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CLIMATE SERVICES: SOLUTIONS FROM COMMERCE TO COMMUNITIES

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

JULY 30, 2009

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

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CLIMATE SERVICES: SOLUTIONS FROM COMMERCE TO COMMUNITIES

THURSDAY, JULY 30, 2009

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 2:37 p.m. in room SR–253, Russell Senate Office Building, Hon. John D. Rockefeller IV, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM WEST VIRGINIA

The CHAIRMAN. According to my watch, it's precisely 2:30, so it's time to start the hearing.

[Laughter.]

The CHAIRMAN. And let me just make an opening statement, and then we're going to hear from our witnesses. And, you know, we've got all kinds of smart people sitting behind them who, I don't know, I just can't bear the thought of you three sitting back there saying nothing at all, but we'll see how it works out. If one of them makes a mistake you can just correct them.

[Laughter.]

The CHAIRMAN. OK. Our Committee has much to do with climate change. We spend much time on aviation and all kinds of other things, and, we're heavily vested in climate change, and we have been for years, but not enough people know that. That's why our Secretary of Commerce is here and our head of OSTP is here, John Holdren.

Our climate shapes every aspect of our lives. It's one of the most important pieces of legislation that we will probably ever do in the history of this country. Climate determines where we build our roads, it determines where people build homes, whether they build homes; it effects our health, it controls all kinds of our energy. Over one-third of our Nation's gross domestic product is affected by weather and climate. I don't think most people know that. I didn't either, until I prepared for this statement.

Climate change is happening. The scientists agree on that. People who say it isn't happening, have a nice day. We have observed rising temperatures and sea levels, reduced snow and ice, longer growing season, and changes in river flow. There's terror about water in the West. And there ought to be. You know, I mean, this—things are happening everywhere. How people can ignore any of it, I just don't understand.

So, these challenges continue to grow, but so does our knowledge of the climate system, the reach of our scientific research. It just happens that our President has surrounded himself with absolutely brilliant scientists, and he's fascinated by technology and research. And so, we couldn't be better positioned to walk into these responsibilities.

We have a responsibility to share what we know, widely, much like trying—you know, the public is sort of saying, "Well what are they doing up there, on healthcare? We don't understand." Well, that's understandable. This is, in some ways, much more complicated and much more abstract, because it's not immediate, it's not something you take out of your pocket and pay to an insurance company. You may not have a house or have a pocket to take something out to give to an insurance company if climate change isn't being addressed in the proper fashion.

We continue to learn so much. Every day, dedicated scientists and entrepreneurs explain new challenges and highlight new opportunities, and it gives me tremendous hope, particularly when I'm faced with the kind of people I'm looking at right now. However, the reality is that, unless that information reaches the people who are confronting climate change on the front lines, it will have been for naught. It is time to take the science out of the laboratories and bring it into our communities, to make it a part of what our people trust, believe, and depend on.

So, this is about putting climate science to work in people's lives, to protect public health by predicting the spread of infectious diseases due to climate change, to anticipate droughts and take actions to reduce their economic and environmental impacts, to adjust our building codes to withstand the increased storm intensity and flooding. It's also about making those tools, and the climate science behind them available—making it transparent and useful to everyday Americans.

This hearing's purpose, and a top priority of this committee, is to make sure that the essential facts—most importantly, research and the latest technology that have come directly from sound climate science—finds its way directly to the people who can put it to work for themselves and their families every day. This means community advocates and business leaders, public and private and government entities, and local, State, and Federal lawmakers.

I would also like to note, when it comes to climate change, that the Commerce Committee, as I mentioned earlier, has a long history of dealing with this crucial intersection where science meets public policy, and the hard work of making a difference. And so, today I look forward to discussing these great challenges in—not all of them, but some of them—and the Federal Government's work to translate climate science into information and services for users to plan for, and respond to, the effects of climate change, which are going on everywhere.

The Department of Commerce, through efforts like the National Climate Service, and the Office of Science and Technology Policy, continue to look for innovative new ways to share information and address mounting public needs, and I'm confident that their leadership will bring the best research and the latest technology front and center.

So, I, for one, am very honored that our two witnesses are here, that they've taken the time. I think that you're on a time constraint, aren't you? No? I think—aren't you?

Secretary LOCKE. Moderate.

The CHAIRMAN. Is it 3:40?

Secretary LOCKE. I think we can go a little bit beyond that.

The CHAIRMAN. You do? OK. Well, but be very honest with me.

Secretary LOCKE. Alright.

The CHAIRMAN. Our Commerce Secretary brings valuable insight to the challenge facing climate change on the global stage. As Director of the White House Office of Science and Technology Policy, John Holdren, who has already had an impact on my life, is charged with a broad mandate of developing and implementing sound science and technology policies and budgets, collaborating across agencies—good luck, John——

[Laughter.]

The CHAIRMAN.—while engaging the wider science and engineering communities in that mission. So, together I hope we can look specifically at bringing all of our stakeholders to the table, helping them stay competitive in emerging markets, and making sure they are investing in our energy future.

So, this hearing is a great opportunity to highlight how sound climate science can drive our economy, empower stakeholders with the tools to respond and thrive.

I thank you.

And I turn now to our good Secretary, Secretary Locke.

STATEMENT OF HON. GARY F. LOCKE, SECRETARY, U.S. DEPARTMENT OF COMMERCE

Secretary LOCKE. Thank you very much, Chairman Rockefeller. It's good to see you again. And I want to thank you for the opportunity to discuss the Department of Commerce's climate capabilities.

I'm also pleased to be joined by Dr. John Holdren, Director of the White House Office of Science and Technology Policy, OSTP. The Department and OSTP are close partners on the climate issues that I want to talk about today.

But, before I do that, I also want to point out, in the audience behind me is Dennis Hightower, the President's nominee to be Deputy Secretary of Commerce. And I believe that he has already met with you and perhaps is scheduled for his confirmation hearing next week.

Also, I want to introduce and acknowledge Jane Lubchenco, who is our Administrator of NOAA, who will, at the end of the month—end of August—be leading the United States delegation to the World Climate Conference in Geneva as Administrator of NOAA, but, more importantly, on behalf of the entire U.S. Government.

Climate change presents America with a daunting challenge, but also an historic opportunity. I'm here today to explain how the Department of Commerce is uniquely situated to help America tackle both of them.

First, the challenge. The world's climate is unequivocally going through dangerous and unpredictable changes. Surface air and ocean temperatures are increasing, sea levels are rising, and wide-

spread melting of glaciers and Arctic sea ice is accelerating. And, just this month, NOAA reported that the world's ocean surface temperature was the warmest on record for June, breaking the previous high set in 2005. These trends are causing more extreme weather, coastal and agricultural degradation, droughts, and wildfires. And, just yesterday, Seattle reported an all-time high in its temperature, reaching 103 degrees. Vancouver, Washington, reached 107 degrees. Seattle is expected to hover at the 100-degree temperature mark for this entire week.

America must take the threat of climate change seriously, but first we have to understand it, and that's where NOAA has been indispensable for decades. NOAA's mandate for climate activities was established in 1978, and its capabilities span operational climate observing networks, global greenhouse gas monitoring, climate predictions and projections, climate research, and climate data stewardship. Indeed, with respect to the World Climate Data Center—that's the world's largest repository of climate and paleoclimate data—that is maintained by NOAA. With all the measurement devices around the world measuring greenhouse gases, 66 percent of the world's measurement systems are maintained by NOAA.

So, NOAA has monitored and measured the carbon cycle in the atmosphere and oceans for 40 years. Its measurements and modeling of carbon dioxide and other greenhouse gas concentrations in the atmosphere are among the most comprehensive in the world.

Commerce's National Institute of Standards and Technology, NIST, has also worked with NASA and others to develop new satellite instruments that measure the Sun's light ten times more accurately than previous instruments.

This information that I've cited isn't merely of academic interest. As you've indicated, these measurements will play an important role in verifying the effectiveness of our domestic and international policies through independent verification of emissions from both domestic and international sources, and allow us to understand whether emission-reduction efforts on the ground, by citizens, business, and government, are having their intended effects on our climate.

NOAA uses its ocean and climate science to support its mandated coastal and ocean stewardship responsibilities, including fisheries management, conservation of coastal habitat, and protection of endangered species, such as salmon. In addition, NOAA provides support to other Federal agencies, State and local governments, but also, critically, to the private sector, as they make decisions about adjusting to climate changes. For example, NOAA helped answer the call of Western Governors for better monitoring and early warning of droughts. And, thanks to this Committee, NOAA is working with its Federal agency partners to respond, through the National Integrated Drought Information System. This is critical to our economy, as unchecked drought causes average annual losses to all sectors of the economy of $6 to $8 billion a year. And NOAA's Air Freezing Index Program has helped the U.S. construction industry make better decisions about when and how to pour concrete building foundations, saving approximately $300 million in material costs every single year.

In the years ahead, a changing climate will undoubtedly force America to rethink our water, energy, transportation and agriculture infrastructure, in light of new wind, water, and temperature patterns. Decision-makers at all levels, public and private, will depend on NOAA to chart a viable way forward.

This is America's climate challenge. But, as I said at the outset, our challenge also presents an opportunity. The scientific and technological innovations that the world will need to mitigate climate change can also spawn one of the most promising areas of economic growth of the 21st century. And I want to see America at the forefront of this innovation.

I just returned from China with Secretary of Energy, Steven Chu, and China is making record investments in clean energy technologies. Our conversations with the Chinese officials yielded tremendous opportunities for partnership, but also showed the way for new markets for U.S. companies. And that means, also, jobs for Americans. But, our conversations with the Chinese raised a serious question, Is the United States going to be a leader in addressing climate change, or will we fall behind? I believe that we are moving in the right direction.

Indeed, the climate change and energy security legislation under consideration in the Congress will create new incentives for energy-efficient technologies, products, and services and reduce our over-dependence on foreign oil. These incentives will foster the creation of new businesses and the jobs, American jobs, that will come with them.

The entire Department of Commerce has already been assisting in this transformation, and we intend to do even more. The Department is promoting "green" innovation, protecting the intellectual property behind new technologies, and developing standards and measurements that will enable innovations, like the smart electrical grid.

The Department is also supporting the commercialization of green ideas, promoting climate-friendly economic development, and helping small- and medium-size manufacturers make their production processes more sustainable.

And the Department is highlighting emerging commercial opportunities, promoting the export of new green products and services, and encouraging industry to become more involved in international climate change discussions.

Mr. Chairman, the Department of Commerce's Congressional mandate for climate activity, starting in 1978; our internationally recognized expertise in climate change research, as well as all of the data that we hold; and our mission to advance U.S. businesses and innovation enable us, the Department of Commerce, to lead America's efforts to meet our climate challenges and capitalize on these opportunities.

I thank you again for the opportunity to address this Committee and I look forward to your questions.

Thank you very much.

[The prepared statement of Secretary Locke follows:]

PREPARED STATEMENT OF HON. GARY F. LOCKE, SECRETARY, U.S. DEPARTMENT OF COMMERCE

Chairman Rockefeller, Ranking Member Hutchison, and other honorable members of the Committee, thank you for the opportunity to discuss the Department of Commerce's climate capabilities. I am pleased to be joined by Dr. John Holdren, Director of the White House Office of Science and Technology Policy (OSTP). The Department and OSTP are close partners on the climate issues I will talk about today.

Climate change presents America with a daunting challenge . . . and an historic opportunity.

I am here today to explain how the Department of Commerce is uniquely situated to help America tackle both of them.

First, the challenge:

The world's climate is unequivocally going through dangerous and unpredictable changes.

- Surface air and ocean temperatures are increasing,
- Sea levels are rising,
- And widespread melting of glaciers and Arctic sea ice is accelerating.

Last month, the U.S. Global Change Research Program released a landmark report, *Global Climate Change Impacts in the United States.* This body of work, a product of 13 Federal agency and outside experts with leadership from the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), confirms many of the climate's troubling changes and gives a comprehensive picture of projected future impacts on specific regions and sectors. We are seeing the impacts of this change in our own backyards in every region of the country, from extreme weather and coastal impacts to drought and wildfire trends.

These trends should trouble anyone concerned about the health of America's environment and the vitality of our economy.

Just this month, NOAA reported the world's ocean surface temperature was the warmest on record for June, breaking the previous high set in 2005. Warmer oceans could create dangerous changes in marine ecosystems, including widespread bleaching of coral reefs in places like the Florida Keys. That development alone may significantly impact thousands of Floridians who depend on fishing and tourism for their livelihood.

If America is to avoid the most damaging effects of climate change, we have to first understand it—and that is where the Department of Commerce is instrumental.

The Department of Commerce is a leader in climate change research and monitoring, providing critical data and services to all levels of government and the private sector—and helping companies and communities understand and adapt to climate change.

NOAA's mandate for climate activities was established in 1978, and its capabilities span operational climate observing networks, global greenhouse gas monitoring, climate predictions and projections, climate research, and climate data stewardship.

For example, NOAA has monitored and measured the carbon cycle in the atmosphere and oceans for 40 years, taking observations on the ground, under the sea, and in space. NOAA's measurements and modeling of carbon dioxide and other greenhouse gas concentrations in the atmosphere are among the most comprehensive in the world—and are widely considered among the best available modeling of carbon sources and sinks.

NOAA's measurements of carbon dioxide concentrations also play an important role in monitoring ocean acidification. As the ocean has absorbed greater amounts of carbon dioxide over the past two centuries, its acidity has increased by 30 percent. Simply stated, rising acidity in the ocean could potentially short-circuit the marine food chain—which would undoubtedly have negative effects on commercially important species like oysters and salmon.

NOAA's climate monitoring is assisted by other agencies within the Department as well as other Federal agencies. Our National Institute of Standards and Technology (NIST) worked with NASA and others to develop new satellite instruments that measure the Sun's light ten times more accurately than previous instruments. Space-based climate monitoring is enabled by partnerships with NASA.

This information isn't merely of academic interest.

These measurements will play an important role in verifying the effectiveness of our domestic and international policies through independent verification of bottom-up emissions—from both domestic and international sources—and allow us to understand whether emissions reductions are having their intended effects on our climate.

NOAA also uses its ocean and climate science to support its mandated coastal and ocean stewardship responsibilities—including fisheries management, conservation of coastal habitats, and protection of endangered species, such as salmon. Incorporating climate impacts like sea-level rise and increasing ocean temperatures into long-term planning for these public trust resources is essential to ensuring their resilience and continued economic and social benefits in a changing world.

In addition, NOAA provides critical information and services to other Federal agencies, state and local governments, and the private sector as they make decisions about adjusting to climate change.

When I was Governor of Washington, I, along with other western Governors, needed information to understand and predict drought, which causes average annual losses to all sectors of the economy of $6 to $8 billion. (*Economic Impacts of Drought and the Benefits of NOAA's Drought Forecasting Services,* NOAA Magazine, September 17, 2002.) It was not just about preparing our agricultural sector—we also needed that information to guide infrastructure investments that required an understanding of long-term regional climate trends. Thanks to this Committee, NOAA is working with its Federal agency partners to respond through the National Integrated Drought Information System. Now, decisionmakers can visit *drought.gov* to receive early warnings about anticipated droughts.

Another real-world service is the climate data that NOAA's air freezing index program provides. It allows building foundations to be more economically constructed, reducing the materials costs of the U.S. construction industry by approximately $300 million per year. (*Economic Value for the Nation,* NOAA Satellites and Information, September 2001.)

The Department of Commerce is working with our Federal partners, including the National Science Foundation, the Departments of the Interior, Agriculture, and Energy, the Environmental Protection Agency, and Dr. Holdren's Office of Science and Technology Policy, among others, to further bridge climate science and the growing needs of public and private decisionmakers.

In the years ahead, a changing climate will undoubtedly force America to rethink our water, energy, transportation and agriculture infrastructure in light of new wind, water and temperature patterns. Decisions on where and how we build a bridge, a levee, an oil pipeline or an irrigation system will all have to take climate change into account. NOAA will be there to inform a viable way forward.

This is America's climate challenge. But, as I said at the outset, our challenge also presents an opportunity.

The scientific and technological innovations the world will need to mitigate climate change can spawn one of the most promising areas of economic growth in the 21st century—and I want to see America at the forefront.

