effective.[166,167,168] As with many illnesses,[169] once impacts are apparent, even the best adaptive efforts can be overwhelmed, and damage control becomes the priority.[62]

Activities that reduce carbon pollution often also provide co-benefits in the form of preventive health measures. For example, reliance on cleaner energy sources for electricity production[174] and more efficient and active transport, like biking or walking,[175] can have immediate public health benefits, through improved air quality and lowered rates of obesity, diabetes, and heart disease.[176] Reducing carbon pollution also reduces long-term adverse climate-health impacts, thus producing cost savings in the near and longer term.[176] Preventing exposures to other climate-sensitive impacts already apparent can similarly result in cost savings. For instance, heat wave early warning systems protect vulnerable groups very effectively and are much less expensive than treating and coping with heat illnesses. Systems that monitor for early outbreaks of disease are also typically much less expensive than treating communities once outbreaks take hold.[12,49,177]

Effective communication is a fundamental part of prevention. The public must understand risk in order to endorse proactive risk management. The public is familiar with the health risks of smoking, but not so for climate change. When asked about climate change impacts, Americans do not mention health impacts,[178] and when asked about health impacts specifically, most believe it will affect people in a different time or place.[179] But diverse groups of Americans find information on health impacts to be helpful once received, particularly information about the health benefits of mitigation (reducing carbon emissions) and adaptation.[180]

Determining which types of prevention to invest in (such as monitoring, early warning systems, and land-use changes that reduce the impact of heat and floods) depends on several factors, including health problems common to that particular area, vulnerable populations, the preventive health systems already in place, and the expected impacts of climate change.[181] Local capacity to adapt is very important; unfortunately the most vulnerable populations also frequently have limited resources for managing climate-health risks.

Overall, the capacity of the American public health and health care delivery systems faces many challenges.[182] The cost of dealing with current health problems is diverting resources from preventing them in the first place. This makes the U.S. population more vulnerable.[183,184] Without careful consideration of how to prevent future impacts, similar patterns could emerge regarding the health impacts from climate change. However, efforts to quantify and map vulnerability factors at the community level are underway.[151,164,185]

There are public health programs in some locations that address climate-sensitive health issues, and integrating such programs into the mainstream public health toolkit as adaptation needs increase would improve public health resilience to climate change.[79,186,187] Given that these programs have demonstrated efficacy against current threats that are expected to worsen with climate change, it is prudent to invest in creating

Large-scale environmental change favors disease emergence

Climate change is causing large-scale changes in the environment, increasing the likelihood of the emergence or reemergence of unfamiliar disease threats.[170] Factors include shifting ranges of disease-carrying pests, lack of immunity and preparedness, inadequate disease monitoring, and increasing global travel. Diseases including Lyme disease and dengue fever pose increasing health threats to the U.S. population; the number of U.S. patients hospitalized with dengue fever more than tripled from 2000 to 2007.[171] Although most cases of dengue fever during that time period were acquired outside the contiguous United States, the introduction of infected people into areas where the dengue virus vector is established increases the risk of locally acquired cases. The public health system is not fully prepared to monitor or respond to these growing disease risks. The introduction of new diseases into non-immune populations has been and continues to be a major challenge in public health. There are concerns that climate change may provide opportunities for pathogens to expand or shift their geographic ranges.[172,173]

the strongest climate-health preparedness programs possible.[153] One survey highlighted opportunities to address climate change preparedness activities and climate-health research[181] before needs become more widespread. *America's Climate Choices: Adapting to the Impacts of Climate Choices* (Table 3.5) provides examples of health adaptation options.[187]

Key Message 4: Responses Have Multiple Benefits

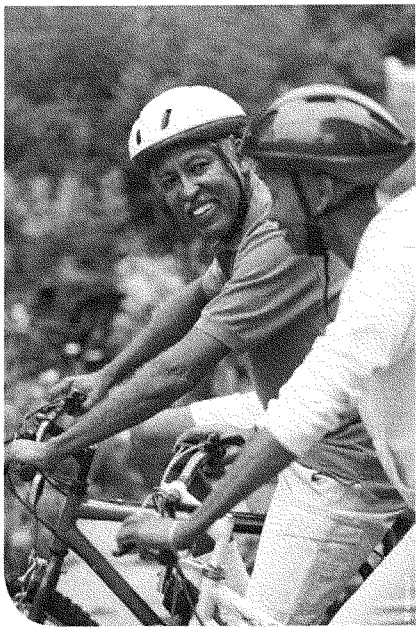
Responding to climate change provides opportunities to improve human health and well-being across many sectors, including energy, agriculture, and transportation. Many of these strategies offer a variety of benefits, protecting people while combating climate change and providing other societal benefits.

Policies and other strategies intended to reduce carbon pollution and mitigate climate change can often have independent influences on human health. For example, reducing CO_2 emissions through renewable electrical power generation can reduce air pollutants like particles and sulfur dioxide. Efforts to improve the resiliency of communities and human infrastructure to climate change impacts can also improve human health. There is a growing recognition that the magnitude of health "co-benefits," like reducing both pollution and cardiovascular disease, could be significant, both from a public health and an economic standpoint.[176,188,189] Some climate change resilience efforts will benefit health, but potential co-harms should be considered when implementing these strategies. For example, although there are numerous benefits to urban greening, such as reducing the urban heat island effect while simultaneously promoting an active healthy lifestyle,[159,190,191] the urban planting of certain allergenic pollen producing species[22] could increase human pollen exposure and allergic illness. Increased pollen exposure has been linked to increased emergency department visits related to asthma and wheezing[192] in addition to respiratory allergic illnesses such as allergic rhinitis or hay fever.[193] The selective use of low to moderate pollen-producing species can decrease pollen exposure.[194]

Much of the focus of health co-benefits has been on reducing health-harming air pollution.[6,174,175,195,196] One study projects that replacing 50% of short motor vehicle trips with bicycle use and the other 50% with other forms of transportation like walking or public transit would avoid nearly 1,300 deaths in 11 midwestern metropolitan areas and create up to $8 billion in health benefits annually for the upper Midwest region.[188] Such multiple-benefit actions can reduce heat-trapping gas emissions that lead to climate change, improve air quality by reducing vehicle pollutant emissions, and improve fitness and health through increased physical activity.[99,197,198,199,200]

Innovative urban design could create increased access to active transport.[99] The compact geographical area found in cities presents opportunities to reduce energy use and emissions of heat-trapping gases and other air pollutants through active transit, improved building construction, provision of services, and infrastructure creation, such as bike paths and sidewalks.[197,201] Urban planning strategies designed to reduce the urban heat island effect, such as green/cool roofs, increased green space, parkland and urban canopy, could reduce indoor temperatures, improve indoor air quality, and could produce additional societal co-benefits by promoting social interaction and prioritizing vulnerable urban populations.[191,197]

Patterns of change related to improving health can also have co-benefits in terms of reducing carbon pollution and mitigating climate change. Current U.S. dietary guidelines and many health professionals have recommended diets higher in fruits and vegetables and lower in red meat as a means of helping



to reduce the risk of cardiovascular disease and some cancers.[199,202,203] These changes in food consumption, and related changes to food production, could have co-benefits in terms of reducing greenhouse gas emissions. While the greenhouse gas footprint of the production of other foods, compared to sources such as livestock, is highly dependent on a number of factors, production of livestock currently accounts for about 30% of the U.S. total emissions of methane.[199,203,204] This amount of methane can be reduced somewhat by recovery methods such as the use of biogas digesters, but future changes in dietary practices, including those motivated by considerations other than climate change mitigation, could also have an effect on the amount of methane emitted to the atmosphere.[205]

In addition to producing health co-benefits,[206] climate change prevention and preparedness measures could also yield positive equity impacts. For example, several studies have found that communities of color and poor communities experience disproportionately high exposures to air pollution.[207,208] Climate change mitigation policies that improve local air quality thus have the potential to strongly benefit health in these communities.

An area where adaptation policy could produce more equitable health outcomes is with respect to extreme weather events. As discussed earlier, Hurricane Katrina demonstrated that communities of color, poor communities, and certain other vulnerable populations (like new immigrant communities) are at a higher risk to the adverse effects of extreme weather events.[152,155] These vulnerable populations could benefit from urban planning policies that ensure that new buildings, including homes, are constructed to resist extreme weather events.[197]

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Introduction to chapter; tourists walking close to misters keeping cool during heat wave in Las Vegas, Nevada, as shown in top banner: ©Julie Jacobson/AP/Corbis

SUPPLEMENTAL MATERIAL
TRACEABLE ACCOUNTS

Process for Developing Key Messages

The key messages were developed during technical discussions and expert deliberation at a two-day meeting of the eight chapter Lead Authors, plus Susan Hassol and Daniel Glick, held in Boulder, Colorado May 8-9, 2012; through multiple technical discussions via six teleconferences from January through June 2012, and an author team call to finalize the Traceable Account draft language on Oct 12, 2012; and through other various communications on points of detail and issues of expert judgment in the interim. The author team also engaged in targeted consultations during multiple exchanges with Contributing Authors, who provided additional expertise on subsets of the key message. These discussions were held after a review of the technical inputs and associated literature pertaining to human health, including a literature review,[209] workshop reports for the Northwest and Southeast United States, and additional technical inputs on a variety of topics.

Key message #1 Traceable Account

Climate change threatens human health and well-being in many ways, including impacts from increased extreme weather events, wildfire, decreased air quality, threats to mental health, and illnesses transmitted by food, water, and diseases-carriers such as mosquitoes and ticks. Some of these health impacts are already underway in the United States.

Description of evidence base

The key message and supporting text summarizes extensive evidence documented in several foundational technical inputs prepared for this chapter, including a literature review[209] and workshop reports for the Northwest and Southeast United States. Nearly 60 additional technical inputs related to human health were received and reviewed as part of the Federal Register Notice solicitation for public input.

Air Pollution:

The effects of decreased ozone air quality on human health have been well documented concerning projected increases in ozone,[6,7,9,11,39] even with uncertainties in projections owing to the complex formation chemistry of ozone and climate change, precursor chemical inventories, wildfire emission, stagnation episodes, methane emissions, regulatory controls, and population characteristics.[4] Ozone exposure leads to a number of health impacts.[1,2]

Allergens:

The effects of increased temperatures and atmospheric CO_2 concentration have been documented concerning shifts in flowering time and pollen initiation from allergenic plants, elevated production of plant-based allergens, and health effects of increased pollen concentrations and longer pollen seasons.[15,16,17,18,20,22,23,24,26,106] Additional studies have shown extreme rainfall and higher temperatures can lead to increased indoor air quality issues such as fungi and mold health concerns.[27]

Wildfire:

The effects of wildfire on human health have been well documented with increase in wildfire frequency[17,29,39,40] leading to decreased air quality[31,32,33] and negative health impacts.[32,34,36]

Temperature Extremes:

The effects of temperature extremes on human health have been well documented for increased heat waves,[51,52,54] which cause more deaths,[47,48] hospital admissions[50] and population vulnerability.[56,57]

Precipitation Extremes - Heavy Rainfall, Flooding, and Droughts:

The effects of weather extremes on human health have been well documented, particularly for increased heavy precipitation, which has contributed to increases in severe flooding events in certain regions. Floods are the second deadliest of all weather-related hazards in the United States.[63,64] Elevated waterborne disease outbreaks have been reported in the weeks following heavy rainfall,[65] although other variables may affect these associations.[66] Populations living in damp indoor environments experience increased prevalence of asthma and other upper respiratory tract symptoms.[67]

Disease Carried by Vectors:

Climate is one of the factors that influence the range of disease vectors; [73,74,76] a shift in the current range may increase interactions with people and affect human health.[71] North Americans are currently at risk from a number of vector-borne diseases.[75,82,83,85,86,87] There are some ambiguities on the relative

role and contribution of climate change among the range of factors that affect disease transmission dynamics.[71,72,73,74,75,76] However, observational studies are already underway and confidence is high based on scientific literature that climate change has contributed to the expanded range of certain disease vectors, including *Ixodes* ticks which are vectors for Lyme disease in the United States.[78,84,89]

Food- and Waterborne Diarrheal Disease:
There has been extensive research concerning the effects of climate change on water- and food-borne disease transmission.[92,93,95,96,97] The current evidence base strongly supports waterborne diarrheal disease being both seasonal and sensitive to climate variability. There are also multiple studies associating extreme precipitation events with waterborne disease outbreaks.[65] This evidence of responsiveness of waterborne disease to weather and climate, combined with evidence strongly suggesting that temperatures will increase and extreme precipitation events will increase in frequency and severity (Ch. 2: Our Changing Climate), provides a strong argument for climate change impacts on waterborne disease by analogy. There are multiple studies associating extreme precipitation events with waterborne disease outbreaks and strong climatological evidence for increasing frequency and intensity of extreme precipitation events in the future. The scientific literature modeling the projected impacts of climate change on waterborne disease is somewhat limited, however. Combined, we therefore have overall medium confidence in the impact of climate change on waterborne and food-borne disease.