I just returned from China, where they are making significant investments in clean energy technologies. My conversations with Chinese officials yielded tremendous opportunities for partnership, and new markets for U.S. industry. But they also raised a serious question:

"Is the United States going to be a leader in addressing climate change, or will we fall behind?"

I believe we are moving in the right direction.

Indeed, the climate change and energy security legislation under consideration in Congress will create new incentives for energy efficient technologies, products and services and reduce our dependence on foreign oil.

These incentives will drive demand that will foster the creation of new businesses and the jobs that come with them.

The entire Department of Commerce stands ready to assist in this transformation.

The Department of Commerce is a vital ally of Main Street American business—serving both as an enabler of innovation and sustainability at home as well as the advocate for U.S. businesses around the world. We can help foster "green" and "blue" jobs that will be created by new businesses offering climate solutions.

The Department is encouraging green innovation. Our Patent and Trademark Office protects the intellectual property behind new technologies, while NIST develops standards and measurements that enable innovations like the Smart Grid, which has the potential to use technology to help deliver electricity more efficiently, save energy, and reduce costs to consumers.

The Department is supporting the commercialization of green ideas. The Economic Development Administration is helping communities adapt in this changing environment, while sustaining their economic development. NIST's Hollings Manufacturing Extension Partnership is helping small and medium-sized manufacturers make their production processes more sustainable.

And, the Department's International Trade Administration is highlighting emerging commercial opportunities, promoting the export of new green products and serv-

ices, and encouraging industry to become more involved in international climate change discussions.

Mr. Chairman, the Department of Commerce's expertise in climate change research and our mission to advance U.S. businesses and innovation, enables us to lead America's efforts to meet our climate challenges, and capitalize on the opportunities.

I thank you again for the opportunity to address this Committee, and I look forward to your questions.

The CHAIRMAN. Thank you, Mr. Secretary.

Dr. Holdren?

STATEMENT OF HON. JOHN P. HOLDREN, PH.D., DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Dr. HOLDREN. Chairman Rockefeller, Senator Begich, it is a great pleasure to be with you again in this room, especially so with my confirmation safely behind me.

It's a particular pleasure to be here in the company of my colleague, Secretary Locke, and to have both of us backed, as it were, by Under Secretary Lubchenco, who, as you know, went through the confirmation process with me in tandem.

The latest and best scientific information forms——

The CHAIRMAN. You don't say that with a great deal of warmth—not with respect to Jane, but with respect to the process. And you shouldn't.

[Laughter.]

Dr. HOLDREN. I won't comment further on that.

The CHAIRMAN. OK.

[Laughter.]

Dr. HOLDREN. But, I'm delighted it's behind us.

[Laughter.]

Dr. HOLDREN. The latest and best scientific information forms the bedrock on which effective policy to combat and cope with climate change has to be built. To assist the government, and society as a whole, understand, mitigate, and adapt to climate change, the agencies of the Federal Government deploy a wide range of powerful science and technology resources. The U.S. Global Change Research Program, USGCRP, brings together into a single interagency program the essential capabilities for research and observations that are widely distributed across these government agencies, 13 of them in all. The USGCRP is managed by a director from one of the participating agencies, currently NASA, with the help of a program office and interagency working groups that plan future research and crosscutting activities, including communications, decision support and information and data issues.

OSTP and OMB, the Office of Management and Budget, work closely with the program office and the working groups to establish research priorities and funding plans to ensure that the program is aligned with the Administration's priorities and reflects agency planning.

The Climate Change Technology Program, CCTP, is the technology counterpart to USGCRP. Its aim is to accelerate the development of new and advanced technologies to address climate change, focusing on energy efficiency enhancements and technologies that can reduce, avoid, or capture and store greenhouse

gas emissions. The Department of Energy serves as the lead agency for that effort. Twelve agencies participate in the interagency coordination efforts of the CCTP.

Clearly, the USGCRP and the CCTP need to coordinate their efforts in order to get the maximum benefit from each effort and from the combination. The necessary interaction has, unfortunately, not always occurred. OSTP is now working with DOE and with OMB to help create the necessary coordination between the USGCRP and the CCTP to help ensure maximum flow and synergy between these science and technology programs.

If I may, Mr. Chairman, I'd now like to elaborate briefly on two aspects of all this that I believe are of particular interest to the Committee and that are treated in some detail in my written statement: the coordination of Earth observations and the development of an effective climate-services capability in the Federal Government.

First, observations. Making the observations needed to determine how the climate is changing, and how those changes are affecting environmental conditions important to human well-being, is the starting point for all understanding of the climate change challenge. And this domain of activity, all by itself, is an immensely complicated endeavor requiring cooperation and coordination across agencies and levels of government, as well as internationally.

The myriad of observations being made today vary widely in purpose and scope, and are distributed among literally hundreds of programs under the purview of Federal agencies and other institutions, domestic and international. To a large degree, up until now these observations have been only loosely coordinated and integrated, but that shortcoming is now widely recognized, the needs and opportunities for doing better have been analyzed in reports produced inside and outside the government, and progress is starting to be made.

The concept of an integrated Earth-observing system has been articulated and increasingly fleshed out by the Group on Earth Observations, GEO, which is a consortium of 79 countries, the European Commission, and over 50 international organizations. Much of that body's effort has been focused on creation of something called the Global Earth Observation System of Systems, which coordinates Earth observations at the international level, facilitates the sharing and productive application of global, regional, and local data from satellites, ocean buoys, weather stations, and other surface and airborne Earth-observing instruments. The United States component of that effort, called USGO, is a standing subcommittee of the National Science and Technology Council, which is coordinated by OSTP.

As Members of this Committee know, however, the outlook for U.S. space-based Earth observation systems is clouded, if you'll forgive my use of that term in this context; and, in particular, continuity of our weather forecasting capabilities is threatened by reductions and delays in the three agency National Polar-orbiting Environmental Satellite System Program—NPOESS, for short—and plans for climate change measurements by this system have been scaled back. In addition, a gap in land imagery is now almost

inevitable, and will impact multiple societal needs, including agriculture, biodiversity, ecosystems, and water.

Clearly, we need to increase oversight and improve interagency coordination in our Earth-observation satellite programs. We need to proactively manage these programs to avert future cost and schedule overruns. Agencies need to work together to manage the contractors building the satellites and to demand cost and schedule accountability.

As Members of this Committee and I agreed during my confirmation hearing, a large part of the responsibility for seeing that this happens rests on OSTP. In this connection, getting NPOESS back on track has been, and remains, a particularly high priority for me and for others in the Administration's leadership team.

I started convening meetings of the relevant officials in the three NPOESS agencies—NASA, NOAA and DOD—to address this issue immediately after I was confirmed, and all are now committed to cooperating in solving the problems that have plagued this critically important program.

We are now forming a task force, within the Executive Office of the President, that will meet regularly with the leaders of the NPOESS effort in NASA, NOAA, and DOD to monitor progress and help overcome obstacles on the way to fixing this program.

Now to climate services. The increasing attention that this concept is getting is rooted in the recognition that coordinated climate information and related services are needed to assist decisionmaking all across the public and private sectors concerning how to deal with climate variability and change. And just as the Nation's climate research efforts require and benefit from interagency and academic partnerships, so, too, will the development and communication of climate change information to users. No single agency is capable of providing all of the information and services needed to inform decisionmaking. To be successful, the delivery of climate services will require sustained Federal agency partnerships and collaborations, engaging climate service providers and end-users alike.

While much work has already been done to evaluate the need for climate services and a national climate service, the Administration believes that additional assessment and analysis of existing climate service capabilities and user needs for climate services is necessary. A national climate service—and, more broadly, our Nation's approach to delivering climate services—will require that such analysis and assessment is ongoing, science-based, user-responsive, and relevant to all levels of interest—that is, local, regional, national and international. The Administration recognizes the need to move forward with the climate services concept.

To this end, OSTP plans to convene an NSTC task force, with representation from the full range of relevant agencies—NOAA, NASA, NIST, USGS, EPA, the Department's of Commerce, Interior, Agriculture, and Energy, and more—to be charged with examining national assets, existing data and information gaps, and costs related to the development of a cohesive framework for delivering accurate climate-related information to the public. This process is intended to lead to a detailed, functional, and organizational approach for delivering climate services to the Nation.

In conclusion, Mr. Chairman, let me emphasize that I regard it as one of the primary challenges to OSTP to provide the oversight and coordination of this country's global-change research, monitoring, and information services that will be needed to ensure that our decisionmakers, our businesses, our farmers, our fishermen, and all of our citizens have the information they need to understand climate change, the ways we can mitigate it, and the ways we can adapt to the degree of change we can't avoid. Working in partnership with the OMB, other White House offices, executive-branch departments and agencies, and the Congress, we aim to pull together the expertise, across the government, to construct the relationships and interactions among these entities that will result in an integrated effort that is both greater than the sum of its parts and adequate to the country's needs.

I look forward to working with the Committee in this effort, and I'll be pleased to try to answer any questions you may have.

[The prepared statement of Dr. Holdren follows:]

PREPARED STATEMENT OF HON. JOHN P. HOLDREN, PH.D., DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Chairman Rockefeller, Ranking Member Hutchison, and Members of the Committee, I thank you for the opportunity to testify at this important hearing. Your Committee has a long history of leadership in addressing the need to improve our scientific understanding of climate change, which is so critical in shaping the kinds of policy decisions with which Congress is now grappling. I will focus my testimony here on the science of global climate change and what it is telling us about the challenges we face as a global community and as a nation, and on the role that the Office of Science and Technology Policy (OSTP) plays in coordinating climate change science and technology programs across the relevant Federal agencies for the benefit of the Nation.

Science and the Climate Challenge

Investments in climate science over the past several decades have contributed to greatly increasing understanding of global climate change, including its attribution mainly to human influences.

We now know that climate is changing all across the globe. The air and the oceans are warming, mountain glaciers are disappearing, sea ice is shrinking, permafrost is thawing, the great land ice sheets on Greenland and Antarctica are showing signs of instability, and sea level is rising. And the consequences for human well-being are already being felt: more heat waves, floods, droughts, and wildfires; tropical diseases reaching into the temperate zones; vast areas of forest destroyed by pest outbreaks linked to warming; alterations in patterns of rainfall on which agriculture depends; and coastal property increasingly at risk from the surging seas. All of these kinds of impacts are being experienced here in the United States as well as elsewhere, as extensively documented in a report of the U.S. Global Change Research program on *Global Climate Change Impacts in the United States* that was released with the endorsement of OSTP and NOAA last month.

We know the primary cause of these perils beyond any reasonable doubt. It is the emission of carbon dioxide (CO_2) and other heat-trapping pollutants from our factories, our vehicles, and our power plants, and from use of our land in ways that move carbon from soils and vegetation into the atmosphere in the form of CO_2. We also know that failure to curb these emissions will bring far bigger impacts from global climate change in the future than those experienced so far. Devastating increases in the power of the strongest hurricanes, sharp drops in the productivity of farms and ocean fisheries, a dramatic acceleration of species extinctions, and inundation of low-lying areas by rising sea level are among the possible outcomes.

And we know what we can and must do to avoid the worst of the possible outcomes of climate change. We can transform our technologies for supplying and using energy from polluting and wasteful to clean and efficient, using new incentives to accelerate the process and new agreements and forms of cooperation to bring the rest of the world along. We can halt and reverse deforestation, and we can modify farming practices in ways that increase rather than decrease the amounts of carbon stored in agricultural soils. Indeed, with care in choice of locations and methods, we

can make our farms and our forests sustainable sources not only of food and fiber but of clean, renewable biofuels to help with the energy side of the solution.

Extensive use of technologies that increase energy end-use efficiency and that supply energy with greatly reduced carbon dioxide emissions will be needed, along with improved management of forests and agricultural soils, to achieve President Obama's stated goal of an 83 percent reduction in U.S. greenhouse gas emissions below 2005 levels by 2050—a goal intended, when coupled with similarly ambitious performance by other major emitting countries, to avoid the worst effects of climate change. Improving the technologies of energy end-use and supply, as well as relevant practices in agriculture and forestry, will play a major role in getting this done. To this end, the Federal Government is increasing funding for research and development across a broad portfolio of greenhouse gas mitigation options, including high-performance buildings; advanced manufacturing; advanced vehicles; clean biofuels; wind, solar, geothermal, and nuclear power; carbon capture and sequestration; advanced energy storage; a more intelligent electric grid; techniques for reducing emissions and/or increasing uptake of CO_2 in agriculture and forestry; and more.

The government will also need to implement incentives, as outlined in the Recovery Act and the FY 2010 Budget, to encourage firms and individuals to choose climate-friendly technologies, to contribute funding for early stage and high-risk research and development where the private sector on its own would do less than society needs, and to help execute ongoing and planned demonstration projects (such as for carbon capture and sequestration) where the scale and risk of the needed efforts would inhibit solely private approaches. The creation of the needed set of signals and supports is of course a primary aim of the comprehensive energy-climate legislation that has been passed by the House and is now under consideration in the Senate.

Unfortunately, it is simply not practical to reduce heat-trapping emissions rapidly enough to halt overnight the build-up of the offending substances in the atmosphere, both because of the inertia in our energy infrastructure and in agricultural and forestry practices and because of the long residence times in the atmosphere of many of the greenhouse gases. Even if the atmospheric concentrations of all of the relevant substances could be stabilized instantaneously, the average surface temperature of the Earth would continue to slowly climb for decades, with accompanying changes in associated climatic phenomena such as rainfall patterns and temperature extremes, because of long lag time needed for the oceans to reach equilibrium with these atmospheric conditions.

This circumstance underlines the need to invest, in parallel with efforts to reduce emissions and increase uptake of the main heat-trapping gases and particles, in adaptation to the changes in climate that can no longer be avoided—*e.g.,* breeding heat- and drought-resistant crop strains, bolstering defenses against tropical diseases, improving the efficiency of water use, managing ecosystems to improve their resilience, and management of coastal zones with sea-level rise in mind. As noted by the USGCRP *Global Climate Change Impacts* report, informed choices about adaptation will need to be made at many scales of human activity, from an individual farmer switching to growing a different crop variety better suited to warmer or drier conditions, to a company relocating key business centers away from coastal areas vulnerable to sea-level rise and hurricanes, to a community altering its zoning and building codes to place fewer structures in harm's way and making buildings less vulnerable to damage from floods, fires, and other extreme events.

When we do all that we ought to do in the way of both mitigation and adaptation, we will benefit not only by avoiding the worst damages from climate change, but also by reducing our overdependence on petroleum, continuing to improve air quality in our cities, preserving our forests as havens for biodiversity and sources of sustainable livelihoods, reducing our vulnerability to the extreme weather events that occur from time to time even when climate is not changing overall, and generating new businesses, new jobs, and new growth in the course of getting it all done.

Accelerating Progress Through Interagency Coordination

The latest and best scientific information forms the bedrock on which effective policy to combat and cope with climate change must be built. To assist the government and society as a whole with understanding, mitigating, and adapting to climate change, the agencies of the Federal Government deploy a wide range of powerful science and technology resources. Each agency has different sets of key specialists and capabilities, different networks and relationships with the external research community, and separate program and budget authorities. The U.S. Global Change Research Program (USGCRP) brings together into a single interagency program the essential capacities for research and observations that are widely distributed across these government agencies. An essential component of success in delivering the in-

formation necessary for decisionmaking is coordination of the programmatic and budgetary decisions of the 13 agencies that make up the USGCRP.

Growing out of interagency activities and planning beginning in about 1988, with relevant heritage going back even further, creation of the USGCRP energized cooperative interagency activities, with each agency bringing its strength to the collaborative effort. In 1990, the USGCRP received Congressional support under the Global Change Research Act (GCRA). The Act called for the development of a research program ". . . to understand, assess, predict, and respond to human-induced and natural processes of global change," and it guided federally-supported global change research for the next decade. In 2001, President Bush established the Climate Change Research Initiative (CCRI) to investigate uncertainties and set research priorities in climate-change science, aiming to fill gaps in understanding within a few years. In the following year, it was announced that the USGCRP and CCRI together would become the Climate Change Science Program (CCSP). The USGCRP label remained attached to many of the program's activities, however, and consistent with the language of the GCRA statute the whole effort is going forward in the Obama Administration as the USGCRP, with CCSP as a component.