Harmful Algal Blooms:
Because algal blooms are closely related to climate factors, projected changes in climate could affect algal blooms and lead to increases in food- and waterborne exposures and subsequent cases of illness.[96,97,98,99,103] Harmful algal blooms have multiple exposure routes.[100]

Food Security:
Climate change is expected to have global impacts on both food production and certain aspects of food quality. The impact of temperature extremes, changes in precipitation and elevated atmospheric CO_2, and increasing competition from weeds and pests on crop plants are areas of active research (Ch. 6: Agriculture, Key Message 6).[105,106] The U.S. as a whole will be less affected than some other countries. However, the most vulnerable, including those dependent on subsistence lifestyles, especially Alaska Natives and low-income populations, will confront shortages of key foods.

Mental Health and Stress-Related Disorders:
The effects of extreme weather on mental health have been extensively studied.[120,122,123] Studies have shown the impacts of mental health problems after disasters,[124] with extreme events like Hurricane Katrina,[125] floods,[126] heat waves,[127] and wildfires[128] having led to mental health problems. Further work has shown that some people with mental illnesses are especially vulnerable to heat. Suicide rates vary with weather,[131,132] dementia is a risk factor for hospitalization and death during heat waves,[127,133] and medications for schizophrenia may interfere with temperature regulation or even directly cause hyperthermia.[134] Additional potential mental health impacts include distress associated with environmental degradation, displacement, and the knowledge of climate change.[122,123,136]

New information and remaining uncertainties
Important new evidence on heat-health effects[44,45] confirmed many of the findings from a prior literature review. Uncertainties in the magnitude of projections of future climate-related morbidity and mortality can result from differences in climate model projections of the frequency and intensity of extreme weather events such as heat waves and other climate parameters such as precipitation.

Efforts to improve the information base should address the coordinated monitoring of climate and improved surveillance of health effects.

Assessment of confidence based on evidence
Overall: **Very High** confidence. There is considerable consensus and a high quality of evidence in the published peer-reviewed literature that a wide range of health effects will be exacerbated by climate change in the United States. There is less agreement on the magnitude of these effects because of the exposures in question and the multi-factorial nature of climate-health vulnerability, with regional and local differences in underlying health susceptibilities and adaptive capacity. Other uncertainties include how much effort and resources will be put into improving the adap-

Confidence Level

Very High
Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus

High
Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus

Medium
Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought

Low
Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts

tive capacity of public health systems to prepare in advance for the health effects of climate change, prevent harm to individual and community health, and limit associated health burdens and societal costs.

Increased Ozone Exposure: **Very High** confidence.
Allergens: **High** confidence.
Wildfires: **Very High** confidence.
Thermal Extremes: **Very High** confidence.
Extreme Weather Events: **Very High** confidence.
Vector-borne Infectious Diseases: **High** or **Very High** confidence for shift in range of disease-carrying vectors. **Medium** confidence for whether human disease transmission will follow.
Food- and Waterborne disease: **Medium** confidence.
Harmful Algal Blooms: **Medium** confidence.
Food Security: **Medium** confidence for food quality; **High** confidence for food security.

Threats to Mental Health: **Very High** confidence for post-disaster impacts; **Medium** confidence for climate-induced stress.

Key message #2 Traceable Account

Climate change will, absent other changes, amplify some of the existing health threats the nation now faces. Certain people and communities are especially vulnerable, including children, the elderly, the sick, the poor, and some communities of color.

Description of evidence base

The key message and supporting text summarizes extensive evidence documented in several foundational technical inputs prepared for this chapter, including a literature review[209] and workshop reports for the Northwest and Southeast regions.[210] Nearly 60 additional technical inputs related to human health were received and reviewed as part of the Federal Register Notice solicitation for public input.

Current epidemiological evidence on climate-sensitive health outcomes in the U.S. indicates that health impacts will differ substantially by location, pathway of exposure, underlying susceptibility, and adaptive capacity. These disparities in health impacts will largely result from differences in the distribution of individual attributes in a population that confers vulnerability (age, socioeconomic status, and race), attributes of place that reduce or amplify exposure (floodplain, coastal zone, and urban heat island), and the resilience of critical public health infrastructure.

Amplification of existing health threats: The effects of extreme heat and heat waves, projected worsening air pollution and asthma, extreme rainfall and flooding, and displacement and injuries associated with extreme weather events, fueled by climate change, are already substantial public health issues. Trends projected under a changing climate are projected to exacerbate these health effects in the future.[62]

Children: The effects of climate change increase vulnerability of children to extreme heat, and increased health damage (morbidity, mortality) resulting from heat waves has been well documented.[16,22,51,53,140] Extreme heat also causes more pediatric deaths,[47,48] and more emergency room visits and hospital admissions.[49,50] Adverse effects from increased heavy precipitation can lead to more pediatric deaths, waterborne diseases,[86] and illness.[141]

The elderly: Heat stress is especially damaging to the health of older people,[45,49,60,133,142,209] as are climate-sensitive increases in air pollution.

The sick: People and communities lacking the resources to adapt or to enhance mobility and escape health-sensitive situations are at relatively high risk.[164]

The poor: People and communities lacking the resources to adapt or to move and escape health-sensitive situations are at relatively high risk.[164]

Some communities of color: There are racial disparities in climate-sensitive exposures to extreme heat in urban areas, and in access to means of adaptation – for example air conditioning use.[149,151,157,211] There are also racial disparities in withstanding, and recovering from, extreme weather events.[155,162]

Climate change will disproportionately impact low-income communities and some communities of color, raising environmental justice concerns.[139,149,151,154,155,157,161,164] Existing health disparities[153,158,159] and other inequities[161] increase vulnerability. For example, Hurricane Katrina demonstrated how vulnerable these populations were to extreme weather events because many low-income and of-color New Orleans residents were killed, injured, or had difficulty evacuating and recovering from the storm.[155,162] Other climate change related issues that have an equity component include heat waves and air quality.[139,149,154,164]

New information and remaining uncertainties

Important new evidence[45] confirmed findings from a prior literature review.[139]

The potential for specific climate-vulnerable communities to experience highly harmful health effects is not entirely clear in specific regions and on specific time frames due to uncertainties in rates of adaptation and uncertainties about the outcome of public health interventions currently being implemented that aim to address underlying health disparities and determinants of health.[206] The public health community has not routinely conducted evaluations of the overall success of adaptation interventions or of particular elements of those interventions.

Assessment of confidence based on evidence
Given the evidence base and remaining uncertainties, confidence that climate change will amplify existing health threats: **Very High**.
Among those especially vulnerable are:
Children: **Very High**.
The elderly: **Very High**.
The sick: **Very High**.
The poor: **Very High**.
Some communities of color: **High**.

Key message #3 Traceable Account

Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As threats increase, our ability to adapt to future changes may be limited.

Description of evidence base
The key message and supporting text summarizes extensive evidence documented in several foundational technical inputs prepared for this chapter, including a literature review[209] and workshop reports for the Northwest and Southeast United States. Nearly 60 additional technical inputs related to human health were received and reviewed as part of the Federal Register Notice solicitation for public input.

A number of studies have demonstrated that prevention activities that reduce carbon pollution, like using alternative energy sources[174] and using active transportation like biking or walking,[188] can lead to significant public health benefits, which can save costs in the near and long term.[176] Health impacts associated with climate change can be prevented through early action at significantly lower cost than dealing with them after they occur. For example, heat wave early warning systems are much less expensive than treating heat-related illnesses.[165] Existing adaptation programs have improved public health resilience.[9,153] One survey highlighted opportunities to address climate change preparedness activities and climate-health research[181] before needs become more widespread.

Considering U.S. public health in general, the cost-effectiveness of many prevention activities is well established.[183] Some preventive actions are cost-saving, while others are deemed cost-effective based on a pre-determined threshold. Early preventive interventions, such as early warnings for extreme weather, can be particularly cost-effective.[166] However, there is less information on the cost-effectiveness of specific prevention interventions relevant to climate sensitive health threats (for example, heat early warning systems). Overall, we have high confidence that public health actions can do much to protect people from some of the impacts of climate change, and that early action provides the largest health benefits.

The inverse relationship between the magnitude of an impact and a community's ability to adapt is well established and understood. Two extreme events, Hurricane Katrina and the European heat wave of 2003, illustrate this relationship well.[187] Extreme events interact with social vulnerability to produce extreme impacts, and the increasing frequency of extreme events associated with climate change is prompting concern for impacts that may overwhelm adaptive capacity.[62,173] This is equally true of the public health sector, specifically, leading to very high confidence that as threats increase, our ability to adapt to future changes may be limited.

New information and remaining uncertainties
A key issue (uncertainty) is the extent to which the nation, states, communities and individuals will be able to adapt to climate change because this depends on the levels of local exposure to climate-health threats, underlying susceptibilities, and the capacities to adapt that are available at each scale. Overall, the capacity of the American public health and health care delivery systems faces many challenges.[182] The cost of dealing with current health problems is diverting resources from preventing them in the first place. This makes the U.S. population more vulnerable.[56,183]

Steps for improving the information base on adaptation include undertaking a more comprehensive evaluation of existing climate-health preparedness programs and their effectiveness in various jurisdictions (cities, counties, states, nationally).

Assessment of confidence based on evidence
Overall, given the evidence base and remaining uncertainties: **High**.
High: Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Prevention provides the most protection; but we do not as yet have a lot of post-implementation information with which to evaluate preparedness plans.
High: Early action provides the largest health benefits. There is evidence that heat-health early warning systems have saved lives and money in U.S. cities like Philadelphia, PA.[165]
Very High: Our ability to adapt to future changes may be limited.

Key message #4 Traceable Account

Responding to climate change provides opportunities to improve human health and well-being across many sectors, including energy, agriculture, and transportation. Many of these strategies offer a variety of benefits, protecting people while combating climate change and providing other societal benefits.

Description of evidence base
The key message and supporting text summarizes extensive evidence documented in several foundational technical inputs prepared for this chapter, including a literature review[209] and work-

shop reports for the Northwest and Southeast U.S. regions.[210] Nearly 60 additional technical inputs related to human health were received and reviewed as part of the Federal Register Notice solicitation for public input.

A number of studies have explored the opportunities available to improve health and well-being as a result of adapting to climate change,[176] with many recent publications illustrating the benefit of reduced air pollution.[6,174,175,195] Additionally, some studies have looked at the co-benefits to climate change and health of applying innovative urban design practices which reduce energy consumption and pollution while increasing public health,[99,188,197,198] decrease vulnerability of communities to extreme events[152,197] and reduce the disparity between different societal groups.[206,207,212]

New information and remaining uncertainties

More studies are needed to fully evaluate both the intended and unintended health consequences of efforts to improve the resiliency of communities and human infrastructure to climate change impacts. There is a growing recognition that the magnitude of these health co-benefits or co-harms could be significant, both from a public health and an economic standpoint.[176,188,189]

Assessment of confidence based on evidence

Given the evidence base and remaining uncertainties, confidence is **Very High.**

Senator BOXER. Last, I would ask unanimous consent that I put in a document that shows that Professor Laurence Tribe was hired by Peabody Coal, the world's largest privately held coal company, to write an opinion that criticized the coal rule.

Senator INHOFE. Without objection.

[The referenced information follows:]

One Of Nation's Most Respected Constitutional Scholars Sells Out To Nation's Largest Coal Company

BY **RYAN KORONOWSKI** POSTED ON DECEMBER 8, 2014 AT 3:23 PM UPDATED: DECEMBER 8, 2014 AT 6:27 PM

Harvard Professor Laurence Tribe

CREDIT: AP PHOTO/KAMENKO PAJIC, FILE

Last week, Harvard law professor Laurence Tribe sent out a broadside he wrote with the world's largest privately-held coal company attacking the Environmental Protection Agency's proposed rule to regulate carbon pollution from existing power plants under

the Clean Air Act. The document submitted by Tribe and coal behemoth Peabody Energy calls the proposed rule a "remarkable example of federal overreach," that "lacks legal basis," to regulate carbon, resting on a "fatally flawed interpretation of Section 111" of the Clean Air Act.

Because this rule is a significant component of President Obama's plan to tackle climate change, and because Obama was Tribe's principal research assistant at Harvard Law School, the document unsurprisingly received some attention. The Wall Street Journal editorial board put it thusly, "Professor Tribe Takes Obama to School."

The press release notes that Tribe "was retained by Peabody Energy to provide an independent analysis of the proposed EPA rule as a scholar of constitutional law," and includes the disclaimer that Tribe's views are his own, and not representative of Harvard University or Harvard Law School. The amount of his retainer has not been made public by Tribe nor Peabody Energy.

Before making several constitutional arguments, the document first presents a defense of the coal industry's role in governmental history, alleging that a rule regulating carbon "repudiates a policy of prudent coal use shared by Democratic and Republican Administrations for decades."