The USGCRP is managed by a director from one of the participating agencies (currently from NASA) with the help of a program office (the USGCRP Integration and Coordination Office) and interagency working groups that plan future research and crosscutting activities, such as communications, decision support, and information and data concerns. OSTP and OMB work closely with the Interagency Integration and Coordination Office and the working groups to establish research priorities and funding plans to assure the program is aligned with the Administration's priorities and reflects agency planning.

The 2010 Budget provides $2.0 billion for USGCRP/CCSP programs, an increase of $46 million or 2.3 percent over the 2009 level (excluding Recovery Act funds). USGCRP programs also received $461 million in Recovery Act funding based on preliminary agency allocations, including $237 million for NASA climate activities. Recovery Act funding also includes $170 million for NOAA climate modeling activities. The 2010 Budget supports research activities including the development of an integrated Earth system analysis capability; a focus toward creating a high-quality record of the state of the atmosphere and ocean since 1979; development of an end-to-end hydrologic projection and application capability; enhanced carbon cycle research on high latitude systems; quantification of climate forcing and feedbacks by aerosols, non-carbon dioxide greenhouse gases, water vapor, and clouds; assessment of abrupt change in a warming climate; examination of the feasibility of development of an abrupt change early warning system; understanding climate change impacts on ecosystem functions; and refining ecological forecasting.

The Climate Change Technology Program (CCTP) is the technology counterpart to USGCRP. Its aim is to accelerate the development of new and advanced technologies to address climate change, focusing on energy-efficiency enhancements and technologies that can reduce, avoid, or capture and store greenhouse gas emissions. The CCTP was established administratively in 2002 and authorized by the Energy Policy Act of 2005, and it began supporting and coordinating programs in 2007. The Department of Energy serves as the lead agency for the effort. Twelve agencies participate in the interagency coordination efforts of CCTP, eight of which also fund activities included in the CCTP portfolio.

The 2010 Budget provides $5.3 billion for CCTP programs, an increase of $52 million over the 2009 level, excluding Recovery Act funds described below. The Budget funds a wide range of activities important to making progress toward climate-change goals. The Budget funds a wide range of activities that support progress toward climate change goals including programs that focus on energy efficiency improvements, low-carbon fuels and power, enabling technologies, such as energy storage and improving the electric power grid, power distribution and controls, and efforts to promote reductions emissions of non-CO_2 greenhouse gases.

CCTP programs received over $25 billion in Recovery Act funding allocations, with most of it supporting DOE programs, including $16.8 billion for energy efficiency and renewable energy, $4.2 billion for electricity delivery and energy reliability, $3.4 billion for efficiency and sequestration programs in fossil energy R&D, and $400 million for the Advanced Research Projects Agency-E (ARPA–E), augmenting the support for advanced research in the DOE science programs. Other agencies also received Recovery Act funding for CCTP-related technology development and deployment, including DOD ($139M), DOT ($100M), NASA ($39M), and NSF ($2M).

Clearly, CCSP and CCTP need to coordinate their efforts in order to get the maximum benefit from each effort and from the combination. The necessary interaction has not always occurred, however. OSTP is now working with DOE and with OMB

to help create the necessary coordination between the CCSP and the CCTP to help ensure maximum flow and synergy between science and technology programs.

Reforming the USGCRP to Address Emerging National Needs

The USGCRP works most effectively to address national needs when the scientific capacities of individual agencies are leveraged with coordinated interagency planning and priority setting across the program. To encourage cooperation and budgetary discipline, the GCRA requires an integrated research plan in combination with an interagency budget cross-cut. With strong OSTP and OMB involvement in their preparation, these collective interagency budgets have enabled significant advances in research efforts, including international field programs that combined the satellite and other capabilities of NASA, satellite, aircraft, ship and network capabilities of the Department of Commerce's NOAA, the university research and field experiment capabilities of NSF, and long-term atmospheric and terrestrial ecosystem observation capabilities of DOE.

These investments led to much more comprehensive and complete data sets for analysis by scientists in all nations, thus promoting, at lower cost to the United States, more complete and faster insight into such phenomena as the El Niño Southern Oscillation (ENSO), the photochemistry of global and polar ozone loss, oceanic uptake of carbon, and much more. Improvement of climate models and transfer of such models to the new generations of massively parallel computers was accelerated by combining the scientific and technical strengths of DOE, the Department of Commerce's NOAA, NSF, and NASA with the world leading high-performance computing capabilities developed by DOE. The sharing of data and model results allowed other agencies, such as the Department of the Interior, the Department of Agriculture, and the Smithsonian Institution to draw on the results to study changes in terrestrial ecosystems, hydrology, agriculture, human settlements, and the polar-regions. The capacity and leadership of the program significantly advanced scientific understanding in ways that continue to benefit society.

Although the USGCRP supports a wide variety of research activities to gain more detailed predictive understanding of climate change, there remain significant gaps in going from an estimate of how much the climate may change to the effects these changes may have on ecosystem services, water resources, natural resource utilization, human health, and societal well-being. It is important for the USGCRP to make a strong commitment to providing the information that society is seeking in order to reduce vulnerabilities and improve resilience to variability and change. For example, a recent National Research Council report recommends restructuring the USGCRP around ". . . the end-to-end climate change problem, from understanding causes and processes to supporting actions needed to cope with the impending societal problems of climate change." [1] This will require the USGCRP to support a balanced portfolio of fundamental and application-oriented research activities from expanded modeling efforts to studies of coupled human-natural systems and institutional resilience.

In addition, it would mean boosting adaptation research; bolstering capacity to monitor change and its impacts (including not only enhancing our monitoring networks on land and for the oceans but also strengthening our system of Earth-observation satellites); producing the sorts of integrated assessment of the pace, patterns, and regional impacts of climate change that will be needed by decisionmakers as input into their deliberations on the metrics and goals to be embraced for both mitigation and adaptation; and making climate data and information accessible to those who need it.

Three areas of particular need for more comprehensive and coordinated treatment from USGCRP are adaptation research, integrated assessment, and climate services. I take up each briefly in turn.

Adaptation Research

There currently exists limited knowledge about the ability of communities, regions, and sectors to adapt to a changing climate. To address this shortfall, research on climate change impacts and adaptation must include complex human dimensions, such as economics, management, governance, behavior, and equity. Interdisciplinary research on adaptation that takes into account the interconnectedness of the Earth system and the complex nature of the social, political, and economic environment in which adaptation decisions must be made would be central to this effort. Given the relationships between climate change and extreme events, the community of researchers, engineers and other experts who work on reducing risks from natural and

[1] National Research Council, 2009. *Restructuring Federal Climate Research to Meet the Challenges of Climate Change.* National Academy Press, Washington, D.C.

human-caused disasters will have an important role to play in framing climate change adaptation strategies and in providing information to support decision-making during implementation. For example, assessments of emergency preparedness and response systems, insurance systems, and disaster-relief capabilities are an important component of a society's adaptive capacity.

Integrated Assessment

Preparing for and adapting and responding to the impacts of climate change must start locally and regionally, as each region is distinct, and each type of impact is experienced in different ways in different places and for different sectors of the economy. Any national assessment activity must engage localities and sectors to aggregate information into a national picture of climate impacts, and should also use this engagement to gather information on the "demand-side" of the adaptation problem, where people live and work, to reorient research and observation investments. While there are certainly issues where national policy steps are warranted, there will be many challenges where individuals, public and private sector organizations, local communities, states, and regions will need to respond. USGCRP activities need to serve all of these scales and stakeholders, not dictating what policies to follow, but providing information and capabilities needed by those experiencing the impacts so that they can prepare for and adapt and respond to future conditions.

Climate Services

Coordinated climate information and services are needed to assist decision-making across public and private sectors. Local planners will want information on likely changes in precipitation amount and flooding rains; farmers and farm cooperatives will want information on changes in season length and temperature, not just for their own farms, but for those of their local and distant competitors; coastal zone managers will want information on likely changes in sea level, storms, and estuarine temperatures; water resource managers will want information on likely changes in snowpack and runoff, and the chance of floods and drought; community health planners will want information on changes in location of freezing conditions and the frequency of extreme heat waves; industry will want information on changes in extremes that might affect their businesses and shipping; those preparing environmental impact statements will need information on how changes in a given location affect environmental outcomes; those doing economic analyses will want information across the region, and much more.

Just as the Nation's climate research efforts require and benefit from interagency and academic partnerships, so too will the development and communication of climate change information to users. No single agency is capable of providing all of the information and services needed to inform decisionmaking. To be successful, the delivery of climate services will require sustained Federal agency partnerships and collaboration with climate service providers and end users.

While much work has been done to evaluate the need for climate services and a National Climate Service, the Administration believes that additional assessment and analysis of existing climate-service capabilities and user needs for climate services is necessary. A National Climate Service and, more broadly, our Nation's approach to delivering climate services will require that such analysis and assessment is ongoing, science-based, user-responsive, and relevant to all levels of interest, *e.g.,* local, regional, national and international. Such a framework must also be able to adapt to new developments in the scientific understanding of climate change and resultant impacts to serve the needs of decisionmakers and the public.

The Administration recognizes that the Nation needs reliable and accurate climate information. To promptly address this issue, the OSTP is working to convene a task force with representation from a diverse group of key agencies whose charge will be to examine national assets, existing data and information gaps, and costs related to the development of a cohesive framework for delivering accurate climate-related information to the public. This process is intended to result in a more detailed functional and organizational approach for delivering climate services to the Nation, in concert with the Administration's views presented here for a broad authorizing framework.

Earth Observations and Continuity of Climate Data Records

Physical, chemical, and biological information about our planet is vital to our ability to plan, predict, respond, and to protect our citizens and infrastructure. Today, millions of individual observations are collected every day, allowing us to examine, monitor, and try to model atmospheric composition, seismic activity, ecosystem health, weather patterns, and hundreds of other characteristics of our planet. Developing the ability to assess and protect environmental services of all kinds—verifying "bottom-up" information used by decisionmakers with independent "top-down" ob-

servation systems—will require continuing efforts to improve our understanding of and ability to measure stocks and flows of water, carbon, and nitrogen at global, regional, and local scales.

Observations are taken from space, and within the Earth system (*in situ*), from the air and on and below the land and the oceans. Obtaining accurate climate data requires calibrated measurement systems that are traceable to national and international standards. Once the integrity of the data is validated, the data can then be interpreted, interpolated, and integrated. The myriad of observations taken today vary widely in purpose and scope and are appropriately distributed among hundreds of programs under the purview of Federal agencies and other institutions and individuals. To a large degree, these observations have been only loosely coupled, coordinated, traceable and integrated. The critical leap forward can only be achieved with a synergy between remotely sensed and *in situ* observations supported by robust data systems.

Increasingly this promise is being realized, and seemingly disparate observations are combined in new ways to produce benefits across multiple societal areas. This recognition has led to the concept of an integrated Earth-observing system as articulated by the Group on Earth Observations (GEO). In order to achieve the synergies and benefits of an integrated system of observations, the United States Group on Earth Observations (USGEO) was formed in 2005 as a standing subcommittee of the National Science and Technology Council (NSTC). That same year, the Global Earth Observation System of Systems (GEOSS), was formed to coordinate observations at the international level. By 2009, 79 countries, the European Commission and over 50 international organizations were engaged in this effort. The U.S. contribution to GEOSS is the Integrated Earth Observation System (IEOS). GEOSS and IEOS will facilitate the sharing and applied usage of global, regional, and local data from satellites, ocean buoys, weather stations, and other surface and airborne Earth-observing instruments. The end result will be access to an unprecedented amount of environmental information, integrated into new data products benefiting societies and economies worldwide.

The state of the U.S. space-based observational system in 2009 is largely unchanged from that of 2005, but the outlook has significantly worsened, according to the National Research Council (NRC) Decadal Survey Report. Continuity of the weather system is threatened by reductions and delays in the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and plans for climate measurements on NPOESS have been scaled back. The likelihood of a gap in land imagery impacting multiple societal needs (*e.g.,* agriculture, biodiversity, climate, ecosystems, water, etc.) is now almost a certainty. In addition, no plans have been developed to continue some of the valuable observations demonstrated by the NASA Earth Observing System (EOS) program that benefit the disaster preparedness, human health, climate, and water areas.

OSTP will play an important role in coordinating interagency satellite observation policy. We must increase government oversight and improve the interagency partnerships central to the management of civilian satellite programs, which among other things, are critical to the Nation's climate and weather forecasting. We need to proactively manage our programs to avert future cost and schedule overruns. Agencies must work together to manage the contractors building these satellites and demand cost and schedule accountability. The management of the NPOESS program and ensuring continuity of weather and climate data is a high priority for the Administration's leadership team. I have directed the formation of a Task Force within the Executive Office of the President (which will include representatives from the Office of Management and Budget as well as the National Security Council) that will meet regularly with NOAA, NASA, and the Department of Defense (DOD), the three agencies partnering on the program, to monitor progress and results in addressing key issues facing the success of this program.

In an overall sense, deployments of new and replacement satellites are not keeping pace with the termination of older systems, even though many existing satellites are operating well past their nominal lifetimes. A number of satellites built as research missions are now seen to have ongoing societal benefit, but there are currently no plans for continuity of many of these. Over the next 8 years, 50 percent of the world's current and planned suite of Earth-observing satellites will be past their useful life. Given the long development times associated with fielding new systems, particularly satellite systems, and absent a dramatically increased commitment to sensor system development, this declining census of instruments and missions could lead to a loss of observing capability in the next decade. This reality reinforces the need to address the recommendations in the NRC's Decadal Survey.

In addition to global observations made from space, *in situ* measurements provide critical data at fine spatial and temporal scales and of parameters and in places not

achievable from space. Our observational infrastructure for *in-situ* measurements is aging and investment in monitoring programs has declined despite growing demand. And, there still remains the grand challenge and promise of using geospatial information to link the broad coverage and context of our top-down remote-sensing view with the comprehensive and detailed measurements made *in situ* in order to best characterize and understand environmental resources.

Development of an integrated climate-observing system stands as a large and urgent challenge. One part of the challenge is that the required observing system must deliver multidecade data records with the accuracy and precision needed to distinguish long-term climate changes from natural variability and other environmental influences. To help ensure compatibility and consistency between various international monitoring organizations and laboratories, the National Institute of Standards and Technology (NIST), the Nation's national measurement institute, can provide traceable measurement techniques and standards based on the International System of Units. In addition, NASA EOS demonstrated the ability to create long-term, high-precision climate data records. The experience of this program has revealed the difficulties in "transitioning" long-term, research-type measurements to an operational system. We have work to do in overcoming the limitations of the current "research to operations" paradigm with respect to climate observations, which require a long-term research effort. The institutional structures and capacity, and specific agency roles and responsibilities must be developed to deliver an integrated climate-observing system.

The effort to evaluate and assess options for the NPOESS program is just the first step toward building a solid foundation of continued Earth observations for the future, which would take into account both the NRC's Decadal Survey as well as the ability to coordinate with GEOSS at an international level.

Conclusion

The climate is changing with increasing potential for disrupting human well-being. We know the causes, and we know what we have to do to avoid the worst of the possible effects. Science, technology, and innovation are all going to be crucial in mastering the climate-change challenge. As Director of OSTP, I regard one of the primary challenges and one of the primary functions of OSTP to be providing the leadership and needed coordination of global change research to ensure that our decisionmakers, our businesses, our farmers, our health care workers, and all our citizens have the information they need to take actions to improve human well-being and environmental management as the climate changes. Working in partnership with the Office of Management and Budget and the Congress, we aim to pull together the expertise across the government, drawing from each agency's distinctive capacity, to construct the relationships and interactions among the agencies that will result in a program for global change research that is both greater than the sum of its parts and adequate to the country's needs.

I look forward to working with the Committee in this effort. I will be pleased to try to answer any questions the Committee may have.

The CHAIRMAN. Thank you very much, Dr. Holdren.

We'll do questions in order of appearance, which, happily, allows me to start.

[Laughter.]

The CHAIRMAN. For Secretary Locke, are you serious, 103 degrees?

Secretary LOCKE. 103 in Seattle yesterday. We moved the whole family out yesterday, caught the plane at 1 o'clock in the afternoon, but, before that, visited with my mom and dad, who are elderly, making sure that they were drinking a lot of liquids, and trying to cool down the house as much as possible. But, the day before, I think we reached about 98, 99 degrees in Seattle, and the rest of the week, all through Saturday and Sunday, it should be close to 100 degrees.

The CHAIRMAN. Well, you'll feel very comfortable in Washington.

[Laughter.]

Secretary LOCKE. We don't have the humidity in Seattle——

The CHAIRMAN. That is true.

Secretary LOCKE.—or the Northwest——

The CHAIRMAN. That is true.

Secretary LOCKE.—like you have here in D.C.

The CHAIRMAN. Now, this, a little bit, steals from what Dr. Holdren was saying, but we've been working very hard to create a National Climate Service in this Committee, and I would like your, sort of, views on a couple of aspects of this.

The—you know, the American Clean Energy and Security Act includes a provision authorizing a National Climate Service. So, I'd like to get a sense of, What do you think the core functions ought to be? Second, if you've looked at that law, do they—does that, sort of, meet your basic criteria, or does it not? But, really, most importantly, from my point of view—and I've seen this so much—I spend so much time on healthcare; I say that with joy and happiness, of course—but, it is so easy for basic truths to be lost to implementation by national public policy, because people get caught up in antigovernment fever or—you know, or they're trying to tell us this or that.

So, in both of your answering questions if—much as you can, weave in, How do we make what we're talking about here somehow friendly to conservatives?

I have a question, later on, should we have a National Climate Service in every state? Now, that's a stupid question, I think. But, it gets at that point. Things that come out of Washington, people are slower to react to. Things that come out of—very confidently out of Washington, people are slower to react to. People don't like change. People from my part of the country like—don't like change, really, hardly at all. And so, this whole matter—it's like getting the Department of Defense and everybody to do work together, as you were talking about, Dr. Holdren—this has to also somehow be felt by the American people, I think, for them to support climate change, in terms of public policy.

Secretary LOCKE. Well, I think that clearly a National Climate Service is badly needed. And the Department of Commerce—NOAA, in particular—we think has been exercising a leadership role in these activities for several decades. We stand ready to work with other Federal agencies on a coordinated approach. And that is the most important thing. We have to have a partnership with the Federal agencies as we provide a National Climate Service.

But, I think, in order to be credible—in order to—and you asked the question, "What are the assets or the attributes most needed of a National Climate Service?—it has to be credible, it has to be authoritative. There needs to be a single point of accountability that everyone in the country—policymakers, local governments, businesses, individuals—can all go to. And this agency or service must provide climate modeling in terms of forecasts and projections. People need to understand what's coming down the road. And it needs to provide regional and national assessments of climate change so that people in different parts of the region understand—can get, as much as possible, tailored scientific information as it pertains to them and their livelihoods and their future. And the climate service has to work closely with stakeholders to really understand and analyze evolving needs.

And finally, I think that this climate service needs to also work on helping the public understand climate change is happening, and what it means—so that we're working with all different levels of citizens, the public and private sector, and individuals. Credibility is at stake; we need authoritative information based on scientific research.

The CHAIRMAN. Just taking that point—and my time is about out—I hope that we really can talk about how we make the public feel participatory. I really believe that. If the healthcare bill fails to pass, it will be because people grabbed onto, sort of, "The government trying to tell me what doctor I can go to"—never leaves that point of view. They're good people, they're wonderful people, they're wonderful Americans, but they will not yield to what they know, as opposed to what might be different.

And so, the question of bringing it to the level of the people. And I'd say this to my two colleagues on the dais, here, to—I really—I just think it's so important that people see climate change, not only as moderately threatening, because it's going to change the way we all live and the way everybody does everything, pretty much, and yet, somehow they understand that it's not being dumped on them, but it's being worked through them—they are stakeholders—so that they are more open to this change, which is going to be very dramatic over a period of years.

My time is out.

And I call upon Senator Begich.

STATEMENT OF HON. MARK BEGICH, U.S. SENATOR FROM ALASKA

Senator BEGICH. Thank you very much. Thank you, Mr. Chairman, for doing this Committee hearing on an issue that, in Alaska—you know, we face this everyday. We've had some conversations already about this. And so, again, thank you for having the Commerce Committee participate in this.

I want to kind of hone in a little bit on—because we have one bill that's kind of moving from the House side over the Waxman-Markey bill. And there are elements—I mean, there's one element, which I'm not—maybe I'll be too parochial here, but let me just say that I know there are, I think, six climate service centers, or climate centers, around the country—none in Alaska, which is the place that's being most affected by climate change, which—somewhat amazing that didn't happen on the House bill, but we'll deal with that, hopefully, here. But, can you—first, both of you—I think you both said, through your testimony, that you agree with the idea of a national climate service, a single point of entry regarding climate change. Do you both agree with that?

Dr. HOLDREN. Yup.

Secretary LOCKE. Yes.

Senator BEGICH. Is that—I just wanted to make sure I understood that in the conversation.

And second, with—understanding that, do you think—and I don't know how much review you've already done on the Waxman-Markey bill—are there suggestions to improve that single point of entry, from your perspective, that you're prepared today, or in the

near future, to give us some recommendations, from both of you? Maybe Secretary Locke first, and then Mr. Holdren.

Secretary LOCKE. Well, first of all, I want to say that everything that we're trying to do at the Department of Commerce is to streamline our operations and make all of our information and services more accessible to the people we serve, whether it's businesses or individuals, with respect to weather. In terms of our businesses, we're revamping our programs to offer one-stop-shop business assistance centers, where all businesses have one focal point, one place that they can go to in every community, instead of going to five or six different offices. We're doing the same thing with a lot of our websites, one single point of contact. That is now happening, with respect to climate services, within NOAA, where we're putting all of the information on all the different programs that we have, one location on its website, one place that people can go to, in terms of understanding the effects of climate change, the need to adapt, as well as all the information that we provide.

The House bill does call for six climate offices in the country. We think that the more offices that there are around the country, then it gets to the Chairman's notion of really bringing the message home in an understandable fashion, and it allows policymakers, whether local governments, water resource managers, to state governments, to businesses, to have a place where they can get more information about the forecasted impact of climate change on their community.

Now, most of the modeling that's being done is on a region-by-region basis. We're not down to a city or a state basis yet. And a lot of the modeling and the forecasting is being done over a decade period, for the next 10, 20 years.

We do have, in fact, weather services and climate services available in every state, and would welcome the opportunity to work with the members of the Committee, depending on the level of funding, in terms of the number of climate offices that we could actually have throughout the country, and—whether it's one for every state—we also need to find out if the states are even interested in having a climate service office in that particular state.

Senator BEGICH. I guess, let me—again, I want to see if there is opportunity—and, again, maybe not today—but, as you look at the Waxman-Markey bill, what recommendations you might have to improve on those elements. But, I guess my point is—and, again, I don't want to be so parochial—but, there's no other state—no other state in this country that would be considered ground zero when it comes to climate change. And yet——

Secretary LOCKE. Well, clearly the——

Senator BEGICH. And yet, when you look at the bill, it doesn't even reference, in a sense, of—you know, we have the natural lab, from the Arctic, the fisheries, acidification, permafrost melting—you don't have to do it now, because we have such limited time, but I think this is an important piece as we try to understand climate change. We have a natural lab, in Alaska, and we should take advantage of it to understand it from a variety of areas that will affect the country for many generations to come. I'm not necessarily looking for just the service center. If we're going to do climate change, it should be a single point of entry, so we can have a better

understanding. Because every committee meeting I have here that climate change comes up, I always ask for the org chart; nothing exists, because it's too complex, in the sense of who handles what, and then, at the end of the day, who pulls the trigger to make the decisions. Because when you have multiple agencies, everyone's going to have jurisdiction.

Dr. HOLDREN. Well, if I may, Senator, let me comment on both aspects of your question.

First of all, I agree with you that Alaska is, unfortunately, a natural laboratory for what's happening in climate change. It's happening faster there, bigger effects are being felt sooner. We need to understand it. And clearly, Alaska's a very important place, both as a producer of relevant data and as a consumer of information that will enable people to better adapt to the degree of climate change that we can't avoid.

The Administration is not ready, at this moment, to make a specific recommendation as to exactly how the whole climate services area should be organized. We are studying it. A number of things are clear about the issue. Those things that are clear include that NOAA is going to have a very big role—there's a large concentration of relevant capabilities in NOAA—but also clear is that a variety of other agencies and departments have big stakes, both on the supply side and the demand side—that is, as providers of information and as users of information—Department of the Interior, Department of Agriculture, EPA, DOE—all are examples of agencies that are going to have to play significant roles in this. It is going to be a big challenge to get the coordination right and to figure out exactly how this is to be structured, and we're still working on it. But I assure you that we are going to come up with an answer that will make it work. It's too important to allow it to fail.

Senator BEGICH. Thank you.

My time is up. And thank you both very much. Appreciate it. And thanks for your written testimony, too.

The CHAIRMAN. Before I call on Senator Cantwell, I have my usual pleasure of announcing that the Senate is accommodating themselves to us. We're going to have a whole series of stacked votes, starting at 3:40. And so, let's make sure that we get the maximum we can from our two witnesses.

STATEMENT OF HON. MARIA CANTWELL,
U.S. SENATOR FROM WASHINGTON

Senator CANTWELL. Thank you, Mr. Chairman. Thank you for holding this important hearing.

And, Secretary Locke and Dr. Holdren, even if we do take major steps to curb greenhouse gases, we are still going to experience some level of warming and impact, and our Nation is going to have to adapt to that. And I guess I'm asking, Do you think that Congress needs a comprehensive action plan on adaptation, and not just mitigation?

Secretary LOCKE. Well, I clearly think that the country, and all sectors within the country, will need to focus on adaptation, a response to the changes in climate. As much as we can try to avoid or mitigate the intended changes, we will—there undoubtedly will be changes in our climate that will have devastating impacts, and

very significant impacts, on all sectors, from recreation to industry to business, agriculture, to the responsibilities of municipal governments, and State and Federal Government, as well. And that's why I think that we need to have that information disseminated. The forecasting must be as accurate as possible, and scientifically based, so that people can make appropriate decisions. The Department of Commerce and NOAA stand ready to work with the White House in partnership with the other Federal agencies, in the creation and organization of a national climate service.

But, we feel that NOAA has been exercising leadership in providing much of the information, sharing that information, collecting the information for many decades, and that we intend, and are desiring, to stay in that strong leadership role with the other Federal agencies.

Senator CANTWELL. Well, we passed an adaptation bill out of this Committee last year, and I hope that we can do so again this year, because the impacts on these communities—they have no ability to plan for some of these things themselves, whether we're talking about something as basic as our hydro system and what happens to that, or flooding areas, or public health problems, just—it's beyond what individual communities can do.

Dr. Holdren, should we be planning for abrupt climate change? And what are the potential consequences of that? And how do we get the additional research that we need in that area?

Dr. HOLDREN. Well, Senator, the first thing I would say is, we're already finding climate change is becoming more abrupt than we expected, even a few years ago. Many different aspects of climate change are happening more rapidly than the Intergovernmental Panel on Climate Change predicted in its recent reports. It could become even more abrupt. Nobody knows for sure. Our understanding of all the details is not adequate to say exactly which potential tipping point might be crossed when, which would cause some of the climatic changes that we're experiencing to accelerate drastically, but we should be ready for it.

I would say that this is simply another dimension of why adaptation is, as the first part of your remark suggested, so important as part of our national strategy for addressing climate change. It's not enough just to focus on mitigation. You're absolutely right that, no matter what we do in mitigation, we cannot stop climate change overnight. There's going to be some more. We have, with mitigation, the possibility of avoiding the worst outcomes, but we have to be ready, on the adaptation side, for whatever comes. And we don't really know enough about it yet. We need more research on adaptation. There are many things that are obvious that we can do in the way of adaptation, including work on developing heat- and drought-resistant crops, including doing coastal planning with sea-level rise in mind, including strengthening our defenses against tropical diseases—a wide variety of things we already know how to do. But, there are many more opportunities that we will discover for adaptation as we study this domain more carefully.

And in my written testimony, I talked about the ways that everybody who has looked at this question carefully, concludes that we should be expanding the research agenda of the U.S. Global Change Research Program to include the adaptation elements, in-

cluding the sociopolitical parts. We have a lot still to understand about the economic and institutional dimensions of adaptation to climate change. And that is an area that is starting to be studied, but we need to do a lot more, and we need to integrate it, in the USGCRP, with the studies that have historically gone on there on the dynamics of climate change itself.

Secretary LOCKE. If I could just point out, Senator, I think the demands for climate information and assistance to adapt to climate change are going to increase over time as people—more and more people see the effects of climate change and understand it, appreciate it, and get worried about it.

Senator Begich raised the issues of Alaska. I mean it is ground zero. It will require assistance, help, in terms of relocation, infrastructure investments, emergency response efforts to flooding and storms that will be coming about, and changes in the weather pattern.

Just in terms of the Cascade Mountains or the Sierra Nevadas, a ski-lift operator of a ski lodge, do they continue to invest or put more money into building chairlifts because, depending on the elevation, 20 years from now, will what now falls as snow actually be only rain?

And so, so many people are going to be depending on this information in making investment decisions on where to build, how far away from rivers and streams—depending on the weather patterns, will some of these rivers and streams be more prone to flooding? Will the floodplains change? That will drive a whole host of decisions among public and private decisionmakers. And the need for climate information, the need for climate services, is even more pronounced.

Senator CANTWELL. Well, I thank our witnesses.

Mr. Chairman, you urged the Subcommittee on Oceans and Atmosphere to have a hearing, earlier in the year on this related topic, in which a lot of the witnesses pointed to the fact that 60 percent of our country's—well, our country's coastal regions—basically, if you took them as economy, a separate economy, they're the third-largest economy in the world. And yet, these are the very areas—our coastal regions, that are the backbone of our U.S. economy—will be the areas that will be impacted by climate change. And so, we will be, economically, very vulnerable without an adaptation plan.

So, I thank the witnesses. And I thank the Chairman for holding this hearing.

The CHAIRMAN. Thank you, Senator Cantwell.

Senator Nelson?

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA

Senator NELSON. Well, on that issue, when can we expect to see some of those plans—for example, on sea-level rise—of the economic and the physical impacts?

Mr. Secretary?

Secretary LOCKE. Well, I'm not sure that we can actually document, immediately, the economic impacts on sea-level rise. We can make those forecasts, and the forecasting models are becoming a

lot more precise every single day and every single year. We're able, now, perhaps, to estimate the climate change for the next—over a decade, instead of 50 years from now—but over the next decade. And that's why I think that we're going to need that cooperation and partnership with local governments, State governments, Federal agencies, as well as private sector, to, for instance, say, if the oceans rise by 6 inches in the next so many years, or a foot in so many years, or even a meter, as so many scientists are predicting over the next 50 years, then we're going to be receiving all that information, and collecting that, from public and private sectors.

Many people on the Marshall Islands are very concerned that the entire Marshall Islands will be underwater. It will be up to the people on the Marshall Islands to present that economic data on the total cost or impact of that level of rise of sea levels.

But, clearly, first we need to have the data. We need to make sure that the public and private sector understand what the effects are.

Senator NELSON. Let me get into that, because we're going to have these votes called. We need the data. Now, we've got a satellite, sitting on the ground, named Discover. The problem is, Who's going to pay for the launch cost? And what Discover will do, when it gets out there at the Lagrange point between the Earth and the Sun, is, it will specifically measure the heat going in and the heat coming out from the Earth so we know precisely how much heat is being trapped in the Earth's atmosphere.

We have put, in the Defense authorization bill, language that requires the Air Force to study, by them taking a very necessary defense instrument and putting on that, that it is needed also at the Lagrange point, and let the Air Force pay the $150-million cost of launching it. So, it's those kind of things that we're trying to get out.

Now, one of the things that's in your bailiwick, and in Dr. Holdren's bailiwick and Dr. Lubchenco's bailiwick, is that we haven't been doing too good with NPOESS. It's not working. What's the Administration's timeline for the decisionmaking?