Georgetown law professor Lisa Heinzerling, an expert who specializes in environmental and natural resources law, administrative law, and the economics of regulation told ThinkProgress that this is unusual. "More substantively I think it was honestly a patently political document."

"It starts off with a kind of paean to coal, and to coal's place in our history and our politics," she said. "It's just not clear where that first section about the history of our political relationship with coal belongs, legally speaking. It's a kind of hint that you shouldn't change anything — that's the way it's always been, it's upset some powerful interests, and therefore you shouldn't change it. It's just a document that's meant to say that these interests have always held sway, and they should continue to do that."

There are two references to Hillary Clinton making the argument that coal "is not going to go away" in the document, which Heinzerling says is "funny, because there's no particular obvious purpose to that legally speaking."

Though Heinzerling is back teaching at Georgetown, in 2009 she joined the EPA to help craft the Supreme Court-mandated carbon regulations. The Court has already decided the EPA has the authority to regulate carbon dioxide emissions — and is required to do

so — under existing law. Even when Tribe and Peabody's arguments shifted to constitution questions, Heinzerling says, they fail to make serious arguments.

"Each of the constitutional arguments are not made in a way that seems seriously pitched to legal actors. They seem much more like a kind of political declaration for an argument pitched to politicians."

Tribe and Peabody Energy do not raise any new points that are relevant from a legal perspective in this document. The strongest argument against the proposed rule is a statutory question about when Section 111 applies to pollution sources that emit different kinds of pollutants. "They talked about that," Heinzerling said, "but it didn't strike me as breaking new ground, but it was in line with a number of comments on that issue."

The document accuses EPA of "fabricating an impermissibly broad delegation of authority and then acting on it — in effect, asserting the power to 'make law.'" He has used this argument before.

"Professor Tribe has represented General Electric in a case before the Supreme Court," Heinzerling said, referring to Professor Tribe's amicus brief he wrote while representing General Electric in *Whitman v. American Trucking Associations*. "In that case the argument was made that the Clean Air Act violated what's called the non-delegation doctrine — the idea that Congress cannot give its authority to the executive branch — because it gave too much discretion."

"Well, he lost. 9-0. Justice Scalia wrote for the Court, and upheld the Clean Air Act against the constitutional challenge."

Where will the courts likely focus after the dust settles?

"If you clear away all the hyperbolic constitutional arguments, there is, at the heart, a statutory question about this part of the Clean Air Act — and whether it applies when the sources in question have been regulated under another provision in the Clean Air Act," Heinzerling continued. "That is a meaningful statutory question. There's disagreements among the parties what the statute does. Agencies get a lot of deference when things are unclear in statutes."

"That's a serious point: it's a standard statutory question, and I think that question can be and should be resolved without all this other constitutional noise. When you really peel away the stuff that doesn't seem to me to be a serious argument, that argument is the

one that remains."

Greg Boyce, Peabody's CEO, told the Financial Times that with a GOP Congress, and plenty of opportunities for judicial delay through industry lawsuits, implementing the rule "was never going to happen in the near-term."

The rule requires states, through extremely flexible, yet tailored plans, to drop carbon emissions the equivalent of 30 percent by 2020. For the most part this can happen through switching from coal to natural gas, though each state can meet its target however it likes. Some in the utility sector, including the Edison Electric Institute and Ohio-based FirstEnergy, noted the flexibility in the rule and how easy it would be to cut emissions. Even still, EPA has said it's considering an alternative timeline after serious lobbying from some utilities, which could weaken the overall target.

Republican senators and governors are looking for ways to torpedo the rules, ranging from readying lawsuits to possibly threatening a government shutdown. Rep. Mike Kelly (R-PA) compared the rules to terrorism, while Bob Murray, CEO of the largest privately-owned mine operator in the U.S., called carbon regulations "evil."

Tribe has been critical of judicial action to address climate change in the past, but has acknowledged the EPA's role in doing so under the Clean Air Act. In 2011, he wrote an op-ed in the Boston Globe criticizing cases wherein victims of climate impacts such as Alaskan villagers and Louisiana coastal residents sued greenhouse gas-emitting fossil fuel companies that emit the greenhouse gases that drive climate change, saying the lawsuits "represent a profoundly dangerous perversion of the judicial process." That case, *American Electric Power v. Connecticut*, resulted in a unanimous decision that agreed with Tribe's position that climate change was not solvable through such judicial tactics. Instead, the Court reaffirmed its decision, in *Mass. v. EPA* the year before that under the Clean Air Act, the EPA must rein in carbon pollution, since it found carbon dioxide endangered public health. Tribe's op-ed seems to acknowledge this, saying that "Congress, through the Clean Air Act and other measures, has empowered the Environmental Protection Agency to regulate greenhouse gases, and that agency has begun to do so, prodded by" *Mass. v. EPA*. The document authored by Tribe and Peabody Energy does not mention EPA's Endangerment Finding, nor public health.

Tribe is making these arguments on behalf of Peabody Energy, the largest private-sector coal company on the planet. With an increasing share of its profits coming from foreign coal mines (2 percent in 2003, 40 percent today), Peabody has still seen its market cap drop so steeply this year that the S&P 500 dropped it from its stock index.

It recently embarked on a PR blitz to reposition coal as a "clean" solution to combatting energy poverty instead of a leading cause of the carbon pollution that drives climate change. The campaign does not mention how the global poor are among the most vulnerable to the impacts of climate change, and cutting emissions saves lives.

Professor Tribe did not respond to a request for comment as of publication time.

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As Brad Johnson notes, Tribe has also done work on behalf of William Koch opposing the Cape Wind project, which would be the first offshore wind farm in the United States. His Harvard Law School page that lists potential conflicts of interest shows him to be serving as counsel for the Alliance to Protect Nantucket Sound. The billionaire Koch brothers' other brother, William Koch, has contributed over $5 million to the Alliance because he is concerned that the turbines would impact the view from his Nantucket estate, though they will be 5.6 miles offshore. According to Gale Courey Toensing, a team of lawyers, including Tribe, filed suit in the First Circuit Court of Appeals in Boston on behalf of the Alliance, alleging the state strong-armed NStar into agreeing to buy power from Cape Wind.

Senator BOXER. Thank you.
Senator INHOFE. Without objection, we are adjourned.
[Whereupon, at 11:04 a.m., the committee was adjourned.]
[Additional material submitted for the record follows.]

The New York Times http://nyti.ms/1jaFVCI

ENVIRONMENT | NYT NOW

Scientists Warn of Rising Oceans From Polar Melt

By JUSTIN GILLIS and KENNETH CHANG MAY 12, 2014

A large section of the mighty West Antarctica ice sheet has begun falling apart and its continued melting now appears to be unstoppable, two groups of scientists reported on Monday. If the findings hold up, they suggest that the melting could destabilize neighboring parts of the ice sheet and a rise in sea level of 10 feet or more may be unavoidable in coming centuries.

Global warming caused by the human-driven release of greenhouse gases has helped to destabilize the ice sheet, though other factors may also be involved, the scientists said.

The rise of the sea is likely to continue to be relatively slow for the rest of the 21st century, the scientists added, but in the more distant future it may accelerate markedly, potentially throwing society into crisis.

"This is really happening," Thomas P. Wagner, who runs NASA's programs on polar ice and helped oversee some of the research, said in an interview. "There's nothing to stop it now. But you are still limited by the physics of how fast the ice can flow."

Two scientific papers released on Monday by the journals Science and Geophysical Research Letters came to similar conclusions by different means. Both groups of scientists found that West Antarctic glaciers had retreated far enough to set off an inherent instability in the ice sheet, one that experts have feared for decades. NASA called a telephone news conference Monday to highlight the urgency of the findings.

The West Antarctic ice sheet sits in a bowl-shaped depression in the earth, with the base of the ice below sea level. Warm ocean water is causing the ice sitting along the rim of the bowl to thin and retreat. As the front edge of the ice pulls away from the rim and enters deeper water, it can retreat much faster than before.

In one of the new papers, a team led by Eric Rignot, a glaciologist at the University of California, Irvine, used satellite and air measurements to document an accelerating retreat over the past several decades of six glaciers draining into the Amundsen Sea region. And with updated mapping of the terrain beneath the ice sheet, the team was able to rule out the presence of any mountains or hills significant enough to slow the retreat.

"Today we present observational evidence that a large sector of the West Antarctic ice sheet has gone into irreversible retreat," Dr. Rignot said in the NASA news conference. "It has passed the point of no return."

Those six glaciers alone could cause the ocean to rise four feet as they disappear, Dr. Rignot said, possibly within a couple of centuries. He added that their disappearance will most likely destabilize other sectors of the ice sheet, so the ultimate rise could be triple that.

A separate team led by Ian Joughin of the University of Washington studied one of the most important glaciers, Thwaites, using sophisticated computer modeling, coupled with recent measurements of the ice flow. That team also found that a slow-motion collapse had become inevitable. Even if the warm water now eating away at the ice were to dissipate, it would be "too little, too late to stabilize the ice sheet," Dr. Joughin said. "There's no stabilization mechanism."

The two teams worked independently, preparing papers that were to be published within days of each other. After it was learned that their results were similar, the teams and their journals agreed to release the findings on the same day.

The new finding appears to be the fulfillment of a prediction made in 1978 by an eminent glaciologist, John H. Mercer of the Ohio State University. He outlined the vulnerable nature of the West Antarctic ice sheet and warned that the rapid human-driven release of greenhouse gases posed "a threat of disaster." He was assailed at the time, but in recent years, scientists have been watching with growing concern as events have unfolded in much the way Dr. Mercer predicted. (He died in 1987.)

Scientists said the ice sheet was not melting because of warmer air temperatures, but rather because relatively warm water that occurs naturally in the depths of the ocean was being pulled to the surface by an intensification, over the past several decades, of the powerful winds that encircle Antarctica.

And while the cause of the stronger winds is somewhat unclear, many researchers consider human-induced global warming to be a significant factor. The winds help to isolate Antarctica and keep it cold at the surface, but as global warming proceeds, that means a sharper temperature difference between the Antarctic and the rest of the globe. That temperature difference provides further energy for the winds, which in turn stir up the ocean waters.

Some scientists believe the ozone hole over Antarctica — caused not by global warming but by an entirely different environmental problem, the human-caused release of ozone-destroying gases — may also be adding energy to the winds. And natural variability may be contributing as well, though scientists do not believe it is the primary factor.

The global sea level has been rising since the 19th century, but Antarctica so far has been only a small factor. The biggest factor to date is that seawater expands as it warms.

But the melting from both Greenland and Antarctica is expected to be

far more important in the future. A United Nations scientific committee, the Intergovernmental Panel on Climate Change, has warned that the global sea level could rise as much as three feet by the end of this century if stronger efforts are not made to control greenhouse gases. The new findings suggest the situation is likely to get far worse in subsequent centuries.

The effects will depend in part on how much money future governments spend to protect shorelines from a rising sea. Research published in 2012 found that a rise of less than four feet would inundate land on which some 3.7 million Americans live today. Miami, New Orleans, New York and Boston are all highly vulnerable.

Richard B. Alley, a climate scientist at Pennsylvania State University who was not involved in the new research but has studied the polar ice sheets for decades, said he found the new papers compelling. Though he had long feared the possibility of ice-sheet collapse, when he learned of the new findings, "it shook me a little bit," Dr. Alley said.

He added that while a large rise of the sea may now be inevitable from West Antarctica, continued release of greenhouse gases will almost certainly make the situation worse. The heat-trapping gases could destabilize other parts of Antarctica as well as the Greenland ice sheet, potentially causing enough sea-level rise that many of the world's coastal cities would eventually have to be abandoned.

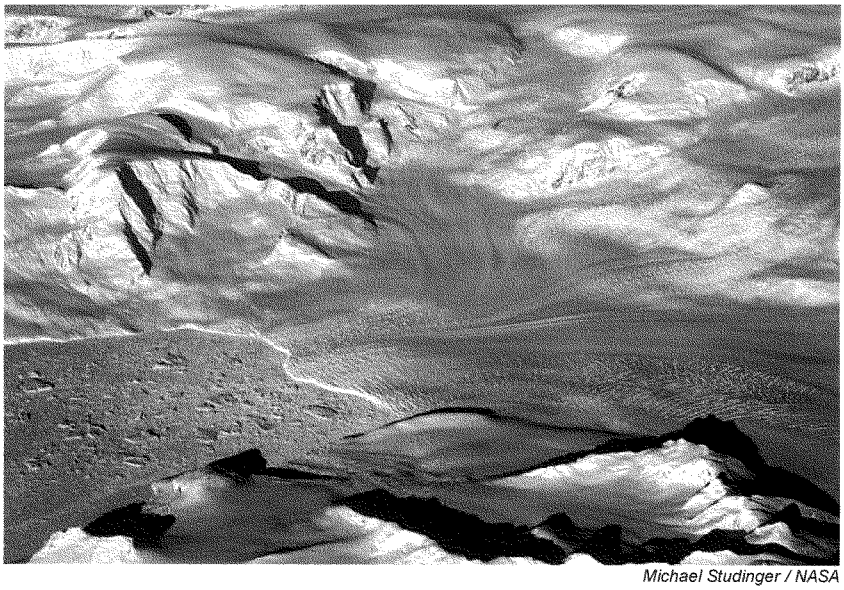
"If we have indeed lit the fuse on West Antarctica, it's very hard to imagine putting the fuse out," Dr. Alley said. "But there's a bunch more fuses, and there's a bunch more matches, and we have a decision now: Do we light those?"