Secretary LOCKE. With respect to NPOESS, Dr. Holdren covered that a little bit in his testimony, but, as I indicated to the Committee at my confirmation hearing, and as I indicated to the House Committee, the NPOESS project, is of utmost concern to me. And, Dr. Holdren and I have been having a lot of conversations about it, and I'm really pleased that Dr. Holdren convened a meeting of all the principals, agencies involved in the NPOESS, and we're now developing an action plan and analysis of what is happening.

The interagency working group that oversees it, on its own, has now concluded, on its own, which is great, including the Defense Department, that the NPOESS management is seriously flawed and must be changed. So, we are, as an administration, with all the players, including Dr. Holdren taking the lead, looking at major changes in NPOESS. It is fundamental to our weather capability and climate service capability.

With respect to the satellite that's on the ground, ready to be launched, I'm very proud to say that the Department of Commerce, NIST—National Institute of Science and Technology—worked with the stakeholders to improve the accuracy of the Total and Spectral

Solar Irradiance Sensor or TSIS for NPOESS so that the uncertainty level is less than 1–100th of a percent, down from the previous .3-and-a-half-tenths percent.

So, we understand how important these satellite programs are, the accuracy and the reliability of the instruments, and the sophistication of the instruments, and—but, we know that—we're very proud of what we're doing on this particular satellite that's ready to be launched, but we also know that all the agencies need to aggressively change the management structure and the success of the NPOESS project.

Dr. HOLDREN. Let me just add to that, if I may, that I did make a strong statement in my oral testimony, and I'll reinforce it here, that it is a high priority for me and the rest of the leadership in the Administration to get this NPOESS system fixed. We have new leadership in all of the relevant positions in the three agencies, and everybody now is committed to cooperate to a degree that has not characterized this three-agency effort in the past, and indeed to the degree that will be needed to get it back on track. We are moving forward. We are forming a task force in the Executive Office of the President to work with the leadership in the agencies to make sure this gets done. It is too important to let it fail.

As to the Discover satellite, I agree with you, it would be a wonderful thing to get that up there. The better our data, the better our ability to respond to climate change, to give people the information that they will need. And I certainly join you, Senator Nelson, in my enthusiasm for getting this done. We are going to figure it out.

Senator NELSON. And NASA's going to have a role in the National Climate Service?

Dr. HOLDREN. Absolutely. Again, I said that in my oral testimony, and I'll say it again, NASA, along with NOAA, NIST, USGS, Agriculture, Interior—the capabilities that are relevant, the needs for the information, are spread across a range of agencies. We're going to get them to coordinate and work together, for sure.

Senator NELSON. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Nelson.

I want to use what I think will probably have to be my last question. Go back to the thing that worries me the most, that we can be doing everything right, here in Washington, with respect to the right kind of research, with the right order of its priority, getting—I mean, you sound, Dr. Holdren, like you're already way ahead of Admiral Blair, in terms of eliminating stovepipes to, you know, major agency consideration and cooperation in climate change problems.

Dr. HOLDREN. We're working on it.

The CHAIRMAN. You've got DOD working with you, you're ahead of a lot of people. But, that's one aspect. It has to be accurate. That's a really hard set of work on the part of thousands of people. It has to be, then, put into form, which has the integrity of the U.S. Government behind it, which, for example, could be validated by the scientific community around the country. But, then there's a huge gap. And I would make that gap—and I'd, in a sense, sort of, separate myself, not in feeling, but just in location, from my three colleagues—two—three colleagues who are here, all of who are

from coastal areas. One of the facts of the Midwest and the Mid-Atlantic is that there is less receptivity to the concept of climate change—I mean, an individual Senator or Congressman might be either way out in front or way out behind—but, the people trust what they can see and feel and understand, and what is somehow given to them through validators who they can trust and understand.

Now, to me, this is important, in terms of being able to do the right type of legislation, and in terms of changing people's attitudes about thing like caulking their homes. Nice little article in the *Washington Post,* I think, this morning about white roofs, and how it's already cooling down somebody's house, and he's really happy about it, and there he is, tapping in the nails on top of the house. I don't—there's not, probably, a great deal of that going on in the part of the country I'm talking about, because it's higher in elevation, certainly not by much, or it's not higher in elevation, but it's insulated inside of the oceans, and they don't have the same fear, generally speaking.

I think it's human nature to avoid having to make difficult changes until you really believe that it's in your interest to do so. I mean, you could have conscription, like you do in the—in World War II, when we finally got it—I think, only by one vote, at that. You know, that's fine, that works there, but it doesn't work on this. You have to convince people that we need to make changes and it's in their interest, it's not government—you know, it's like—even I—I feel this, when I read a report by some international organization of scientists which say that everything is proceeding at twice the speed of deterioration, worse than they had come out with 2 years before. And they've got a long acronym name, and it just sort of goes right on through my head, because it's not close at hand. I can't talk about that to the people I represent, because they don't know what it is, and they're not moved by it. And you understand what I—already, what I'm saying. But, this whole question of—as we do our work, that we somehow bring the American people into it, in a way which is not preemptive or nasty or threatening, but which is clearly to their self-interest and which, therefore, to some extent, they might even come to welcome.

Secretary LOCKE. Well, I think it begins with making sure that the agencies that are involved in a National Climate Service, whether NASA, NOAA, Department of Agriculture, that because they come from a highly respected position, in the first place, that the information they impart will be viewed as credible. And I think, for a National Climate Service to be effective, it has to have that credibility. And so many of the Federal agencies, that I think will be part of that partnership, have that credibility.

Of course, NOAA has that incredible credibility, and the National Weather Service has that credibility, which people in the mid-States have always relied on. The National Weather Service, in terms of weather for crops and for so many other decisions that—in the construction industry, and recreation, and the list goes on and on.

But, NOAA has been doing—providing this data, for decades, and we are proud of that leadership position. In many cases, we are the world's largest, most-respected repository of climate data informa-

tion, greenhouse gas data, and we intend to continue to exert that leadership position.

I also think that we need to figure out ways in which we can disseminate that information, all of the information, from all the different Federal agencies, in a way that's more appealing to the general public. And so, what we're doing at the Department of Commerce, at NOAA, for instance, to have all our climate information services basically at one stop, one location, one website, to make it easier for users, public/private sector, individuals, government, to access, I think, is key.

And second of all, there will always be some people who, even with the information, will fail to take the necessary steps. As Governor, there were parts of the State of Washington that routinely flooded and the Federal Government, with FEMA, was always going in and providing help. And we would tell these people, "You really need to move out of the floodplain." The insurance companies would no longer insure their homes. And yet, they stayed. Even though it would be more cost effective to take the State and Federal funds, insurance funds, and move, or even move the entire town, and yet people would resist until the very, very last minute.

But, I think that, with information, most Americans are willing to make changes. And if they know that it's in their economic interest to make changes, whether simply to insulate your house, put more insulation in the attic, and you can show the payback, and the payback of using energy-efficient appliances, I think most people, most Americans, want that information, desire that information, and will act accordingly.

Dr. HOLDREN. Senator, if I may just add——

The CHAIRMAN. Please.

Dr. HOLDREN.—to what the Secretary has said, and take off from his last point.

The fact that this is not just a bad-news story, that this is a story of challenge, but also of opportunity, that there are ways to address the climate change issue in a manner that will make money, that will create jobs, that will drive new industries, I think it's terribly important that we get better at communicating this message that we're not simply in a position where we have to wring our hands. There's a lot we can do, both to reduce the potential damages of climate change, but to benefit from innovation and what we often call win-win approaches, measures that make sense in their own right, even if you weren't worried about climate change, but will help you with climate change, as well. Getting people off of the floodplains is a good example of that. We should be doing that anyway, just on the basis of the frequency with which major floods come along, even in a climate that is not changing. We simply have to do it even more urgently with climate changing.

We have to get better at telling the story, but the story is also telling itself more and more powerfully. And even in parts of the country which may initially not be experiencing such a high rate of obvious climate change, people will continue to turn on their televisions and see what's happening elsewhere and, I think, ultimately, come to the understanding that this a challenge that we're all in together and that we all have to meet.

The CHAIRMAN. Just to end my time, the perfect example is in, let's say, West Virginia. Four percent of our land is flat, as I am painfully aware, and everything else is—goes up or down. We have a lot of rain. Water is not our problem. And we have a lot of flooding. That's a big problem. People get flooded out of their houses because they have five generations who have lived on this house on the Little Coal River or the Big Sandy River, or whatever it is, and it gets flooded out. And only 4 percent of the people had flood insurance, 20 years ago; only 4 percent of the people have flood insurance today. They get flooded out, and move back in—and move back in, really, to nothing. They get taken in by their neighbors, because that's what we do in West Virginia—you never have to open up a National Guard armory. You do, in case, but you don't—it doesn't get used, because people take each other in. In other words, they are using traditional means of overcoming newer and worse and more dangerous problems, simply because the silt level is building up, and all the rest of it.

And I—I'm not asking a question, I'm just trying to urgently make the point that people accept something as being in their interest, not because somebody's going to make money off of it—that's for—the lucky entrepreneurs will have that—but, the rest will be changing the way they live, and being a little grumpy about it, in certain parts of the country, including some of the coastal areas, I'm sure. I'm sure that's true in Alaska. You know, people don't like change.

So, I just think it's a huge psychological factor in the incredible work that all of you at the table, and behind the table, are doing to virtually save this Nation and this planet. No response required.

Senator Begich?

Senator BEGICH. Thank you very much.

First, I want to thank the panel and the Chairman, because you just—you know, I have a new home, here, and I—you just reminded me—I had to put it on my list, here—to get the white coating for my black tar roof, so I can save a little energy. So, you just made me think about it, so thank you very much for that part of it, for a personal opportunity.

Secretary LOCKE. And maybe put on a solar panel, on top, while you're at it.

[Laughter.]

Senator BEGICH. Well, you know, I'm north, so it doesn't bring the sun in properly, but thank you for that.

You know, the commentary—and this is where I'm struggling—in part, is what the Chairman talked about, which is simplification of the message so the public understands what's in it for them. I mean, that's basically—in order to get their interest—they do see it, but when they see, you know, Shishmaref, Alaska, disappeared in the ocean, and you live in Kansas, it's not a direct connection; but yet, it will be at some point. So, how we make that real is important. And I think the Chairman has a very good point there.

But, the one that—I'm going to throw out an idea. I know, in some existing legislation, this exists, to some extent, but not for all departments. But, in order to get the coordination—and what I see—now, again, I've gone through, now, a couple of these hearings with different folks. Everyone has a piece of climate change, in

some form or another. The goal is to try to bring it together, coordinate it. But, in the—I know, in the Waxman-Markey bill, the national climate office—or service office isn't going to be in place for 3 years. It actually has a delayed implementation time, which—of course, I would argue that it should be now, and then work to implement. But, as a former mayor, getting departments on a common goal is a difficult task. As a mayor—strong mayor for—I could pull the trigger and make him do it. You're going to run in—an office within the White House, you run a department, which, in itself, is going to be difficult.

What happens if this could occur, and tell me what you think of this. If, in the end day of a climate change bill, that all budgets that are directly related to climate change issues have to be a unified budget—in other words, the budget's drive the operations around here.

VOICE. Right.

Senator BEGICH. You know, great policy—everyone talks about great reports, but the money drives the show. So, if it was required that all the budgets have to be unified in one central point, maybe your office or some office that has to review that so you're not duplicating efforts or spreading efforts around—does that make any sense to either one of you? And I—maybe the things that are too logical won't make sense here in this group, but I'm hoping——

Dr. HOLDREN. Well, Senator, we actually do that, to a very substantial extent, in the interaction of OMB with OSTP——

Senator BEGICH. Let me hold you there. This is what I know about—yes. But, when we see it, we really don't see it stand out that way. I mean, OMB tries to bring it—I'm familiar with that. But, I sit in—I mean, I'm on the Arms Services Committee, I hear what Senator Nelson talked about. DOD has a piece of the action. You know, everyone has a piece. But, from a policymaker standpoint, we don't see that.

Dr. HOLDREN. Well, maybe that's another part of the story we need to get better at telling——

Senator BEGICH. Right. Well, I——

Dr. HOLDREN.—coordination is among those different pieces.

Senator BEGICH. Yes. I mean—but, you agree with that principle.

Dr. HOLDREN. Yes.

Senator BEGICH. OK.

Secretary LOCKE. I think it's a great idea to have, on—a single document that shows all the spending and the budgets related to climate services from all the different agencies——

VOICE. Right.

Secretary LOCKE.—so that the policymakers are able to see what NASA is doing, what EPA is doing, what Agriculture is doing, what Interior is doing, what NOAA is doing, what NIST is doing within the Department of Commerce, so you see, in one format, what everyone is doing by way of climate services, so that you, as a policymaker, can say, actually, that you think this area needs to be increased or this area is deficient, this area is being neglected, and this area needs to be emphasized.

Senator BEGICH. Now, let me ask you one more step. And, Mr. Holdren or Secretary Locke, either one of you could answer this. But, again, as a former mayor, I know OMB's operation is—it's

number-crunching, it's balancing—policy is a piece of it, but not as much as the agencies.

Should there be one person or one director or level person that says, "I see the whole budget, but, geez, Department of Commerce—you know, Ag's already doing this. We're not going to have you budget for that"—or vice versa—should one person or one agency have that role? Not—OMB is a different ballgame, I mean they're the guys that you all go to, you plead your case, and they smile, and say, "Thank you very much," and then they do whatever they do, and then they give you back a budget, and you have to live with it. But, from a policy standpoint.

Dr. HOLDREN. Well, I actually have a very specific responsibility to do that, together with Peter Orszag, the Director of OMB. And I bring the science and technology policy perspective that is responsible for integrating the pieces from the different agencies. And if that's gotten wrong, it's my fault. The——

Senator BEGICH. But, I guess——

Dr. HOLDREN.—the Administration's budget request does include a section where the various interagency crosscutting programs are described in one place. And I very strongly suspect that, in future years, the climate services will be a category that gets that sort of attention.

Senator BEGICH. But, it's this——

Dr. HOLDREN. The Global Change Research Program already gets that sort of attention, but climate services, I expect, will get it, in the future, so one will be able to see what the whole picture looks like, who's doing what, where the gaps are, and what needs to be filled. I completely agree that that's desirable, and I say to you, if it doesn't happen in the White House in this domain, it's going to be my fault.

Senator BEGICH. OK. Well, I would—I appreciate that, for taking the heat. But, the piece, too, for example—and my time is up, and we're—got to run to votes—but, you know, I look at the title of your office, Science and Technology; I don't see "Economic Development," so forth, so on. So, the coordination of all these pieces—there's so much engaged in this. I mean, as we talk about the Arctic, which is the premier result of climate change——

VOICE. Yes.

Senator BEGICH.—Defense Department's going to be a critical piece of that, Transportation's going to be a critical piece, the Coast Guard will be a critical piece. So, that's—I appreciate your comments, because I think that's where I continually go back to, that if you don't coordinate this, develop it enough, where we, as policymakers, can see the big picture and see how all these play into it, and not duplicate our efforts, but really focus them, we're losing ground quickly.

Dr. HOLDREN. No, I do understand, Senator. And let me just mention that my Deputy Director for Policy is dual-hatted with the National Economic Council.

Senator BEGICH. Good.

Dr. HOLDREN. My Associate Director for National Security and International Affairs, who has not yet been appointed, but I hope to be coming to this Committee soon with the nomination, will be dual-hatted with the National Security Council.

So, we are aware of these intersections and the need to coordinate across these boundaries.

Senator BEGICH. Great.

Dr. HOLDREN. And my own inclination, for my whole long disciplinary career, has been crossing boundaries and putting pieces together, so I do intend to get it right in the White House.

Senator BEGICH. Thank you very much. And, Secretary Locke, thank you very much, also, for your commentary.

Secretary LOCKE. Thank you.

The CHAIRMAN. Let me just end on this note, we—the reason that Senator Begich and I are asking these questions, and others ask these questions, is only made possible because we already have in place the beginning of all of this, the right beginning, which is called "you." The President, I think, has surrounded himself with some of the most brilliant choices—Dr. Holdren, I don't want to embarrass you, but I sometimes refer to you as "walking on water."

[Laughter.]

The CHAIRMAN. That may be the end of your career, but——

[Laughter.]

The CHAIRMAN. You know, we brought that 5-percent carbon guy from New Hampshire, and had him sit right where you are, and he told us all about it, because you told me about it. A really superb technical scientific team. And everything else, of the questions we ask and "How do Americans understand all this, and react to it?" is incredibly important. But, we're—what we—we need to know that is already in place and working is the top part of the team, spreading out and coordinating, superb thinking, superb arguments, and, you know, a superb policy.

So, I—frankly, it's one of the most exciting things about this Administration, is just the presence of all of you.

And, on that dour note, the hearing is over.

[Whereupon, at 3:50 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO HON. GARY F. LOCKE

Question 1. How is the Department of Commerce reorganizing its programs to be more user-focused and respond to community and business needs to address climate change?

Answer. One of my priorities as Secretary is to ensure that the services the Department of Commerce provides to the American people and businesses are easily accessible and user-friendly. In June 2009, I launched the Department's "one-stop" shop initiative to provide a single point of contact for the full-spectrum of Commerce programs available to business owners. The first "one-stop" shop will open in Detroit, Michigan, and will serve as a model for other metropolitan centers across the country.

In the same way, I believe there is a strong need for a National Climate Service that is coordinated across Federal agencies and user-driven to meet the needs of public and private sector decision-makers. NOAA is already working to improve and strengthen its climate services. However, more needs to be done. The Department of Commerce is working with its Federal partners, including the National Science Foundation, the Departments of Agriculture, Energy, and the Interior, the Environmental Protection Agency, the National Aeronautics and Space Administration, and the Office of Science and Technology Policy, among others, to address the growing demand for climate services.

NOAA already provides a wide array of climate information and services including ground, ocean and space-based observations, climate assessments, drought early warning information, and climate predictions and projections. This information is delivered to a range of users. For example, NOAA provides information to local coastal managers to help prepare for and mitigate against likely changes in sea level, storms and ocean temperatures.

For inland and coastal states alike, the issue of water management in our changing climate is critical. For example, NOAA's climate information indicates that the state of West Virginia is projected to continue receiving very heavy rainstorms with longer dry periods between. Targeted climate services are helping state and local managers to ensure that heavier rainfall can be handled by stormwater systems and reservoirs are big enough to ensure ample water supply during dry periods.

In 2008, NOAA began an effort to improve its integrated climate services to, among other things, develop and deliver a broader range of operational climate information products and services in partnership with other Federal agencies with trust resource mandates. To ensure NOAA is best organized internally to coordinate its climate services, I have asked Dr. Lubchenco to integrate the climate services interspersed throughout NOAA's line offices into one office so users only have to knock on one door to access NOAA's diverse expert resources.

I look forward to working with the Committee on these efforts.

Question 2. Has the United States ever conducted an oceans assessment to analyze the effects of global change? Would NOAA support an oceans assessment, either by the United States or as an international effort?

Answer. No, to the best of my knowledge, the United States has not conducted a comprehensive national oceans assessment to analyze the effects of global climate change on the environment and ecosystems.

President Obama, recognizing the need for a comprehensive national oceans policy, including an ecosystem-based framework for the long-term conservation of our resources, established the White House Ocean Policy Task Force. Under Secretary Lubchenco, representing the Department of Commerce, has provided a strong voice on the Task Force.

Should the Task Force develop recommendations for an integrated ocean ecosystem assessment, the Department, through NOAA, stands ready to bring its assets and expertise to bear to support such an effort.

Question 3. Is our current greenhouse gas monitoring and measurement system sufficient to meet our needs to verify emission reductions at the regional, national, and international levels? If not, what is lacking with the current system and how do we make improvements?

Answer. NOAA's sustained efforts to monitor and measure the carbon cycle in the atmosphere and oceans over more than 40 years provide a key component of the basis for our understanding of climate change today.

In addition, NOAA and its sister agency, the Department's National Institute of Standards and Technology play a crucial role in ensuring the accuracy and reliability of monitoring by providing an unbiased scientific assessment of the quality of current greenhouse gas measurements and models, as well as evaluation and validation of new standards and measurement methods.

Other Federal greenhouse gas monitoring and measurement systems also provide a strong foundation for emission reduction efforts today. EPA, USDA, and DOE have facility, corporate, regional and national level reporting systems that can be used to support comprehensive economy wide and credible reduction programs for greenhouse gases. Examples include the Inventory of U.S. Greenhouse Gases and Sinks, EPA's proposed mandatory reporting rule for greenhouse gases, measurement of CO_2 emissions from the electric power sector under the Clean Air Act's Acid Rain Program (accounting for 1/3 of all U.S. CO_2 emissions), and robust statistical systems for gathering activity data from energy and land-use that are implemented by DOE and USDA, respectively. The U.S. Government has worked with partner nations on the implementation of measurement systems to track emission reductions internationally.

Our country is poised to embark on a critical effort to curb greenhouse gas emissions to avoid the most severe impacts of climate change. To be effective in this endeavor, we must upgrade the current greenhouse gas and aerosol monitoring system to ensure our monitoring of greenhouse gases is comprehensive, coordinated, and globally coherent. Current greenhouse gas monitoring systems implemented by Federal science agencies are designed to support research to understand the role of the carbon cycle and gases and aerosols in climate change. However, the growing need for scientific verification and support for efforts to mitigate climate change requires a sustained, more comprehensive and operational monitoring system. Such an approach should combine ground-based and space-based observations, self-reporting by industry, carbon-cycle modeling, fossil-fuel use data, land-use data and a strong analytic component. This comprehensive approach has proven instrumental in the effective implementation of other policy frameworks for reduction of atmospheric pollutants, including the greenhouse gas sulfur hexafluoride and ozone depleting hydrochlorofluorocarbons, both covered by the *Montreal Protocol*.

A comprehensive monitoring and analysis system that involves a number of agencies will allow validation, on regional scales, whether reported emissions are consistent with atmospheric concentrations. Such understanding and verification are critical to determining whether domestic and international policy decisions are having their intended effects, and being implemented equitably and efficiently.

Question 4. There is growing interest to establish and operate a National Climate Service. Yet, there was not a request for the National Climate Service in the FY 2010 budget request for NOAA. How does NOAA's budget support this effort? Will you include a robust request for the National Climate Service in your FY2011 budget for NOAA?

Answer. A National Climate Service should be established as the bridge between decision-makers and climate change science and information, providing timely and authoritative information, such as predictions of changing temperatures and water availability, and assessments of associated impacts, risks, and vulnerabilities.

NOAA provides a wide-array of climate information and services including ground, ocean and space-based observations, climate assessments, drought early warning information, and climate predictions and projections. NOAA currently works with a broad spectrum of users to provide climate change information to help inform resource management, business, and industry decisionmaking.

NOAA is already moving forward to improve and strengthen its climate services. NOAA envisions a National Climate Service as a partnership that would be established among other Federal agencies, various levels of government, and the private sector. While there is no specific request for the National Climate Service in FY 2010, NOAA's budget request provides a foundation for strengthening climate services and building a broader national effort.

NOAA requested $297 million for climate activities in FY 2010. The FY 2010 request supports and enhances NOAA's integrated program of climate observations, research, modeling, prediction, decision support, and assessment.

NOAA has taken several near-term actions within its existing authorities to improve how it delivers climate science and services. NOAA has been evaluating climate services activities within the agency, and is actively engaging its partners and the user community to determine their specific information needs and the contributions these groups may bring to the development of climate services. NOAA looks forward to engaging in these dialogues with the Congress, its Federal agency partners, and the range of public and private sector interests in climate services, as the Administration moves forward to coordinate and expand its national climate science programs and develop the FY 2011 budget.

Question 5. How is NOAA helping coastal communities, marine resource managers, and ocean industries adapt to climate change? What additional authorities and resources does the Department need to improve marine adaptation efforts?

Answer. Climate change is already having significant impacts on our coastal and marine resources, environments, and communities. Given its stewardship responsibilities, NOAA is both a producer and a consumer of climate change information. NOAA' s climate services already reach coastal communities, marine resource managers and ocean industries. NOAA provides local managers information on likely changes in sea level, storms and ocean temperatures. In addition, coastal communities, decision-makers, and relevant industries and organizations have been engaged in an ongoing dialogue about their needs for climate information and access to the climate services they require.

Climate change information is already being incorporated into marine resource and coastal ecosystem management decisions within NOAA through adaptation planning for marine fisheries, coastal and ocean habitats. NOAA's mandated responsibilities include, for example: fisheries, endangered species and marine mammal management, National Marine Sanctuaries, and coastal and estuarine management. With each of these mandates, NOAA managers must account for the effects of climate variability and change on coastal and marine ecosystems, resources, and communities to adapt their management practices accordingly. For example, NOAA is incorporating climate information into living resource management in a variety of ways, such as considering water use planning decisions in salmon management, measuring and evaluating the effects of sea level rise and the loss of sea ice on protected resources, and determining the impact of warming ocean temperatures on the productivity and distribution of fisheries, marine mammals, and habitats.

In addition, NOAA supports other Federal agencies, state and local governments, and the private sector, as they make decisions about adapting to climate change including coastal planning and development efforts, maritime transportation, water resource management, and other issues such as insurance, energy and agriculture. For example, NOAA is integrating its climate and ocean ecosystem observations and predictions to improve its delivery of climate information and tools to ocean and coastal decision-makers, and to assist them in managing and adapting to a changing climate.

Question 6. Given NIST's critical role in developing the foundational science to enable Earth observations, climate science, mitigation technologies, and cap and trade monitoring and verification, how are they coordinating with other agencies to ensure accurate assessments of climate change?

Answer. NIST will continue to provide the basis for the unbiased scientific assessment of the quality of current greenhouse gas measurements. These activities span the range of measurements upon which a comprehensive U.S. monitoring system will be based and ensures its international recognition. Expansion of NIST's engagement with other Federal agencies, including NOAA, NASA, NSF, EPA, the Departments of Transportation, Energy, and Agriculture, will provide the measurements and standards foundation of a comprehensive monitoring system.

In addition, NIST is initiating engagement with the private sector to strengthen current measurement practices and standards, to develop new measurement approaches for monitoring and verification, and, where feasible, to provide a range of measurement approaches for individual emissions source or sink monitoring. Because the private sector will bear significant responsibility for facility-by-facility implementation of mitigation approaches, cooperative efforts between industry and government will enhance the quality of U.S. inventories through development and use of measurements and standards closely tied to national measurement standards and measurement science. The long history of successful NIST engagement with the private sector, in its third party role, and with the consensus standards community will strengthen confidence in greenhouse quantity determination, improving compliance with market-based reforms and regulation of carbon pollution. As harmonization of U.S. inventories with those of other countries becomes a more pressing

need, the internationally-recognized measurements and standards foundation provided by NIST will be critical to acceptance of U.S. inventories internationally.

Some specific examples of current NIST involvement include:

- Participation in policy-level coordination activities at the interagency and international levels.
- Participation in measurement and monitoring discussions in many strategic working groups, committees and workshops along with other Federal agencies, the academic climate change research community and the private sector.
- Direct interaction with other Federal agencies in the following areas:
  - *Measurement and calibration standards for remote-sensing satellite instruments and sensors.* NISI has partnered on workshops with the satellite programs at NASA and NOAA to improve satellite measurements associated with climate change and to reduce key discrepancies in climate measurements. NIST also works with NASA, USGS, and NOAA's satellite programs (NPOESS, GOES–R, CLARREO, EOS, LDCM etc.) to help improve the accuracy and comparability of satellite measurements.
  - *Measurement needs in greenhouse gas monitoring system.* NIST is developing new measurement science and standards to improve the accuracy and comparability of climate change and greenhouse gas measurements. NIST works with NASA to provide key laboratory data that supports satellite measurements of the state of the atmosphere.
  - *Identification of gaps in the measurement capabilities critical to climate change monitoring.* NIST, with American Recovery and Reinvestment Act funding, has developed a grant program to solicit new measurement science technology in support of climate and environmental measurement.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO HON. JOHN P. HOLDREN, PH.D.

Question 1. How is the Administration keeping an eye on the budgets of individual Federal agencies, as well as on the overall Global Change Research Program so that the Nation has a well-funded, comprehensive climate program—one that serves the Nation's needs?

Answer. OSTP, the Council on Environmental Quality, the Office of Management and Budget, and the Office of Energy and Climate Change monitor the budgets and activities of Federal climate change programs on an ongoing basis. OSTP provides leadership for the U.S. Global Change Research Program (USGCRP), and we are integrating its activities with other climate change programs such as the Climate Change Technology Program, our international climate change programs, and ongoing climate-related activities in departments and agencies that do not otherwise fall under the purview of USGCRP. We use USGCRP and agency expertise and data to identify and address research gaps, and we actively seek out resources or initiatives to close the gaps. We are currently engaged with OMB in a comprehensive assessment of Fiscal Year (FY) 2010 climate change spending, and we have begun to identify resource requirements, scientific opportunities, and science and technology needs in the climate change domain in preparing the FY 2011 budget request.

Question 2. What do you see as the strengths and weaknesses of the Global Change Research Program? What specific changes would you recommend to respond to current and future climate change challenges?

Answer. The U.S. Global Change Research Program (USGCRP) brings together into a single interagency program the essential capacities for research and observations on climate change that are widely distributed across government agencies. Growing out of interagency activities and planning beginning in about 1988, and receiving congressional support under the Global Change Research Act (GCRA) in 1990, the USGCRP has energized cooperative interagency activities, with each agency bringing its strength to the collaborative effort. An essential component of success in delivering the information necessary for decisionmaking is coordination of the programmatic and budgetary decisions of the 13 agencies that make up the USGCRP. OSTP and OMB work closely with the USGCRP Interagency Integration and Coordination Office and the USGCRP interagency working groups to establish research priorities and funding plans to assure the program is aligned with the Administration's priorities and reflects agency planning.

The cooperative work of the USGCRP agencies has yielded significant advances in our characterization, understanding, and ability to predict climate variability and change. This integrated work culminated in the recent release of the report, *Global*

Climate Change Impacts in the United States, which provides concrete scientific evidence that the climate is changing and presents the most comprehensive available picture of likely current and future impacts on specific regions and sectors.

USGCRP's strength in climate science is attested to in a recent evaluation by the National Research Council[1] The same study, however, also identified areas for programmatic improvement, including the need to make progress on applying climate-science knowledge in management and decisionmaking, improving predictive capabilities at regional and local scales, and increasing understanding of human impacts.

Another recent NRC study[2] points to the difficulty of transforming the program from one focused on understanding causes and processes of climate change to support for actions needed to cope with the approaching societal problems associated with its impacts. This transition will require the USGCRP to support a balanced portfolio of fundamental and application-oriented research activities from expanded modeling efforts to studies of coupled human-natural systems and institutional resilience.

Both NRC studies emphasize the need to link sound climate change science and information with decision-making for society's benefit. For example, it is important for the USGCRP to make a strong commitment to providing the information that society is seeking in order to reduce vulnerabilities and improve resilience to variability and change. One essential element for making this link is the coordination of the programmatic and budgetary decisions among the 13 agencies comprising the USGCRP. This coordination role must continue based on a fully integrated research plan with an interagency budget crosscut. There are specific research areas that the research plan should include to better link science and information with decision-making, and these areas must be addressed by expertise from agencies that are strong in social sciences and economics as well as the physical and biological sciences.

Question 3. How is the Office of Science and Technology Policy engaging and coordinating the efforts of academia, private industry, and Federal agencies to develop an integrated and comprehensive network to provide usable climate information to stakeholders and decisionmakers?

Answer. Coordinated climate information and services are needed to assist decision-making across public and private sectors. Just as the Nation's climate research efforts require and benefit from interagency and academic partnerships, so too will the development and communication of climate change information to users.

While much work has been done to evaluate the need for climate services and a National Climate Service, the Administration believes that additional assessment and analysis of existing climate- service capabilities and user needs for climate services is necessary. A National Climate Service and, more broadly, our Nation's approach to delivering climate services will require that such analysis and assessment is ongoing, science-based, user-responsive, and relevant to all levels of interest, *e.g.,* local, regional, national and international. Such a framework must also be able to adapt to new developments in the scientific understanding of climate change and resultant impacts to serve the needs of decision-makers and the public.