Correction: May 12, 2014

An earlier version of this article misstated the surname of the lead author of a paper in Science about the accelerated flow of glaciers in West Antarctica. He is Ian Joughin, not Joaquin.

A version of this article appeared in print on May 13, 2014, on page A1 of the New York edition with

UCIrvine News



Michael Studinger / NASA

UCI and NASA glaciologists, including Isabella Velicogna and Tyler Sutterley, have discovered that the melt rate of glaciers in West Antarctica has tripled, with the loss of a Mt. Everest's worth of water weight every two years. Download image

West Antarctic melt rate has tripled: UC Irvine-NASA

Irvine, Calif., Dec. 2, 2014 – A comprehensive, 21-year analysis of the fastest-melting region of Antarctica has found that the melt rate of glaciers there has tripled during the last decade.

The glaciers in the Amundsen Sea Embayment in West Antarctica are hemorrhaging ice faster than any other part of Antarctica and are the most significant Antarctic contributors to sea level rise. This study is the first to evaluate and reconcile observations from four different measurement techniques to produce an authoritative estimate of the amount and the rate of loss over the last two decades.

"The mass loss of these glaciers is increasing at an amazing rate," said scientist Isabella Velicogna, jointly of the UC Irvine and NASA's Jet Propulsion Laboratory. Velicogna is a coauthor of a paper on the results, which

has been accepted for Dec. 5 publication in the journal *Geophysical Research Letters*.

Lead author Tyler Sutterley, a UCI doctoral candidate, and his team did the analysis to verify that the melting in this part of Antarctica is shifting into high gear. "Previous studies had suggested that this region is starting to change very dramatically since the 1990s, and we wanted to see how all the different techniques compared," Sutterley said. "The remarkable agreement among the techniques gave us confidence that we are getting this right."

The researchers reconciled measurements of the mass balance of glaciers flowing into the Amundsen Sea Embayment. Mass balance is a measure of how much ice the glaciers gain and lose over time from accumulating or melting snow, discharges of ice as icebergs, and other causes. Measurements from all four techniques were available from 2003 to 2009. Combined, the four data sets span the years 1992 to 2013.

The glaciers in the embayment lost mass throughout the entire period. The researchers calculated two separate quantities: the total amount of loss, and the changes in the rate of loss.

The total amount of loss averaged 83 gigatons per year (91.5 billion U.S. tons). By comparison, Mt. Everest weighs about 161 gigatons, meaning the Antarctic glaciers lost a Mt.-Everest's-worth amount of water weight every two years over the last 21 years.

The rate of loss accelerated an average of 6.1 gigatons (6.7 billion U.S. tons) per year since 1992.

From 2003 to 2009, when all four observational techniques overlapped, the melt rate increased an average of 16.3 gigatons per year — almost three times the rate of increase for the full 21-year period. The total amount of loss was close to the average at 84 gigatons.

The four sets of observations include NASA's Gravity Recovery and Climate Experiment (GRACE) satellites, laser altimetry from NASA's Operation IceBridge airborne campaign and earlier ICESat satellite, radar altimetry from the European Space Agency's Envisat satellite, and mass budget analyses using radars and the University of Utrecht's Regional Atmospheric Climate Model.

The scientists noted that glacier and ice sheet behavior worldwide is by far the greatest uncertainty in predicting future sea level. "We have an excellent observing network now. It's critical that we maintain this network to continue monitoring the changes," Velicogna said, "because the changes are proceeding very fast."

About the University of California, Irvine: Founded in 1965, UCI is the youngest member of the prestigious Association of American Universities. The campus has produced three Nobel laureates and is known for its academic achievement, premier research, innovation and anteater mascot. Led by Chancellor Howard Gillman, UCI has more than 30,000 students and offers 192 degree programs. Located in one of the world's safest and most economically vibrant communities, it's Orange County's second-largest employer, contributing $4.8 billion annually to the local economy.

Media access: Radio programs/stations may, for a fee, use an on-campus ISDN line to interview UC Irvine faculty and experts, subject to availability and university approval. For more UC Irvine news, visit news.uci.edu. Additional resources for journalists may be found at communications.uci.edu/for-journalists.

Also:

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→ Next Post: James McGaugh receives Grawemeyer Award for Psychology

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RESEARCH LETTER
10.1002/2014GL061940

Key Points:
- Four independent techniques of mass balance agree in the Amundsen Sea Embayment
- Most of the loss from that sector occurred in the last 10 years
- Produce regional mass balance record cross validated by four techniques

Supporting Information:
- Readme
- Figure S1
- Figure S2

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Mass loss of the Amundsen Sea Embayment of West Antarctica from four independent techniques

Tyler C. Sutterley[1], Isabella Velicogna[1,2], Eric Rignot[1,2], Jeremie Mouginot[1], Thomas Flament[3,4], Michiel R. van den Broeke[5], Jan M. van Wessem[5], and Carleen H. Reijmer[5]

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Abstract We compare four independent estimates of the mass balance of the Amundsen Sea Embayment of West Antarctica, an area experiencing rapid retreat and mass loss to the sea. We use ICESat and Operation IceBridge laser altimetry, Envisat radar altimetry, GRACE time-variable gravity, RACMO2.3 surface mass balance, ice velocity from imaging radars, and ice thickness from radar sounders. The four methods agree in terms of mass loss and acceleration in loss at the regional scale. Over 1992–2013, the mass loss is 83 ± 5 Gt/yr with an acceleration of 6.1 ± 0.7 Gt/yr^2. During the common period 2003–2009, the mass loss is 84 ± 10 Gt/yr with an acceleration of 16.3 ± 5.6 Gt/yr^2, nearly 3 times the acceleration over 1992–2013. Over 2003–2011, the mass loss is 102 ± 10 Gt/yr with an acceleration of 15.7 ± 4.0 Gt/yr^2. The results reconcile independent mass balance estimates in a setting dominated by change in ice dynamics with significant variability in surface mass balance.

1. Introduction

The glaciers flowing into West Antarctica's Amundsen Sea Embayment (ASE) are a focal point of glaciological studies due to their rapid acceleration, large negative mass balance, and unstable bed configuration [*Hughes*, 1973; *Rignot*, 1998, 2001]. The ASE glaciers flow with some of the highest surface velocities in the continent while draining a catchment that receives high rates of snowfall [*Rignot et al.*, 2011a; *Mouginot et al.*, 2014; *van den Broeke et al.*, 2006; *Lenaerts et al.*, 2012; *Medley et al.*, 2014]. Observations from satellite radar interferometry have shown significant surface velocity increases on the Pine Island (PIG) and Thwaites (THW) glaciers since the 1990s in conjunction with significant retreats of their grounding line positions [*Rignot*, 1998, 2001; *Rignot et al.*, 2002, 2014]. Increased mass fluxes from the smaller regional glaciers of Smith (SMI), Kohler (KOH), Pope (POP), and Haynes (HAY) have also contributed significantly to the overall acceleration in ice mass discharge into the embayment [*Thomas et al.*, 2004; *Rignot et al.*, 2008; *Mouginot et al.*, 2014]. *Mouginot et al.* [2014] report a 77% increase in total ice discharge of the ASE (145 ± 22 Gt/yr increase) between 1973 and 2013, with 50% of the discharge increase occurring between 2003 and 2009. Elevation measurements of PIG have shown strong and accelerated dynamic thinning over areas of fast flow, extending from the calving front to the upper tributaries [*Park et al.*, 2013; *Pritchard et al.*, 2009; *Flament and Rémy*, 2012]. This sector has been identified as the largest contributor from Antarctica to present-day global sea level rise using gravity data and the mass budget method [*Rignot et al.*, 2011b]. Projections from ice sheet numerical models suggest that the region will continue to be a considerable source of global sea level rise over the next century [*Seroussi et al.*, 2014; *Joughin et al.*, 2014; *Favier et al.*, 2014]. Still differences remain among published mass balance estimates for the ASE [*Shepherd et al.*, 2002; *Zwally et al.*, 2005; *Rignot et al.*, 2008; *Sasgen et al.*, 2013; *Medley et al.*, 2014]. In particular, radar altimeter estimates [*Shepherd et al.*, 2002; *Zwally et al.*, 2005] are typically lower than estimates from the mass budget method [*Rignot et al.*, 2008]. These discrepancies can be partially resolved by comparing data over the same time period and the same region but prior to this research had not yet been done.

Here we examine, during the overlapping periods, the mass balance of the ASE using four independent methods: (1) satellite time-variable gravity, (2) mass budget method (MBM), (3) satellite radar altimetry, and (4) satellite and airborne laser altimetry. We use 12 years of time-variable gravity measurements from the

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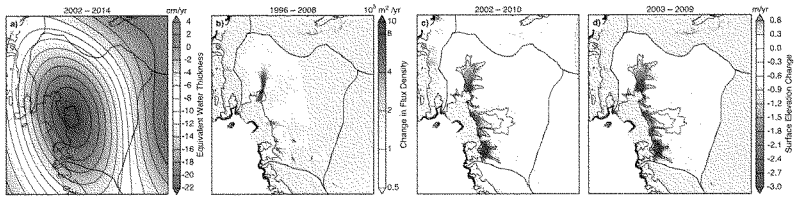

Figure 1. (a) Ice mass trend estimated using GRACE time-variable gravity in centimeter of water equivalent. The red contour delineates 0 cm yr^{-1}. (b) Change in ice flux density between 1996 and 2008 combining velocity changes from *Mouginot et al.* [2014] and ice thickness from *Rignot et al.* [2014]. (c) Elevation change estimated using repeat Envisat radar altimetry from *Flament and Rémy* [2012]. (d) Elevation change from laser altimetry combining ICESat-1 (GLAS) with Operation IceBridge (ATM and LVIS). Contours on Figures 1c and 1d denote surface ice speeds of 125 (red), 250 (blue), and 500 (green) m/yr from *Rignot et al.* [2011a]. Plots are overlaid on a MODIS mosaic of Antarctica [*Haran et al.*, 2013].

NASA/DLR GRACE (Gravity Recovery and Climate Experiment) satellite mission, 22 years of ice discharge from interferometric synthetic aperture radar (InSAR) data and surface mass balance (SMB) output products from the Regional Atmospheric Climate Model (RACMO2.3) [*van Wessem et al.*, 2014], ice thickness data derived from Operation IceBridge (OIB) radio echo sounding, 9 years of radar altimetry data from the European Space Agency Environmental Satellite (Envisat) mission, 7 years of laser altimetry data from ICESat, and 3 years from OIB. We determine the differences between the different methods in terms of mass balance, $dM(t)/dt$, and acceleration in mass balance, d^2M/dt^2, and conclude with a reconciled and comprehensive estimate of the ASE contribution to sea level in 1992–2014 evaluated using multiple techniques.

2. Data and Methods

We use 135 monthly GRACE Release-5 (RL05) gravity solutions provided by Center for Space Research (CSR) for the period April 2002 to May 2014 [*Bettadpur*, 2012]. Each CSR solution consists of fully normalized spherical harmonic coefficients ($C_{\ell m}$, $S_{\ell m}$) up to degree, ℓ, and order, m, 60. We substitute the GRACE-derived C_{20} coefficients with monthly estimates from satellite laser ranging [*Cheng et al.*, 2013], and we account for the variation of the Earth's geocenter using degree 1 coefficients provided by *Swenson et al.* [2008]. Leakage effects from outside the ice sheet are calculated as described in *Velicogna and Wahr* [2013]. We correct the GRACE mass changes for glacial isostatic adjustment (GIA), the Earth's viscoelastic response to the glacial unloading over the past several thousand years using GIA coefficients from *Ivins et al.* [2013] regional ice deglaciation model. We smooth the corrected GRACE spherical harmonics using a 250 km radius Gaussian averaging function [*Jekeli*, 1981], and we generate regular latitude-longitude monthly ice mass grids. We use the grids to calculate the linear trend in a least squares regression simultaneously fitting annual and semiannual signals [*Velicogna*, 2006; *Wahr et al.*, 1998] to obtain digital maps of ice mass balance for the ASE (Figure 1a).