To promptly address this issue within the Federal Government, OSTP is working to convene a task force with representation from a diverse group of key agencies whose charge will be to examine national assets, existing data and information gaps, and costs related to the development of a cohesive framework for delivering accurate climate-related information to the public. This process is intended to result in a more detailed functional and organizational approach for delivering climate services to the Nation.

As part of the process to engage external stakeholders and customers, the USGCRP has undertaken a series of "listening sessions" with a variety of stakeholder groups, including from academia, private industry, and nongovernmental organizations, around the country to gain a better understanding of the emerging needs for climate information and ways in which Federal research might be shaped to meet those needs. The program and its member departments and agencies have also commissioned a number of reports from the National Research Council to help guide it in its current activities and future planning, including the recently published NRC reports *Restructuring Federal Climate Research to Meet the Challenges of Climate Change* (2009) and *Informing Decisions in a Changing Climate* (2009). To be successful, the delivery of climate services will require sustained Federal

[1] NRC, 2007, Evaluating Progress of the U.S. Climate Change Science Program: Methods and Preliminary Results, National Academies Press, Washington, D.C., 170 pp.

[2] NRC, 2009, Restructuring Federal Climate Research to Meet the Challenges of Climate Change, National Academies Press, Washington DC, 266 p.

agency partnerships, such as those fostered by the USGCRP, and collaboration with climate service providers and end users.

Question 4. Dr. Holdren, given that a national assessment of climate change has not been conducted since 2000, are you making it a priority to do so within the next 4 years as required by law?

Answer. Yes, absolutely. The recently released *Global Climate Change Impacts in the United States* report and the underlying Synthesis and Assessment Products provide a useful foundation on which to build the next national assessment.

Question 4a. If yes, how will the Administration make sure the assessment has broad stakeholder participation to determine the risks and costs of climate change impacts on the United States and to evaluate options for responding? If no, why not?

Answer. Broad stakeholder participation is critical for this type of comprehensive assessment and product. We will employ a wide variety of traditional techniques for gathering this input such as public meetings, requests for comments on drafts published in the Federal register, interaction with academe, and others. We will also take advantage of new methods currently being pioneered at OSTP and other government agencies to promote open government and to engage stakeholders via a variety of electronic means such as web-postings and blogs.

Question 5. Has the United States ever conducted an oceans assessment to analyze the effects of global change? Would you support an oceans assessment, either by the United States or as an international effort?

Answer. While a comprehensive assessment of the oceans and global change has never been undertaken, a number of domestic and international efforts have assessed some of the effects of climate change on coastal and oceanic regions. Many aspects of coastal effects were recently documented in the U.S. Global Research Program (USGCRP)'s report, *Global Climate Change Impacts in the United States.* Coastal regions will be considered in the national assessment under discussion by the USGCRP that is mandated by the U.S. Global Change Research Act and due in 2012. In addition, the National Marine Fisheries Service and international counterparts conduct assessments of fishing pressure and the status of living marine resources, and these efforts should contribute to our understanding in the long term. A global marine assessment to complement the efforts already undertaken by the Intergovernmental Panel on Climate Change (IPCC) is under consideration by the Intergovernmental Oceanographic Commission and other United Nations bodies. It is unclear at this early stage whether the effort would be cost-effective and significantly add to the IPCC and other efforts.

Question 6. Is our current greenhouse gas monitoring and measurement system sufficient to meet our needs to verify emission reductions at the regional, national, and international levels?

Answer. Methods are currently available for calculating GHG emissions and uptake at scales from projects to nations. The capacity to confirm such calculations with observations with the needed coverage and at all the relevant scales does not yet exist, however. I believe that the existing information and measurement capabilities are adequate to support the initiation of national climate policies, but achieving the high level of accuracy, precision, and confidence that decision-makers and the public will want concerning offsets and the reality of emissions reductions or uptake increases claimed for other initiatives in the agriculture, forestry, energy, and other sectors will require continuing effort to improve our understanding of and ability to accurately and precisely measure stocks and flows of carbon and nitrogen at global, regional, and local scales.

Question 6a. If not, what is lacking with the current system and how do we make improvements?

Answer. At the Earth's surface (*in situ* systems on land, sea, and airborne platforms) the United States currently has good approaches for taking inventory of greenhouse gas emissions. Fossil fuel emissions are tracked by EPA and EIA, while biosphere contributions to emissions (*e.g.,* agriculture, forests, soils), are tracked by USDA. In addition, the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) provides most of the world's long-term measurements of greenhouse gases in the atmosphere, and currently operates 2/3 of the global atmospheric greenhouse gas observing sites. NOAA and NSF together also provide about half of the world's oceanic greenhouse gas measurements. However, these systems do not account for all greenhouse gases, and our biosphere monitoring is not comprehensive. Further, the current surface-based carbon dioxide monitoring network alone is too sparse to identify the locations of carbon sinks, or tell us what controls changes in their efficiency from year to year.

In space, NASA, NOAA, and USGS operate satellites that acquire surface characteristics of the land and ocean, as well as weather satellites that provide information necessary for tracking gas distributions in the atmosphere. Current space-based capabilities need to be tied to accurate *in situ* surface sensor measurements and higher-density space-based observations are necessary for fine scale monitoring of sources and sinks of greenhouse gases that will allow for the verification of emissions reductions offsets and of the effects of climate change. Additionally, measurements at all spatial and temporal scales must be based on internationally-recognized measurement standards, established and disseminated for the U.S. by the Department of Commerce's National Institute of Standards and Technology (NIST), to ensure their accuracy and comparability.

In the future, space-based remote sensing of atmospheric CO_2 has potential to deliver data products with the accuracy, precision, temporal and spatial resolution, and coverage to independently assess the variability of CO_2 sources and sinks at regional, national and international levels. This information could help facilitate emissions reduction verification. Robust surface-based observations will be necessary in the testing and refining of satellite measurement capability, and the ability to measure and describe components contributions to aggregate CO_2 sources and sinks.

Question 7. Do you think that our current Earth observing capabilities are adequate to provide decision-makers and policymakers with the information they need to respond to climate change?

Answer. The United States and our partners around the world operate a vast array of instruments and systems that provide data on many important phenomena, but the development of an integrated climate observing system stands as an important challenge. Long-term, high-accuracy, stable environmental observations are essential to define the state of the global integrated Earth system, its history and its future variability and change. To a large degree, the existing Federal observational capabilities have been only loosely integrated. The critical leap forward can only be achieved with a synergy between remotely sensed and *in situ* observations supported by robust data systems. One endeavor to address this challenge is the Global Climate Observing System (GCOS), a "system of systems" that builds on the climate-relevant components of existing observing systems. GCOS is the climate observing system within the Global Earth Observation System of Systems (GEOSS) developed under the auspices of the intergovernmental Group on Earth Observations (GEO).

Question 7a. What are your plans to develop a robust, long-term, national Earth observing strategy to meet those needs?

Answer. OSTP is currently addressing this challenge via the U.S. Group on Earth Observations (USGEO), an interagency subcommittee of the National Science and Technology Council charged with developing an integrated Earth observation system to ensure that adequate data, products, and services are available to wisely manage human and natural systems. This integrated approach takes into account the Earth observation activities of Federal, State, regional, local, tribal government, non-governmental organizations, academia, commercial firms and foreign governments, and it will encourage the full, open, and timely sharing and exchange of data, products, and services.

Question 7b. How can you ensure that these observational data are comparable between different agencies, platforms, and countries?

Answer. To ensure that observational data are comparable between different agencies, platforms, and countries, the strategy being worked on by USGEO will encourage the adoption of widely accepted standards, such as web-services-based service oriented architecture, as well as data management principles such as multi-use, preservation, quality, and access. Further, traceability of the measurements to standards based on the International System of Units (SI) such as provided by NIST and similar organizations around the world is fundamental for ensuring data accuracy and comparability independent of when and where the measurements were made. Data harmonization and interoperability efforts are coordinated nationally by USGEO, and internationally by the Group on Earth Observations (GEO).

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BY HON. DAVID VITTER TO HON. JOHN P. HOLDREN, PH.D.

Question 1. When was the last recorded global warming, as recorded by satellites? Does this shake your confidence at all in the climate models?

Answer. Satellite data records for the temperature of the lower atmosphere (near the Earth's surface) have been available since 1979. In 2006, a summary comparing

the satellite data and surface temperature records as recorded by thermometers (Climate Change Science Program Synthesis and Assessment Product 1.1 "Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences") showed a substantial upward trend for the global averages of temperature for both the lower atmosphere and at the surface, starting at the beginning of the satellite data record and continuing through 2005, the most recent year that was analyzed in the study. (See the response to question 5 for a discussion of the need to look at long-term trends versus year-to-year-variability.) This long-term upward trend has continued in the surface temperature record, and is also accurately reproduced by the climate models, as shown in the recently released U.S. Global Change Research Program (USGCRP) report entitled "Global Change Impacts in the United States" (2009). (See section titled "Global Climate Change," pages 13–26.) The most recent data (last updated for August 2009) can be found on the website *http://data.giss.nasa.gov/gistemp/*, with the methodology documented in the reference Hansen et al 2006: Global temperature change. *Proc. Natl. Acad. Sci.,* 103, 14288–14293, doi:10.1073/pnas.0606291103. Thus the data records from both the satellites and surface thermometers, as well as the analyses of computer models, are all in agreement that the warming of the recent decades is real, continuing, and primarily due to human-caused emissions of heat-trapping gases.

Question 2. Some scientists have said that climate is always changing—either warming or cooling? Is this correct, and for how many years (thousands, millions, billions) has the climate been changing?

Answer. Climate has changed on many time scales throughout Earth's multi-billion-year history, for reasons ranging from variations in the sun's output, to re-arrangement of land and ocean areas under continental drift, to variations in Earth's orbit and tilt, to gradual changes in the composition of the atmosphere as a result of geochemical and biological processes, to more rapid changes in atmospheric composition caused by volcanism and asteroid impacts. The changes in climate now being imposed by human additions of heat-trapping gases and particles to the atmosphere are more rapid than almost all of the natural changes that came before—hence more difficult for ecosystems to adjust to. It can be added that the most rapid of the natural changes were associated with massive extinctions, and even some of the less rapid natural changes that occurred in the human era are thought to have played decisive roles in the disappearance of a number of premodern civilizations.

Question 3. Was the climate warmer 1000 yrs ago than today?

Answer. Paleoclimate analyses (in which temperature is inferred from tree rings, ice cores, sediment layers, fossil pollens, and so on) are used to answer such questions, since the global thermometer record only goes back about 150 years. These analyses, which are necessarily approximate, indicate that some regions in Northern Europe may have been warmer 1000 years ago than in the 20th Century, but that the globe as a whole was very likely cooler than in the 20th Century. (See for example the 2006 National Research Council report, "Surface Temperature Reconstructions for the Last 2,000 Years", which notes "an array of evidence that includes . . . pronounced changes in a variety of local proxy indicators, such as melting on icecaps and the retreat of glaciers around the world, which in many cases appear to be unprecedented during at least the last 2,000 years.")

Question 4. Would it be accurate or inaccurate to say that sea levels have been rising steadily for about 18,000 years, and why?

Answer. Inaccurate. Following the end of the last ice age (approximately 21,000 years ago), sea level rose by about 120 meters, taking 18–19,000 years to do so before stabilizing between 3,000 and 2,000 years ago. The evidence indicates that global sea level did not change significantly from then until the late 19th Century. The average rate of sea level rise in the 20th Century was about 1.5 millimeters per year; since 1993, the rate of rise has been around 3 mm per year, and the rate is continuing to increase.

Question 5. Graphs that have been distributed recently on Capitol Hill by a number of organizations show that the climate has not warmed since 1998, while CO_2 levels have been rising.

a. Please provide the most current satellite and balloon data.

b. Please provide a comparison of the EACH of the model projections starting in the Year 2000 with the data from satellites and balloons.

Answer. Attempts to support the claim that the Earth has not been warming since 1998 have generally been based on global average surface air temperatures as measured by thermometers, which are indeed a more direct and relevant indicator, compared to satellite and balloon measurements, of what is happening where it most matters—namely where the people, other organisms, soils, and most of the ice and liquid water are. The mistake in these attempts is that they confuse short-

term variability with long-term trends. A recent peer-reviewed paper (Easterling, D.R., and M.F. Wehner, 2009: Is the climate warming or cooling? Geophys. Res. Letts, 36, doi:10.1029/2009GL037810.) directly addresses the issue of confusing short-term variability with long-term warming due to increasing greenhouse gases. The paper shows that periods of a decade or two that show no warming or even slight cooling are found both in the observed record during periods of long-run warming and in climate-model simulations of strong warming driven to increasing greenhouse gases.

Furthermore, 1998 was an exceptionally hot year—hotter than all of the succeeding ones until 2005—because it superimposed a very powerful El Niño on top of the long-run warming trend. This is evident in the year-by-year, global-average surface temperature data compiled by NASA (Figures 1 and 2). Also evident in these figures are: (1) the sudden coolings caused by the El Chichon and Pinatubo volcanic eruptions in the early 1980s and early 1990s, respectively, and (2) in Figure 1 two periods are highlighted that show no warming, even with the strong overall warming. These figures show that o One cannot draw valid conclusions about long-term trends from either the individual peaks or the individual valleys in year-to-year temperature trends.

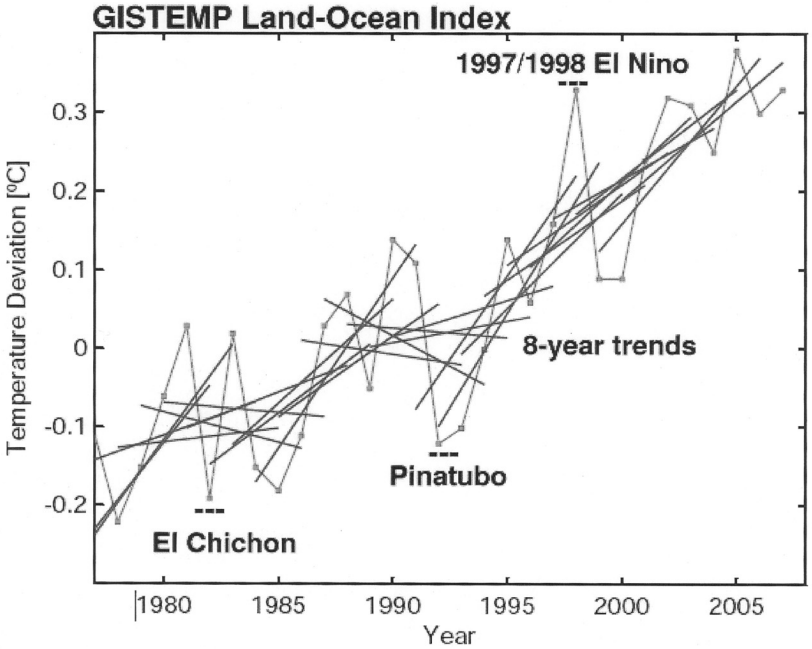

Figure 1. Globally averaged surface air temperature compiled by NASA. Blue lines are eight-year overlapping trend lines.

Taking a closer look the effects of short-term variability can be separated from long-run trends by averaging over multi-year periods—the longer the averaging period, the less evident the short-term variability becomes and the easier it is to see the underlying longterm trend. Shown in blue in Figure 1 are 8-year trend lines. These give the average rate of change over the 8-year period where each line begins. One can see that the high short-term variability of the 1980s and very early 1990s produced both upward and downward 8-year trend lines in this period. But one can also see that, even despite the large El Niño temperature spike in 1998, the 8-year trend lines from 1991 onward are all sloping upward—that is, all showing warming.

In Figure 2, a longer averaging time reduces the influence of short-term variability still further. The blue lines now show the 15-year trends, and one sees that they are consistently upward from the beginning of the plot in the late 1970s through the end of the data in 2007.