We generate time series of ice mass balance for ASE by applying the least squares mass concentration (mascon) approach described in *Velicogna et al.* [2014] to the Antarctic Ice Sheet. To do this, we cover the entire ice sheet with a set of equal-area mascons (Figure S1 in the supporting information). Each mascon is a 3° diameter spherical cap with a mass equal to a uniformly distributed centimeter of water [*Farrell*, 1972; *Sutterley et al.*, 2014]. For each mascon, we calculate a set of Stokes coefficients, which we smooth with a 250 km Gaussian function and convert into mass. We simultaneously fit the mascon Stokes coefficients to the monthly GIA-corrected GRACE coefficients to obtain estimates of the monthly mass variability for each mascon. This procedure retrieves scaled estimates of regional ice mass variation at each time step. We calculate the mass anomaly time series, $M(t)$, for the ASE through summation of the regional mascons. To calculate dM/dt, we first smooth the mass anomaly time series to remove annual variations and then calculate the derivative over 13 month windows using a Savitzky-Golay filter [*Velicogna*, 2009; *Savitzky and Golay*, 1964]. Uncertainty in the GRACE estimates of ice mass changes are a combination of GRACE measurement error, leakage error, GIA uncertainty, and statistical uncertainty. Errors are calculated as described in *Velicogna et al.* [2014].

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Ice mass balance from the mass budget method (MBM) is calculated combining estimates of ice discharge (D) with surface mass balance (SMB) for each drainage basin as in [*Rignot et al.*, 2011b]. For ice discharge, we use the measurements provided in *Mouginot et al.* [2014]. For SMB, we use the monthly products calculated from a 1979–2013 climate simulation of RACMO2.3 [*Ligtenberg et al.*, 2013; *van Wessem et al.*, 2014]. Field data have been used to estimate the RACMO absolute precision [*van de Berg et al.*, 2006]. In the Antarctic, the uncertainty (1σ) in SMB over grounded ice averages 7% or 144 Gt/yr [*Lenaerts et al.*, 2012]. In ASE, the uncertainty in SMB increases to 14.8% or 28 Gt/yr [*Rignot et al.*, 2008]. RACMO2.3 products are available through December 2013. To compare the results with GRACE, the rates of ice discharge are linearly interpolated into a set of monthly fluxes assuming that seasonal variations in regional ice velocity are minimal, which has been verified over short time periods. We calculate the monthly dM/dt time series by subtracting D from SMB. We generate monthly anomaly time series, $M(t)$, from the MBM by subtracting ice discharge monthly rates from surface mass balance monthly rates and calculating the cumulative $M(t)$ time series.

We use along-track repeat Envisat radar altimetry measurements from the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales at the Le Centre National de la Recherche Scientifique [*Flament and Rémy*, 2012]. The along-track altimetry technique increases the number of processed data points on the Antarctic ice sheet compared to the traditional crossover analysis. We use 83 cycles of 35 day repeat orbits retrieved over the period September 2002 to October 2010. Relative surface elevations are calculated for 500 m radius disks using a least squares algorithm which simultaneously solves for radar waveform properties, along-track slope, cross-track slope, regional surface curvature assuming a quadratic shape, and the elevation time series [*Flament and Rémy*, 2012; *Rémy and Parouty*, 2009]. The waveform properties are computed using the ice sheet-optimized ICE-2 retracking algorithm, which solves for leading edge amplitude, leading edge width, trailing edge slope, waveform backscatter coefficient, and the corrected range [*Legrésy et al.*, 2005]. Additional corrections to account for the varying electromagnetic properties of the ice sheet surface are also included [*Flament and Rémy*, 2012; *Rémy and Parouty*, 2009]. Seasonal variations in radar penetration due to snowpack properties may still account for part of the seasonal signal in ice sheet elevation. To compare with GRACE, we use the Envisat individual elevation time series obtained every kilometer along track to build monthly 25 km^2 grids for the same dates used by the GRACE fields when the Envisat data are available on the 35 day repeat orbit. Error estimates for each grid point are calculated as described in [*Flament and Rémy*, 2012]. Figure 1c shows the map of surface elevation change from Envisat for the period September 2002 to October 2010. We use the two-step smoothing and Savitzky-Golay differentiation procedure previously described in the GRACE analysis to calculate the dV/dt time series.

We also use elevation measurements from ICESat-1, Operation IceBridge (OIB) Airborne Topographic Mapper (ATM) and Land, Vegetation and Ice Sensor (LVIS) to quantify the surface elevation change. Our ICESat measurements are Release-33 of the GLA12 Antarctic and Greenland Ice Sheet Altimetry data provided by the National Snow & Ice Data Center (NSIDC) [*Zwally et al.*, 2012]. We remove cloud-affected data points following the methods described in *Howat et al.* [2008], *Pritchard et al.* [2009], *Smith et al.* [2009], and *Sørensen et al.* [2011]. Elevation changes are calculated in reference to the WGS-84 ellipsoid, corrected for saturation effects with the GLA12 correction product [*Zwally et al.*, 2012], and for Gaussian-Centroid (G-C) offset [*Borsa et al.*, 2014]. OIB ATM, and LVIS data products are used as additional constraints to the surface shape and elevation time series [*Krabill*, 2010; *Blair and Hofton*, 2010]. We use a least squares approach to simultaneously solve for the elevation time series and surface shape (e.g., along-track and cross-track slope) of 1 km surface patches [*Schenk and Csatho*, 2012]. The OIB aerial laser altimetry data sets greatly increase the total number and spatial coverage of elevation data points within each surface patch [*Schenk and Csatho*, 2012; *Rezvan-Behbahani*, 2012]. For the temporal component, a low-order polynomial is chosen to reduce the impact of annual variations, which may not be captured in the two to three campaign acquisitions per year. Errors for each time step are calculated propagating the regression fit error as described in *Schenk and Csatho* [2012], and the GIA uplift uncertainty. From our reconstructed centroid time series, we calculate interpolated maps of relative surface elevation using inverse multiquadric radial basis functions and calculate elevation change maps by differentiating sets of interpolated elevation maps [*Hardy*, 1971]. Figure 1d shows the map of surface elevation change from ICESat/IceBridge for the period 2003–2009.

In order to convert the surface elevation measurements from Envisat and ICESat/OIB into ice mass, we apply a simple density conversion assuming that the surface changes in areas of fast flow (speed greater than about 50 m/yr) are entirely due to ice dynamics, i.e., are taking place at a density of 900 ± 20 kg/m^3

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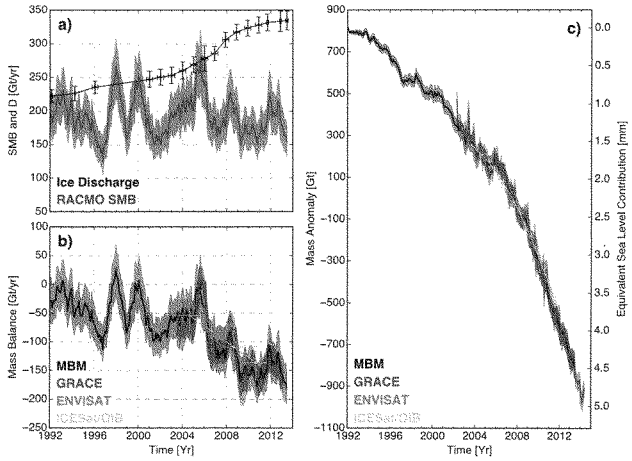

Figure 2. (a) Rates of RACMO surface mass balance, SMB (blue), and ice discharge, D, from *Mouginot et al.* [2014] (black). (b) Mass balance estimates, $dM(t)/dt$, and (c) cumulative mass anomalies, $M(t)$, for the Amundsen Sea Embayment (ASE) of Antarctica from the Mass Budget Method, MBM (black), GRACE time-variable gravity (red), Envisat radar altimetry (green), and ICESat/IceBridge laser altimetry (orange).

[*Shepherd et al.*, 2012]. This assumption is justified by the fact that changes in surface elevation (Figures 1c and 1d) are strongly correlated with the changes in speed (Figure 1b), not with changes in SMB. In slower-moving regions, changes in surface elevation are assumed to be dominated by changes in SMB rather than ice dynamics (the latter is also not observable over the entire domain). Over the slow-moving interior, we employ a density of 550 ± 250 kg/m^3, i.e., we include a 45% uncertainty. Our final error combines the errors from both regions.

3. Results

Figure 1 shows the map of GRACE ice mass trend for January 2003 to May 2014, the change in ice flux density (product of ice velocity by ice thickness) between 1996 and 2008 combining ice motion from InSAR with ice thickness from BEDMAP2 [*Fretwell et al.*, 2013], Envisat radar altimetry dH/dt for 2002–2010 and ICESat, OIB, and LVIS dH/dt for 2003–2009. GRACE trend (Figure 1a) shows a significant mass loss in the region, with a loss per unit area exceeding 20 cm water equivalent per year. The limited spatial resolution of the GRACE data (~350 km) compared to the size of the glaciers limits the interpretation of the spatial pattern of ice mass change.

The map of flux density change (Figure 1b) highlights the speed up of all glaciers in the region: PIG, THW, SMI, KOH, POP, and HAY [*Mouginot et al.*, 2014]. The maps of surface elevation change from Envisat (Figure 1c) and ICESat/OIB (Figure 1d) indicate that ASE is dominated by ice thinning. The rate of thinning is higher in regions of fast flow, as denoted by the velocity magnitude contours from *Rignot et al.* [2011a], and areas of larger change in flow speed in Figure 1b. We find thinning of PIG propagating upstream, broad thinning of THW, and significant thinning of the smaller HAY, SMI, POP, and KOH. The rates of surface thinning exceed several meters per year in the areas of fast flow, and the spatial pattern of thinning is consistent with the pattern of ice velocity change. This confirms that the pattern of thinning is due to changes in ice dynamics instead of changes in SMB.

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Table 1. Mass Balance of the Amundsen Sea Embayment of West Antarctica[a]

Data Set	Date Range	Mass Balance (Gt/yr)	Change in Mass Balance (Gt/yr^2)
GRACE	2003–2009	−90 ± 8	−16.4 ± 2.6
MBM	2003–2009	−89 ± 7	−19.6 ± 3.5
Envisat	2003–2009	−74 ± 8	−15.5 ± 3.6
ICESat/OIB	2003–2009	−81 ± 16	−13.8 ± 9.6
GRACE	2003–2011	−104 ± 7	−15.5 ± 1.7
MBM	2003–2011	−105 ± 6	−18.0 ± 2.3
ICESat/OIB	2003–2011	−95 ± 14	−13.8 ± 6.3
GRACE	2003–2013	−108 ± 7	−11.9 ± 1.3
MBM	2003–2013	−110 ± 6	−13.6 ± 1.9
MBM	1992–2013	−83 ± 5	−6.1 ± 0.7

[a]Mean mass balance and change in mass balance calculated for each period simultaneously using a weighted least squares regression from the mass balance time series, $dM(t)/dt$.

Because of the inherent difference in spatial resolution and temporal coverage between the different data sets, it is difficult to compare the spatial pattern of the mass balance results. Instead, we focus on the basin-scale assessment of mass balance. During the entire time period (1992–2013), variations in SMB modulate the $dM(t)/dt$ time series significantly (Figure 2a). The average SMB for this time period is 185 ± 26 Gt/yr; yet interannual variations in SMB up to 150 Gt are not uncommon in the GRACE, Envisat, and MBM time series (Figure 2b).

During the common period, 2003–2009, GRACE, MBM, and Envisat mass balance time series, $dM(t)/dt$, are in good agreement in terms of total magnitude and timing of the cyclic oscillations (Figure 2b). The three $dM(t)/dt$ time series agree within ±13%. Over the same period, the GRACE, Envisat, and MBM time series of cumulative mass anomaly, $M(t)$, agree within ±5% (Figure 2c).

The ICESat/OIB time series does not capture interannual variations because of its low temporal sampling (two to three measurements per year). Over the period common to all four techniques, 2003–2009, however, we find an excellent agreement with all the other techniques in terms of average mass balance and acceleration in mass balance. We find a total mass loss of 81 ± 16 Gt/yr for ICESat/OIB, 90 ± 8 Gt/yr for GRACE, 89 ± 7 Gt/yr for MBM, and 74 ± 8 Gt/yr for Envisat. During the same period, the acceleration in loss are, respectively, 13.8 ± 9.6 Gt/yr^2 for ICESat/OIB, 16.4 ± 2.6 Gt/yr^2 for GRACE, 19.6 ± 3.4 Gt/yr^2 for MBM, and 15.5 ± 3.6 Gt/yr^2 for Envisat (Table 1).

We calculate a reconciled mass balance for the ASE during 2003–2009 as a linear average of the individual estimates from GRACE, MBM, Envisat, and ICESat/OIB and the associated error as the sum in quadrature of each technique error. We find a rate of mass loss of 84 ± 10 Gt/yr with an average acceleration of 16.3 ± 5.6 Gt/yr^2. For comparison, over the entire period of 1992–2013, the mass loss of ASE as determined by the MBM averages 83 ± 5 Gt/yr with an acceleration of 6.1 ± 0.7 Gt/yr^2, or almost 3 times less than in the more recent period.