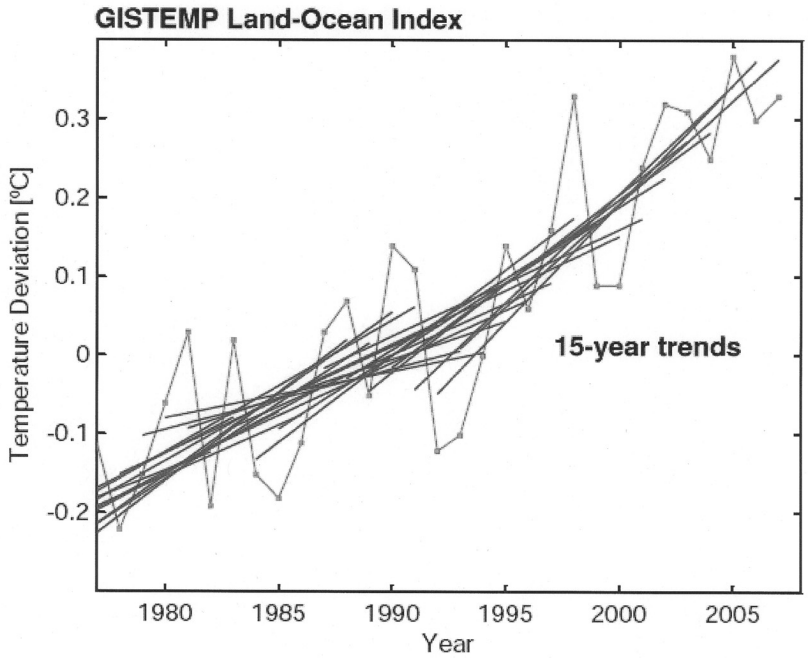

Figure 2. Same as in Figure 1 except the trend lines are for fifteen-year periods.

To understand the relation of surface temperature measurements to those made from balloons and from satellites—and how these different sorts of measurements are now understood to be consistent with each other and with the predictions of climate models, please see the two enclosed references (Climate Change Science Program Synthesis and Assessment Product 1.1 "Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences"; and Santer *et al.,* 2008: "Consistency of modeled and observed temperature trends in the tropical troposphere", Intl. J. Climatol., 28, 1703–1722, doi:10.1002/joc.1756).

Unlike weather forecast models that start with the observed conditions and then simulate days or weeks into the future, climate models are started with conditions in, typically, 1,750 or 1,850, and then run without knowledge of observed conditions, except for observed changes in greenhouse gases and volcanic aerosols, to 2,000. To simulate future climate they are then run with scenarios of increasing greenhouse gases usually to 2,100. Climate models are not designed to try to simulate short-term variations (*i.e.,* decadal to even multi-decadal) in the climate, but the longer term changes in the baseline climate over multiple decades to centuries. What the models thus simulate (and each model is run a number of times to account for the chaotic behavior of the atmosphere) is the envelope of possible conditions over a period, and the question is then whether the observed climate is within that envelope of conditions. The crucial result of these comparisons is that the observed climate IS within the envelope of model simulations if and only if the model simulations include both human and natural influences over the course of the 20th Century. Figure 3 (from Easterling and Wehner 2009) shows one example of a climate model simulation for the 21st Century starting in 2001 that has strong increasing greenhouse gases and warms by about 4°C by 2100. Two periods are highlighted, 2001–2010 and 2016–2031, both of which show slight cooling, even though the simulation shows strong overall warming by the end of the 21st Century. Thus, due to natural variability of the climate, periods of a decade or two that show no warming are expected, even with strong warming by the end of this century.

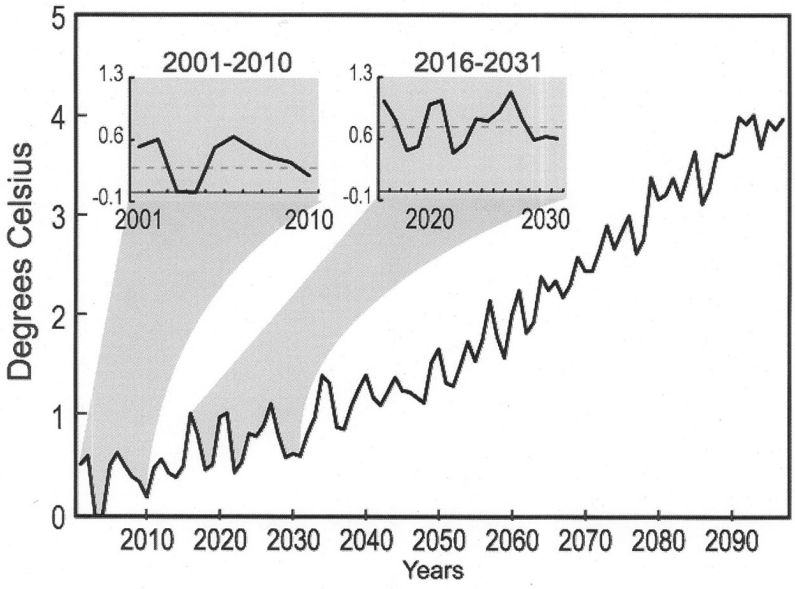

Figure 3. One realization of the globally averaged surface air temperature from the ECHAM5 coupled climate model forced with the SRES A2 greenhouse gas increase scenario for the 21st Century.

Question 6. Would it be accurate to state that the climate cooled between 1940 and 1975 while CO_2 levels rose rapidly after WW-II?

Answer. After rising rapidly during the first part of the 20th century, global average surface temperature did cool somewhat (on the order of 0.2°C) in the period from 1940 to about 1975. During this time period, increases in reflective particles in the atmosphere, from both industrial activities and volcanoes, more than compensated for the increases in the concentration of CO_2. Thereafter, the increasingly rapid rise of CO_2 came to dominate, with the help of pollution-control measures that reduced particle concentrations without doing anything about CO_2.

When the best estimates of the time histories of radiative forcing by anthropogenic greenhouse gases and particulate matter are included in modern climate models, along with solar variability and volcanic eruptions, they reproduce with remarkable fidelity the temperature trajectory observed over the 20th Century, including the cooling period between 1940 and 1975.

Question 7. Why is it that climate models try to picture such events as 'anomalous' and adjust their model assumptions only AFTER the fact?

Answer. Scientists are not suggesting that the cooling period from 1940 to 1975 was "anomalous"—as noted above, it is explained by current understandings of the relative importance of positive and negative forcings, natural and anthropogenic, over time. It may be added that science routinely proceeds by identifying discrepancies between theory and measurement, or between modeling and measurement, and then seeking to determine whether it is the theory (and/or models) are flawed, or the measurements that are lacking. Global climate models and our understanding of Earth's climate system, as well as our ability to make systematic measurements of climate parameters, continue to improve through this interplay between scientific theory and observations.

Question 8. Do you agree that CO_2 is essential to plant growth—and all agriculture? As well, are you aware of current projects to convert algae to biofuels that are looking at injecting CO_2 to increase growth? Would such projects be working under the assumption that increased CO_2 can increase plant growth?

Answer. Yes, CO_2 is an essential input to photosynthesis in both natural and managed vegetation. And, under some circumstances, including adequate availability of water, nutrients, and sunlight, increasing the amount of CO_2 available to plants will increase their productivity. This is indeed the idea behind projects to ac-

celerate the growth of algae, for conversion to biofuels, with the use of CO_2 emitted by fuel-burning power plants.

As for the effects on plant growth of the ongoing build-up of atmospheric CO_2 as a result of human activities, the picture is complicated because of the changes in temperature and other climatic variables that accompany the CO_2 increase. The conventional wisdom about effects of climate change on the productivity of farms and forests, up until a few years ago, was that modest increases in temperature accompanied by increases in atmospheric CO_2 and rainfall (which increases in a warmer world because evaporation increases) would lead to increases in plant growth in many regions and thus to increases in crop yields and sustainable forest output. Only when the global average temperature increase reached 3.6°F (2°C) or more above the pre-industrial value, it was thought, would the effects of heat stress on plants offset the beneficial effects of increased CO_2 and increased rainfall in enough places to lead to declines in farm and forest productivity on a global basis.

Recent improvements in understanding of plant physiology, the ecology of plant pests and pathogens, and the implications of changes in average temperatures for temperature extremes and for changes in the patterns of precipitation and evaporation—all underpinned not just by theory and modeling but by observations—have changed this picture for the worse. It now seems that many plants are less helped by extra CO_2 and more hurt by heat stress and pests and pathogens (which generally do better in a warmer climate) than had been thought. Crop and forest productivity is being further imperiled in many regions by increased incidence of drought, which tends to increase in a warmer world, despite an increase in global precipitation, in part because more of the rainfall occurs in extreme events (with more of the water lost to storm runoff) and the intervals between these events often increase (with more soil drying from the combination of the longer interval and higher temperatures).

Question 9. If indeed the observed 20th Century warming is not due to CO_2 increase but is naturally caused—likely a recovery from the Little Ice Age—do you see any point to limiting the emission of CO_2?

Answer. The scientific evidence is very strong that the pronounced warming of the last part of the 20th Century, continuing into the 21st, has been and is being driven primarily by the buildup in the atmosphere of CO_2 and other heat-trapping gases and particles caused by human activities. The so-called "Little Ice Age" (which was not a glacial period but a moderate cooling) was a regional (Europe) rather than a global phenomenon. Scientific consensus clearly indicates that the first part of the question is a faulty premise as global warming is unequivocal and primarily human-induced (IPCC 2007) and there is no plausibility to the proposition that the observed global warming could be a "recovery" from a regional cooling. If one did, nonetheless, believe that the recent warming was mainly explained by such a recovery, there would still be a good argument for trying to avoid the adverse impacts of the further warming that the solid science of greenhouse-gas influences indicates will be the result of further CO_2 build-up in the atmosphere.

In addition to the warming caused by increasing amounts of atmospheric CO_2, the recently released U.S. Global Change Research Program (USGCRP) report entitled "Global Change Impacts in the United States" (2009) states the following:

> "In addition to carbon dioxide's heat-trapping effect, the increase in its concentration in the atmosphere is gradually acidifying the ocean. About one-third of the carbon dioxide emitted by human activities has been absorbed by the ocean, resulting in a decrease in the ocean's pH. Since the beginning of the industrial era, ocean pH has declined demonstrably and is projected to decline much more by 2100 if current emissions trends continue. Further declines in pH are very likely to continue to affect the ability of living things to create and maintain shells or skeletons of calcium carbonate. This is because at a lower pH less of the dissolved carbon is available as carbonate ions.
>
> "Ocean acidification will affect living things including important plankton species in the open ocean, mollusks and other shellfish, and corals. The effects on reef-building corals are likely to be particularly severe during this century. Coral calcification rates are likely to decline by more than 30 percent under a doubling of atmospheric carbon dioxide concentrations, with erosion outpacing reef formation at even lower concentrations. In addition, the reduction in pH also affects photosynthesis, growth, and reproduction. The upwelling of deeper ocean water, deficient in carbonate, and thus potentially detrimental to the food chains supporting juvenile salmon has recently been observed along the U.S. West Coast."

Question 10. If the G–5 (China, India, Brazil, Mexico and South Africa) and Russia do not commit to legally verifiable reductions, at what point will the global concentrations reach 450 ppm GHG?

Answer. The Intergovermental Panel on Climate Change (IPCC) Fourth assessment report stated in 2007 that, "The total CO_2-equivalent concentration of all long-lived GHGs is now about 455 ppm CO_2-eq." Incorporating the cooling effect of aerosols, other air pollutants and gases released from land-use change into the equivalent concentration, leads to an effective total CO_2-eq concentration of about 380 ppm. Future greenhouse gas emissions, and the resultant atmospheric concentrations, depend on future demographic, economic, and technological developments, all of which are uncertain. If we assume that the Organisation for Economic Cooperation and Development (OECD) countries reduce their combined emissions to 80 percent below 1990 levels by 2050, and that there is no reduction below the IPCC's reference scenarios in the combined emissions of the non-OECD countries, then the total radiative forcing would reach the equivalent of 450 ppmv of carbon dioxide by 2045, plus or minus 5 years. Stabilizing the atmosphere at less than 450 ppmv CO_2-equivalent would require significant emission reductions by non-OECD countries to begin before 2030. Legally binding commitments by these countries that they will do so are highly desirable, though other options should also continue to be explored.

Question 11. If the global target of 50 percent reduction of emissions by 2050 is to be achieved, what is the corresponding U.S. reduction required by 2030, 2040, and 2050? Provide this answer assuming that there are no commitments as described in Q–10 above?

Answer. The reduction in U.S. emissions that is required to achieve a given global reduction depends on the emissions of other countries. The emissions of all other countries are not specified in the question. If, however, we assume that there is no reduction below the reference scenarios in non-OECD emissions, then it is impossible to achieve a global target of a 50 percent reduction in emissions by 2050. This is because the projections of future emissions from non-OECD countries in the reference scenarios exceed current total world emissions.

Question 12. You recently shared that the idea of geoengineering the climate is being discussed at the White House. You have also shared that one such extreme option includes shooting pollution particles into the upper atmosphere to reflect the sun's rays and that such an experimental measure would only be used as a last resort. Can you discuss what technologies you have discussed with fellow staff, and the cost-benefit analysis the White House is using? In addition, can you share why this would be necessary if the earth continues to cool at the same pace it has over the last 7+ years?

Answer. The reporter's question that I answered in the affirmative was whether geoengineering had ever been mentioned in conversations about climate change in the White House. In my answer I indicated that there is probably no aspect of the climate-change issue that has not been mentioned in such discussions, and I went on to say that, as a scientist, my personal view is that we need to look at all of the possibilities in order to understand their potential leverage, their limitations, their costs, and their side effects. None of this is the same as saying, as was erroneously reported, that geoengineering is currently "under consideration" to be a component of the White House's climate strategy.

Indeed, the "mentions" of geoengineering in White House discussions of which I am aware have largely been unfavorable, based on current understandings suggesting that effectiveness would be low in relation to costs and risks, except in the case of such simple (and limited) measures as making roofs and pavement white instead of black in order to reflect sunlight that otherwise would be absorbed. But I think most would agree that geoengineering ideas should continue to be studied and evaluated in the scientific community, in case something more promising can be identified. The reason for continuing scientific attention to all of the possibilities for both mitigation of global climate change (measures to reduce its pace and magnitude) and adaptation to it (measures to reduce the damages from the degree of climate change we fail to avoid) is that the great bulk of the scientific evidence indicates that warming is continuing (see answer to Question 5) and that the growth of impacts from it is accelerating.

Question 13. Can you explain how it is possible to increase the cost of energy (which would include everything from electricity and fuel to heat a home, to gasoline, manufactured goods and food) on the poor without reducing their standard of living or limiting their freedom?

Answer. Under a cap-and-trade program, an increase in the cost of energy for low-income households can be offset through a variety of methods of returning a portion

of the value of emissions allowances to households. For example, a system in which most allowances were auctioned, and most of the auction revenue was returned to households through a tax credit on a per-capita basis, could provide a net benefit to low-income households. By creating incentives for consumers to conserve energy and consumption of energy-intensive goods and services, this approach is more economically efficient than an alternative that effectively shields households from seeing any changes in energy prices. In fact, the Congressional Budget Office (CBO) has estimated that H.R. 2454, which would implement a cap-and-trade system to reduce GHG emissions, would provide net benefits to households in the lowest income quintile in 2020: CBO estimated that the bill would impose average gross costs of $425 per household in the lowest income quintile in 2020, but also provide an average financial benefit of $465 to these households. In addition, demand response, weatherization programs and improved energy-efficiency standards for vehicles and appliances could lead to net reductions in family expenditures on energy despite higher energy prices. For example, households may reduce their demand for energy and energy-intensive goods in response to a carbon price, which then makes them less vulnerable to future increases in the prices of energy.

Question 14. Why is it that India believes it is necessary to increase their fossil fuel consumption, and as a consequence their GHG emissions, in order to bring a significant portion of their population out of poverty?

Answer. Per-capita energy use in India is currently 20 times less than in the United States, 10 times less than in most other developed countries, and 4 times less than in China. Today, 40 percent of India's population does not have access to electricity. Improved energy services are necessary for the continued economic development of India. Increasing the efficiency of energy use can make a substantial contribution to improved energy services, but India's total energy consumption is likely to continue to increase for some time. In the near-term, these increases will be provided mostly by fossil fuels, because they are the options currently most available at scale at competitive costs. In the longer term, increased reliance on low-carbon energy sources, such as wind, solar, modern biomass, and nuclear energy, as well as the use of carbon sequestration, can largely decouple economic development from greenhouse gas emissions.

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