Over the time period 2003–2011, we have coincident data sets from ICESat/OIB, GRACE, and MBM. We find a mass loss of 95 ± 14 Gt/yr for ICESat/OIB, 104 ± 7 Gt/yr for GRACE, and 105 ± 6 Gt/yr for MBM. During the same time period, the acceleration in mass loss is 13.8 ± 6.3 Gt/yr^2 for ICESat/OIB, 15.5 ± 1.7 Gt/yr^2 for GRACE, and 18 ± 2.3 Gt/yr^2 for MBM (Table 1). This period includes the ICESat period (2003–2009) and the period of yearly OIB campaigns (2009–2011) when ICESat is no longer available. During 2003–2011, our reconciled estimate from GRACE, MBM, and ICESat/OIB is an average mass loss of 102 ± 10 Gt/yr with an acceleration of 15.7 ± 4.0 Gt/yr^2, which is not significantly different for that in 2003–2009.

4. Discussion

The excellent agreement and high correlation between independent time series from GRACE, MBM, Envisat, and ICESat/OIB during their common period significantly increases confidence in the various analyzed techniques. The coincidence in magnitude and temporal oscillations of the time series provides a significant cross validation of the techniques at the regional scale in a glaciological setting where mass changes are

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significant. The agreement within the confidence intervals confirms that the error estimates for the different techniques are realistic. Beyond the end of the MBM, Envisat, and ICESat/OIB record (mid-2012), the ongoing GRACE time series of $M(t)$ measurements (Figure 2c) indicate that the mass loss of the ASE is continuing at the same rate after 2012 until the middle of year 2014 which is the end of our current GRACE record. As new SMB estimates are produced and longer time series of OIB laser data are acquired, we will extend the duration and quality of the ice sheet mass balance record in the region.

Our mass balance numbers are within the error estimates of the recent CryoSat-2 estimates from [*McMillan et al.*, 2014] who report a mass loss of 120 ± 18 Gt/yr for the time period 2010–2013 for basins 21 and 22, the equivalent of ASE in this study. For comparison, we calculate an average mass loss of 144 ± 7 Gt/yr from the linear average of GRACE and MBM in 2010–2013. The lower number from CryoSat-2 is likely due to the variability in firn depth and snowfall affecting the short-term (3 year) Cryosat-2 time series. Overall, however, the mass balance estimates agree within confidence intervals.

Although the ICESat/OIB mass balance time series do not capture interannual variations in ice elevation, our results suggest that it correctly captures the total change in mass balance of the ASE. Hence, campaign-style measurements by OIB, combined with the long-term reference from ICESat, are sufficient to extend the time series of laser altimetry data in time and maintain a consistent record of ice mass balance in the region. In our estimate, we only use the OIB data within 1 km of the ICESat tracks. The elevation change results could be improved by including additional ATM and LVIS tracks acquired in the region since 2002, but the statistical analysis would become significantly more complex. With our approach, we confirm that the resulting numbers are already consistent with those obtained with more comprehensive, complementary, independent MBM and GRACE techniques.

In the ASE, the choice of the GIA correction only minimally impacts the GRACE mass balance estimates. Here we use the *Ivins et al.* [2013] regional GIA model. Using any of the other available GIA changes the mass balance numbers by 8% or 9 Gt/yr for the *Whitehouse et al.* [2012] model and 2% or 2 Gt/yr for the *A et al.* [2013] global model based on ICE-5G ice history [*Peltier*, 2004]. These errors are within the uncertainty bounds of the reconciled estimates. Results using GIA coefficients from the *Whitehouse et al.* [2012] deglaciation model are included in the supporting information (Figure S2).

The Envisat and ICESat/OIB results fall within the error estimates of the GRACE and MBM time series when changes in surface elevation in areas of fast flow (speed greater than about 50 m/yr) are assumed to be taking place at the density of ice, here 900 ± 20 kg/m^3, i.e., to be due to ice dynamics, and changes in slower-moving regions are assumed to occur at 550 ± 250 kg/m^3, i.e., to be dominated by changes in SMB rather than ice dynamics. Overall, most change in mass in the ASE occur at low elevation (97% of the loss is contained below 1300 m elevation) and at high speed (87% of the loss for areas flowing above 50 m/yr), where changes are very likely to take place at the density of ice. We note that Envisat measurements may miss some of the coastal region due to loss of signal along the edges of the ice sheet typical of satellite radar altimeters.

The ASE receives high rates of snowfall compared to the average in Antarctica [*Lenaerts et al.*, 2012; *Medley et al.*, 2014]. In 1992–2013, the RACMO2.3 SMB averages 185 ± 26 Gt/yr for the ASE. SMB varies significantly over short time scales (σ = 27 Gt/yr in 2002–2013). Over the entire 22 year period, however, changes in SMB are negligible, −0.2 ± 0.3 Gt/yr^2 (Figure 2a). Our study confirms that multidecadal periods of observation are needed to determine the long-term trend in ice mass balance and its acceleration and to minimize the impact of firn compaction on altimetry results [*Rignot et al.*, 2011b; *Shepherd et al.*, 2012; *Wouters et al.*, 2013]. Similarly, it is difficult to evaluate the exact partitioning between SMB and ice dynamics over short periods. For example, the partitioning in mass balance over 2003–2009 does not reflect the partitioning over 1992–2013.

The longer MBM record and its comparison with independent techniques provides evidence that the increase in regional mass loss is caused almost entirely by changes in ice velocity. The long-term (1992–2013) change in SMB (−0.2 ± 0.3 Gt/yr^2) is small compared to the change in ice discharge (+5.7 ± 0.4 Gt/yr^2) (Figure 2a). The SMB fluctuations modulate the yearly mass balance yet never mask out the trend in dynamic loss in the region. Most of the ice mass loss took place in the past decade. The cumulative loss of 1160 ± 30 Gt during the 2002–2013 GRACE period is 71% of the total loss of 1630 ± 30 Gt for the 1992–2013

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period. The losses correspond to equivalent rises of global sea level of 3.2 ± 0.1 mm and 4.5 ± 0.1 mm for the 2002–2013 and 1992–2013 periods, respectively (Figure 2c).

5. Conclusion

In this study, we quantify the ice sheet mass balance of the ASE using four independent geodetic techniques. We find an excellent agreement in mass loss and acceleration in mass loss from these independent techniques during common periods at the regional scale in a sector that dominates the mass balance of the continent. We show that OIB campaign style measurements are sufficient to extend the time series of mass balance estimates using ICESat laser altimetry data in time and maintain a record of ice mass balance in the region. We also show that the significant fluctuations in SMB observed over short periods average out after a couple of decades. The comprehensive record, evaluated from multiple techniques, of mass loss in West Antarctica, produced here shows a tripling in mass loss in recent years with respect to the entire analyzed period 1992–2013. The rapid rate of convergence of the independent techniques examined herein indicates that the measurements have now reached maturity and may be used with increased confidence for glaciological interpretation and inclusion in ice sheet numerical models with data assimilation methods.

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Senate Climate Change Legislation
Vote History

October 30, 2003. **Vote 43-55.**
McCain-Lieberman "Climate Stewardship Act of 2003" (S. 139).
Roll Call Vote No. 420
Republicans: Chafee, Collins, Gregg, McCain, Snowe

June 22, 2005. **Vote 38-60.**
McCain Amendment 826 (to H.R. 6 "Energy Policy Act of 2005") to provide for a program to accelerate the reduction of greenhouse gas emissions in the United States.
Roll Call Vote No. 148
Republicans: Chaffee, Collins, Gregg, Lugar, McCain, Snowe

June 6, 2008. **Vote 48-36 (6 more absent Senators asked that their intentions to vote yes be entered into the record).**
Lieberman-Warner "Climate Security Act of 2008" (S. 2191).
Vote 11-8 in Senate Cmte. on Environment and Public Works (December 5, 2007).
Senate Report No. 110-337.
Amended version (S. 3036) voted on by Senate (June 6, 2008).
Roll Call Vote No. 145
Republicans: Collins, Dole, Martinez, Smith, Snowe, Sununu, Warner, McCain (by letter), Coleman (by letter).

November 5, 2009. **Vote 11-1.**
Kerry - Boxer "Clean Energy Jobs and American Power Act" (S. 1733).
Vote 11-1 in Senate Cmte. on Environment and Public Works.
Senate Report No. 111-121.

May 12, 2010. **Press Conference.**
Kerry-Lieberman Press Conference on Climate Change Effort.
http://www.kerry.senate.gov/press/release/?id=5e1dc216-ce17-4cc2-92e1-8321efc8240c

June 10, 2010. **Vote 47-53.**
Murkowski joint resolution disapproving a rule submitted by the Environmental Protection Agency relating to the endangerment finding and the cause or contribute findings for greenhouse gases under section 202(a) of the Clean Air Act.
Roll Call Vote No. 184

Sciencexpress Reports

Ice Shelf Melting Around Antarctica

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We compare the volume flux divergence of Antarctic ice shelves in 2007–2008 with 1979–2010 surface accumulation and 2003–2008 thinning to determine their rates of melting and mass balance. Basal melt of 1325 ± 235 gigatons per year (Gt/year) exceeds a calving flux of 1089 ± 139 Gt/year, making ice shelf melting the largest ablation process in Antarctica. The giant cold-cavity Ross, Filchner, and Ronne ice shelves covering two-thirds of the total ice shelf area account for only 15% of net melting. Half of the meltwater comes from 10 small, warm-cavity southeast Pacific ice shelves occupying 8% of the area. A similar high melt/area ratio is found for six East Antarctic ice shelves, implying undocumented strong ocean thermal forcing on their deep grounding lines.

The Antarctic Ice Sheet and its 58-m sea level equivalent (*1*) is buttressed along most of its periphery by floating extensions of land ice called ice shelves and floating ice tongues (Fig. 1). Ice shelves cover an area >1.561 million km^2, comparable in size to the Greenland Ice Sheet, and fringe 75% of Antarctica's coastline while collecting 20% of its snowfall over 11% of its area (*2*, *3*). These features are nourished by the inflow of continental ice from grounded glaciers, surface accumulation and freezing of marine ice on their undersides. They lose mass to iceberg calving and basal melting along with topside sublimation and wind drift. Ice shelves exert considerable control on glacier stability and Antarctic Ice Sheet mass balance (*4*–*6*) and play significant roles in ocean stratification and bottom water formation (*7*).

The traditional view of ablation from Antarctic ice shelves has been that it occurs mostly by iceberg calving, with basal melting only contributing 10 to 28% of the total mass loss (*3*–*6*). Estimates of ice shelf meltwater production derived from oceanographic data (*8*–*10*, e.g.) are impractical for synoptic circumpolar coverage. Numerical simulations of ice-ocean interactions extend from individual ice shelves to circumpolar models at various resolutions, but comparisons with observations are limited, and estimates of total ice shelf meltwater production have varied from 357 to 1,600 gigatons per year (1 Gt = 10^{12} kg) (*3*, *7*, *11*). Glaciological estimates have focused on few ice shelves (*6*, *12*, *13*) or near a fraction of glacier grounding lines (*14*) due to incomplete velocity and thickness mapping.

Here we present more accurate, higher-resolution glaciological estimates of ice shelf melting around the entire continent. At any point on an ice shelf of thickness H and velocity vector $\mathbf{v}$, the rate of ice shelf thickening $\partial H/\partial t$ equals the sum of net surface mass balance *SMB* minus net basal melting B minus the lateral divergence in volume flux $H\mathbf{v}$ (*15*). A negative value of B indicates the freeze-on of marine ice. The calculation of volume flux divergence on a point per point basis yields the distribution of freeze/melt (Fig. 1). The integration of the total inflow and outflow within the ice shelf perimeters yields the area-average melt rate and total melt water production (Table 1).

For *SMB*, we use output products from the Regional Atmospheric and Climate Model RACMO2 (*16*), which is forced at the lateral boundary and sea surface by global reanalyses of the European Centre for Medium-Range Weather Forecasts. RACMO2 includes surface melt water retention due to refreezing, evaporation, wind drift and sublimation. The products have been validated with field data and an error propagation analysis (*17*) to a precision of 7 to 25%, average 10%, depending on location. We use the average *SMB* for the years 1979–2010 to represent a longer-term state.

Ice shelf thickness is from Operation IceBridge (OIB) (*18*, *19*) and BEDMAP-2 (*1*) (fig. S1, supplementary materials). It combines direct measurements from radio echo sounding, with indirect estimates from altimetry-derived ice shelf surface elevation assuming hydrostatic equilibrium with a nominal precision of 15 to 50 m (*20*). Flux gates are selected at the location of Interferometric Synthetic Aperture Radar (InSAR)–derived grounding lines, which are more precise than derived from photogrammetric techniques or visible imagery (*21*), with accompanying impacts on estimates of volume fluxes. Ice-front flux gates are at the seaward limit of the volume flux data, within 1 to 3 km of ice-front positions digitized from a 150-m spacing mosaic of Advanced Land Observing System (ALOS) Polarimetric SAR (PALSAR) data for the years 2007-2008.

Ice shelf flow vector velocities are from InSAR data collected in 2007–2008 and processed at 450 m spacing (*22*). The average precision in speed is 4 m/year and 1.7° in direction (fig. S2). In the absence of vertical shear on floating ice, the surface-derived velocity is equivalent to a depth-averaged velocity. We survey 99.5% of Antarctic ice shelf area in 2007–2008 (Table 1), or 1.554 million km^2, excluding a few smaller ice shelves where ice thickness is not well known (table S1). Drainage boundaries between ice shelves, including the eastern and western Ross, are defined by flow vector direction. Ice rises and islands are excluded from the ice shelf area estimates but included in the *SMB* calculation.

Ice-shelf thickening $\partial H/\partial t$ for the period 2003–2008 is calculated using the procedure in (*23*), with an error dependent on firn depth corrections (fig. S3). The results are combined with *SMB* and the flux divergence to calculate B, with a precision dominated by uncertainties in ice-front thickness and firn depth corrections (table S1). We also calculate the results for $\partial H/\partial t = 0$, i.e., no ice shelf thickness change, to obtain a reference rate B_{ss} corresponding to the amount of freezing or melting that would be required to maintain an ice shelf in "steady state" for 2007–2008 (fig. S4).

The freeze/melt distribution confirms that basal melting is strongest near the grounding zones of major glaciers and along the ice fronts of some of the largest ice shelves, especially Ronne (Fig. 1). Ice shelf melting decreases away from grounding lines and becomes negative (accretion of marine ice) on all large ice shelves and some smaller ice shelves. This general pattern of melting and freezing beneath ice shelves is well understood (*4*–*6*, *15*) and is governed by the Coriolis-influenced transport and vertical mixing of ocean heat, the pressure-dependence of the freezing point of seawater, and the sea floor and cavity morphology. On some large ice shelves, freezing is concentrated on the western sides, consistent with an oceanic circulation during which seawater is first cooled, freshened and made more buoyant by melting.

The highest melt rates are detected in the southeast Pacific sector of the Antarctic Peninsula and West Antarctica, from the northern end of George VI to the western end of Getz Ice Shelf. On slow-moving to nearly-stationary ice shelves like the Wilkins, George VI, Abbot and Sulzberger, basal melting entirely consumes the inflow of individual glaciers within a few km of their grounding zones. High melt rates are

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also revealed in the grounding zones of the Amery, Moscow University, Shackleton, and Totten in East Antarctica.

In contrast, low melt rates are found under the largest ice shelves, e.g., the Ross West, except near deep grounding lines. Maximum grounding line depth is only 0.9 km under the Ross West but 2.1 km under the Filchner and Ronne, 1.8 km under Ross East, and 2.4 km under the Amery (*1*). Each additional 100 m adds 0.076°C to the thermal driving of seawater that may have started out near the sea surface freezing point. Differences in observed melt rate may also be accentuated by variations in flushing time and tidal activity (*24*).

Total ice inflow and outflow for each ice shelf is summarized in Fig. 1 and Table 1. Ice-front flux is a proxy for, but not identical to, iceberg calving, which occurs at irregular time intervals ranging from years to decades. The higher basal melting near some ice-shelf fronts (*12*, *25*) results from stronger tidal currents and mixing, especially in combination with a shallow water column (*24*), as along the eastern front of Ronne [150 ± 50 m in (*1*) versus 350 ± 100 m for Ross or 500 ± 250 m for Filchner]. Ice-front fluxes may overestimate iceberg calving where near ice front melting is significant and calving is infrequent; conversely, large icebergs may on average be thicker than the ice front, in which case ice front fluxes underestimate calving.

The total ice shelf grounding line inflow of 1,696 ± 146 Gt/year combined with an *SMB* input of 430 ± 81 Gt/year is partitioned into an ice-front flux of 1,089 ± 139 Gt/year and a basal meltwater production of 1,325 ± 235 Gt/year. Basal melting thus accounts for 55 ± 10% of ice shelf mass ablation. The corresponding area-average melt rate of 85 ± 15 cm/year is three times as large as the average *SMB* on ice shelves (28 ± 5 cm) and five times the average *SMB* on grounded ice sheet (16 ± 1 cm) (*16*), illustrating the considerable importance of ocean interactions in freshwater transfers between the ice and ocean.

The grounding line flux of all surveyed ice shelves accounts for 83 ± 7% of the total ice discharge into the Southern Ocean (Table 1). Total Antarctic grounded ice discharge (*26*) is 352 ± 30 Gt/year higher than our grounding line flux because of additional discharge from smaller ice shelves and ice walls that terminate in the ocean (*27*). An equal partitioning of these missing areas between calving and basal melting (see supplementary materials) would increase in-situ meltwater production to 1,500 ± 237 Gt/year and ice-front flux to 1,265 ± 139 Gt/year.

The comparison of basal melting, B (Fig. 1) with steady state melting, B_{ss} (fig. S4, Table 1, and table S1) shows that many ice shelves are near equilibrium ($B \sim B_{ss}$), while some are thickening ($B < B_{ss}$) and others are thinning ($B > B_{ss}$). High basal melting is therefore not synonymous with thinning. Ice shelves with high melt rates can be in a state of mass balance, but meltwater production is 28 ± 9% higher than required to maintain the ice shelves in overall steady state (1037 ± 218). Ice shelves in the Amundsen Sea sector (Pine Island to Getz) contribute 59% of the 287 ± 89 Gt/year imbalance, an attrition rate twice that of their glacier source regions over the same time period (*26*). Similarly, the total imbalance of all Antarctic ice shelves combined is more than twice that of the grounded ice (*26*).

The ratio of calving to melting averages 0.45 ± 0.3, but exhibits significant regional variability (Table 1), with area-average melt rates varying from negative to > 40 m/year. This wide range reflects diverse ocean environments, which include seawater temperature, the depths of troughs and sills that influence the access of oceanic heat to ice shelf cavities, and the sea ice formation and drifts resulting from atmospheric forcing.

Large ice shelves generate a disproportionally small portion of the total ice shelf meltwater despite high production rates in their deep grounding zones and along lengthy ice fronts. The four giants with areas > 100,000 km^2 (Ross East, Ross West, Filchner and Ronne) cover 61% of the total ice shelf area but contribute only 15% of the meltwater at an average rate of 13 cm/year. The low melt rates result from the relatively weak ocean heat source provided by cold shelf waters, in turn leading to substantial marine ice accretion (*28*). Despite areas 3-10 times larger than the Getz, none of the big four ice shelves produce as much meltwater, with the Ross West contributing no net melt. Meltwater from the southeast Pacific-Antarctic sector (George VI through Getz) accounts for 48% of the total meltwater over only 8% of the area, with the Getz being the largest meltwater source in Antarctica during the study period. B averages 5.1 m/year in this region, from a maximum of 43 m/year under the short Ferrigno Glacier tongue, to a minimum of 1.8 m/year beneath the Abbot. That area-average rate may seem low for a warm-cavity Southeast Pacific ice shelf, but the moderate-sized, shallow-draft Abbot (*29*) ranks 8th overall in meltwater production, while maintaining a positive mass balance ($B < B_{ss}$).

Meltwater production from several small East Antarctic ice shelves in the Wilkes Land sector is larger than expected. Area-average melt rates from Dibble through Vincennes (4-11 m/year) are comparable to Amundsen Sea ice shelf rates from Crosson through Land (4-11 m/year), while meltwater produced by Shackleton and West (73 and 27 Gt/year) rivals that from Thwaites and Sulzberger (98 and 18 Gt/year). Except for the region from 140-150°W where the Mertz and Ninnis float in cold shelf waters, oceanographic data are sparse along the Wilkes Land coastline. "Modified" warm deep water at a temperature near 0°C has been reported 40 km south of the continental shelf break northeast of Totten (*30*). By analogy with observations in the Amundsen Sea, our results suggest the presence of seawater at similar temperatures under several East Antarctic ice shelves. Even zero-degree seawater at outer continental shelf depths could expose ice shelves with deep grounding lines like the Totten (2.2 km), Moscow (2.0 km) and Shackleton (1.8 km) to temperatures more than 3°C above their melting points. To evaluate the impact of these warm deep waters on ice shelf melting, more information is needed about their spatial and temporal variability on the outer shelf, and links via glacially scoured troughs to the vulnerable glacier grounding lines.

Our glaciological estimates are generally consistent with recent results from high-resolution ocean models in the Amundsen, Bellingshausen, and Weddell Seas (*29*, *31–33*) (see supplementary materials), but melting of the largest ice shelves is notably less here than in circumpolar models (*7*, *11*). Discrepancies between model results and observations have been attributed to deficiencies in atmospheric forcing, the representation of sea ice cover, the smoothing of bottom topography and assumptions regarding cavity shape. Some models yield annual cycles and decadal variability (*29*) that can now be compared for specific periods with glaciological measurements, which need to be extended in time.

Our results indicate that basal melting accounts for a larger fraction of Antarctic ice shelf attrition than previously estimated. These improved glaciological estimates not only provide more accurate and detailed reference values for modeling, but a baseline for similar future studies. Ice shelf melt water production exhibits a complex spatial pattern around the continent, with an outsized contribution of smaller, fast-melting ice shelves in both West and East Antarctica. Warm-cavity ice shelves along the southeast Pacific coastline, predicted and observed to be sensitive to ocean warming and circulation strength (*9*, *34*), are thinning and losing mass rapidly. Nearly half of the East Antarctic ice shelves are also thinning, some due to probable exposure to "warm" seawater, with connections to ice drainage basins grounded below sea level.

Continued observations of ice shelf velocity and thickness change, along with more detailed information on cavity shape, seafloor topography and atmospheric and oceanic forcing variability are critical to understand the temporal variability and evolution of Antarctic ice shelves. Continued warming of the ocean will slowly increase ice shelf thinning, but if major shifts in sea ice cover and ocean circulation tip even large ice shelf cavities from cold to warm (*35*), there could be major changes in ice shelf and thus ice sheet mass balance.

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Supplementary Materials
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Supplementary Text
Figs. S1 to S4
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Table 1. Meltwater production of Antarctic ice shelves, with ice shelves named counter clockwise in Fig. 1. Areas in square kilometers exclude ice rises and islands. Grounding line flux (GL), surface mass balance (SMB), ice-front (proxy for calving) flux (Ice Front), ice-shelf mass gain ($\partial H/\partial t$ in water mass equivalent), and basal meltwater production in gigatons (1 Gt = 10^{12} kg) per year, with area-average basal melt rate in meter of water per year indicated in parenthesis. Total Antarctica on the last row includes non-surveyed coastal sectors. Ice shelf names are from United States Geological Survey and (*3*). Surveyed ice-shelf mass loss of 287 ± 89 Gt/year in 2003–2008 ($\partial H/\partial t$) is 28 ± 9% higher than that required to maintain the ice shelves in steady state for 2003–2008. *, Larsen B data (velocity, thickness) prior to the 2002 collapse; thinning rate from the remnant part of the ice shelf only. Additional details in table S1.

Name	Area km²	GL Gt/year	SMB Gt/year	Ice front Gt/year	$\partial H/\partial t$ Gt/year	Basal melt Gt/year (m/year)
Larsen G	412	0.9 ± 0.2	0.1 ± 0	0.7 ± 1	0.0 ± 0	0.3 ± 0.2 (0.71 ± 0.6)
Larsen F	828	1.5 ± 0.3	0.3 ± 0.1	0.6 ± 1	-0.7 ± 0.5	1.2 ± 0.4 (1.4 ± 0.5)
Larsen E	1,184	3.6 ± 0.7	0.4 ± 0.1	1.5 ± 1	1.1 ± 0.7	1.4 ± 1 (1.2 ± 0.9)
Larsen D	22,548	18.5 ± 4	9.8 ± 2	6.3 ± 1	20.5 ± 14	1.4 ± 14 (0.1 ± 0.6)
Larsen C	46,465	29.6 ± 3	23.8 ± 4	31.3 ± 3	1.4 ± 67	20.7 ± 67 (0.4 ± 1)
Larsen B*	6,755	13.6 ± 3	3.0 ± 0.6	8.9 ± 1	-4.5 ± 13	12.2 ± 14 (1.8 ± 2)
Wordie	277	13.8 ± 1	0.3 ± 0	7.6 ± 3	-0.1 ± 0	6.5 ± 3 (23.6 ± 10)
Wilkins	12,866	7.8 ± 2	8.3 ± 2	0.7 ± 0.4	-3.4 ± 16	18.4 ± 17 (1.5 ± 1)
Bach	4,579	5.4 ± 1	1.8 ± 0.3	0.8 ± 0.2	-4.0 ± 0.3	10.4 ± 1 (2.3 ± 0.3)
George VI	23,434	68.2 ± 5	12.7 ± 2	5.7 ± 1.2	-13.8 ± 16	89.0 ± 17 (3.8 ± 0.7)
Stange	8,027	21.0 ± 3	6.0 ± 1	4.6 ± 0.8	-5.6 ± 5	28.0 ± 6 (3.5 ± 0.7)
Ant. Peninsula	127,375	184 ± 26	66 ±13	69 ± 13	-9 ± 74	191 ± 80 (1.5 ± 0.6)
Ronne	338,887	156.1 ± 10	59.3 ± 11	149.2 ± 22	-47.4 ± 22	113.5 ± 35 (0.3 ± 0.1)
Ferrigno	117	11.2 ± 1	0.16 ± 0	6.6 ± 2	-0.3 ± 0	5.1 ± 2 (43.4 ± 17)
Venable	3,194	14.6 ± 2	3.5 ± 1	6.5 ± 1	-7.7 ± 1	19.4 ± 2 (6.1 ± 0.7)
Abbot	29,688	34.0 ± 4	25.0 ± 5	2.4 ± 0.5	4.7 ± 18	51.8 ± 19 (1.7 ± 0.6)
Cosgrove	3,033	5.2 ± 1	1.5 ± 0.3	1.3 ± 1.2	-3.1 ± 2	8.5 ± 2 (2.8 ± 0.7)
Pine Island	6,249	126.4 ± 6	4.6 ± 0.9	62.3 ± 5	-33.2 ± 2	101.2 ± 8 (16.2 ± 1)
Thwaites	5,499	113.5 ± 4	4.8 ± 0.9	54.5 ± 5	-33.7 ± 3	97.5 ± 7 (17.7 ± 1)
Crosson	3,229	27.4 ± 2	3.7 ± 0.7	11.7 ± 2	-19.2 ± 1	38.5 ± 4 (11.9 ± 1)
Dotson	5,803	28.4 ± 3	5.7 ± 1	5.5 ± 0.7	-16.6 ± 2	45.2 ± 4 (7.8 ± 0.6)
Getz	34,018	96.7 ± 5	34.2 ± 7	53.5 ± 2	-67.6 ± 12	144.9 ± 14 (4.3 ± 0.4)
Land	640	14.5 ± 1	0.8 ± 0.1	12.2 ± 1	-0.7 ± 0.3	3.8 ± 1 (5.9 ± 2)
Nickerson	6,495	7.8 ± 1	4.6 ± 0.9	4.3 ± 0.6	3.9 ± 1	4.2 ± 2 (0.6 ± 0.3)
Sulzberger	12,333	15.1 ± 2	8.2 ± 2	1.0 ± 0.2	4.1 ± 2	18.2 ± 3 (1.5 ± 0.3)
Swinburne	900	4.9 ± 0.4	0.9 ± 0.2	1.5 ± 0.3	0.6 ± 0.2	3.8 ± 0.5 (4.2 ± 0.6)
Withrow	632	1.3 ±0.2	0.3 ± 0.0	1.2 ± 0.3	0.1 ± 0.1	0.3 ± 0.4 (0.5 ± 0.6)
Ross West	306,105	73.0 ± 4	33.5 ± 6	100.4 ± 8	7.6 ± 17	-1.4 ± 20 (0.0 ± 0.1)
West Antarctica	756,822	730 ± 47	191 ± 36	494 ± 57	-208 ± 36	654 ± 89 (0.9 ± 0.1)
Ross East	194,704	56.1 ± 4	31.0 ± 6	45.9 ± 4	-7.8 ± 11	49.1 ± 14 (0.3 ± 0.1)
Drygalski	2,338	9.6 ± 0.6	0.3 ± 0.1	3.0 ± 1	-0.8 ± 0.4	7.6 ± 1 (3.3 ± 0.5)
Nansen	1,985	1.3 ± 0.5	0.3 ± 0.1	0.2 ± 0.1	0.4 ± 0.1	1.1 ± 0.6 (0.6 ± 0.3)
Aviator	785	1.1 ± 0.2	0.2 ± 0.	0.2 ± 0.1	-0.3 ± 0.1	1.4 ± 0.2 (1.7 ± 0.3)
Mariner	2,705	2.5 ± 0.4	1.1 ± 0.2	0.6 ± 0.2	0.6 ± 0.3	2.4 ± 0.6 (0.9 ± 0.2)
Lillie	770	3.6 ± 0.3	0.2 ± 0.	0.5 ± 0.1	0.0 ± 0.	3.4 ± 0.3 (4.4 ± 0.4)
Rennick	3,273	4.8 ± 1	0.7 ± 0.1	0.8 ± 0.2	-2.3 ± 0.9	7.0 ± 1 (2.2 ± 0.3)
Cook	3,462	36.0 ± 3	1.7 ± 0.3	27.6 ± 3	5.5 ± 1	4.6 ± 5 (1.3 ± 1)
Ninnis	1,899	27.6 ±2	1.3 ± 0.2	24.6 ± 3	2.0 ± 0.9	2.2 ± 3 (1.2 ± 2)
Mertz	5,522	20.0 ± 1	3.6 ± 0.7	12.0 ± 2	3.6 ± 1	7.9 ± 3 (1.4 ± 0.6)
Dibble	1,482	12.5 ± 1	1.5 ± 0.3	8.2 ± 0.9	-2.3 ± 0.7	8.1 ± 1 (5.5 ± 0.9)
Holmes	1,921	26.0 ± 2	2.8 ± 0.5	24.7 ± 4	-2.5 ± 1	6.7 ± 4 (3.5 ± 2)
Moscow Univ.	5,798	52.3 ± 1	4.7 ± 0.9	29.6 ± 3	-0.1 ± 3	27.4 ± 4 (4.7 ± 0.8)
Totten	6,032	71.0 ± 3	6.2 ± 1	28.0 ± 2	-14.0 ± 2	63.2 ± 4 (10.5 ± 0.7)
Vincennes	935	12.7 ± 1	0.5 ± 0.1	6.8 ± 1	1.3 ± 0.6	5.0 ± 2 (5.3 ± 2)
Conger/Glenzer	1,547	1.7 ± 0.4	0.9 ± 0.2	1.1 ± 0.8	-2.1 ± 1	3.6 ± 1 (2.3 ± 0.9)
Tracy/Tremenchus	2,845	0.6 ±0.4	1.0 ± 0.2	0.2 ± 0.1	-1.7 ± 2	3.0 ± 2 (1.5 ± 0.7)
Shackleton	26,080	55.0 ± 4	16.2 ± 3	30.3 ± 3	-31.7 ± 14	72.6 ± 15 (2.8 ± 0.6)
West	15,666	41.9 ± 4	6.9 ± 1	32.6 ± 7	-11.1 ± 7	27.2 ± 10 (1.7 ± 0.7)
Publications	1,551	5.8 ± 0.8	0.4 ± 0.1	5.2 ± 1	-0.5 ± 0.8	1.5 ± 2 (1.0 ± 1)
Amery	60,654	56.0 ± 0.5	8.5 ± 2	59.4 ± 8	-21.4 ± 21	35.5 ± 23 (0.6 ± 0.4)
Wilma/Robert/Downer	858	10.3 ±0.5	0.6 ± 0.1	0.8 ± 0.4	0.0 ± 0	10.0 ± 0.6 (11.7 ± 0.7)
Edward VIII	411	4.1 ± 0.8	0.4 ± 0.1	0.3 ± 0.1	0.0 ± 0	4.2 ± 0.8 (10.2 ± 2)
Rayner/Thyer	641	14.2 ± 1	0.3 ± 0.1	7.8 ± 0.6	0.0 ± 0	6.7 ± 1 (10.5 ± 2)
Shirase	821	15.0 ± 1	0.4 ± 0.1	9.6 ± 1	0.0 ± 0	5.7 ± 1 (7.0 ± 2)
Prince Harald	5,392	8.3 ± 1	4.1 ± 0.8	10.3 ± 2	4.0 ± 2	-2.0 ± 3 (-0.4 ± 0.6)
Baudouin	32,952	22.0 ± 3	8.4 ± 2	6.5 ± 1	9.8 ± 11	14.1 ± 12 (0.4 ± 0.4)
Borchgrevink	21,580	19.6 ± 3	6.1 ± 1	17.5 ± 3	0.7 ± 4	7.5 ± 6 (0.3 ± 0.2)
Lazarev	8,519	3.7 ± 0.6	2.0 ± 0.4	3.1 ± 1	-3.6 ± 2	6.3 ± 2 (0.7 ± 0.2)
Nivl	7,285	3.9 ± 0.8	1.8 ± 0.3	1.3 ± 0.4	0.6 ± 1	3.9 ± 2 (0.5 ± 0.2)
Vigrid	2,089	2.7 ± 0.4	0.4 ± 0.1	2.0 ± 0.4	-2.0 ± 0.4	3.2 ± 0.7 (1.5 ± 0.3)
Fimbul	40,843	24.9 ± 4	12.7 ± 2	18.2 ± 2	-4.0 ± 7	23.5 ± 9 (0.6 ± 0.2)
Jelbart	10,844	9.9 ± 1	4.9 ± 0.9	8.8 ± 2	6.9 ± 2	-1.0 ± 3 (-0.1 ± 0.3)
Atka	1,969	0.9 ± 0.2	0.8 ± 0.1	1.0 ± 0.2	1.1 ± 0.2	-0.5 ± 0.4 (-0.2 ± 0.2)
Ekstrom	6,872	4.1 ± 0.8	2.6 ± 0.5	2.3 ± 0.6	0.0 ± 0	4.3 ± 2 (0.6 ± 0.2)
Quar	2,156	1.9 ±0.2	0.5 ± 0.1	0.6 ± 0.1	-0.5 ± 0.4	1.4 ± 0.5 (0.7 ± 0.2)
Riiser-Larsen	43,450	21.5 ± 3	12.7 ± 2	12.1 ± 2	13.4 ± 8	8.7 ± 9 (0.2 ± 0.2)
Brunt/Stancomb	36,894	20.3 ± 3	11.4 ± 2	28.1 ± 4	2.6 ± 4	1.0 ± 7 (0.03 ± 0.2)
Filchner	104,253	97.7 ± 6	13.4 ± 2	82.8 ± 4	-13.6 ± 7	41.9 ± 10 (0.4 ± 0.1)
East Antarctica	669,781	782 ± 80	174 ± 33	546 ± 70	-70 ± 34	480 ± 116 (0.7 ± 0.2)
Total surveyed	**1,553,978**	**1,696 ± 146**	**430 ± 81**	**1,089 ± 139**	**-287 ± 89**	**1,325 ± 235 (0.85 ± 0.1)**
Total Antarctica	1,561,402	2,048 ± 149		1,265 ± 141		1,500 ± 237

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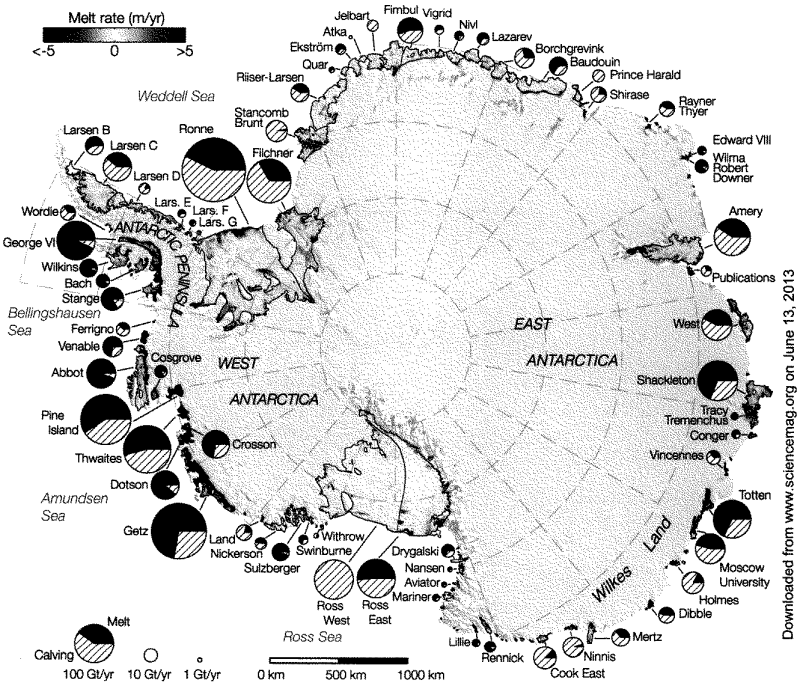

Fig. 1. Basal melt rates of Antarctic ice shelves color coded from < –5 m/year (freezing) to > +5 m/year (melting) and overlaid on a 2009 MODIS mosaic of Antarctica. Ice-shelf perimeters in 2007–2008, excluding ice rises and ice islands, are thin black lines. Each circle graph is proportional in area to the mass loss from each shelf, in gigatons (1 Gt = 10^{12} kg) per year, partitioned between iceberg calving (hatch fill) and basal melting (black fill). See Table 1 and table S1 for additional details on ice shelf locations, areas, and mass balance components.

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