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THE ADMINISTRATION'S VIEW ON THE STATE OF CLIMATE SCIENCE

HEARING

BEFORE THE

SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

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THE ADMINISTRATION'S VIEW ON THE STATE OF CLIMATE SCIENCE

WEDNESDAY, DECEMBER 2, 2009

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ENERGY INDEPENDENCE
AND GLOBAL WARMING,
Washington, DC.

The committee met, pursuant to call, at 10:04 a.m., in room B–318, Rayburn House Office Building, Hon. Edward J. Markey (chairman of the committee) presiding.

Present: Representatives Markey, Herseth Sandlin, Salazar, Inslee, Sensenbrenner, Shadegg, Miller, Sullivan, Capito, and Blackburn.

Staff Present: Ana Unruh Cohen, Jonah Steinbuck.

The CHAIRMAN. Good morning, and welcome to the Select Committee on Energy Independence and Global Warming.

For many Members of Congress and the public, the concern about global warming may seem like a relatively new development. In fact, scientists, including those advising the U.S. Government, have issued warnings about the rising concentrations of carbon dioxide in the atmosphere throughout the last four decades.

After a report from his science advisory committee, President Lyndon Johnson noted in a 1965 special address to Congress that, quote, a steady increase in carbon dioxide from the burning of fossil fuels has altered the composition of the atmosphere.

In 1978, Robert White, the first administrator of the National Oceanic and Atmospheric Administration, warned that carbon dioxide emissions can have consequences for climate that pose a considerable threat to future society. More recently, the National Academy of Sciences found in a 2001 report requested by President Bush that, quote, global warming could well have serious adverse societal and ecological impacts by the end of this century.

In a report issued earlier this year, U.S. science agencies concluded that climate changes are underway in the United States and are projected to grow. Administration scientists once predicted the impacts of global warming. Now they can confirm them. And unfortunately, families from New Orleans to Alaska are living with the harsh consequences.

Given the upcoming international climate conference in Copenhagen, and the continuing work on domestic clean energy legislation in Congress, an update on the administration's view of the state of climate science is timely. In 2007, the Intergovernmental Panel on Climate Change found in their comprehensive assessment

that global warming is unequivocal and that this warming is primarily due to human activities.

This decade has been the hottest in recorded history, with all of the years since 2001 being in the top 10 hottest. This summer, the ocean was the warmest in NOAA's 130-year record. The extent of Arctic summer sea ice for the past few years has shrunk dramatically compared to the previous two decades, with the reduction roughly three times the size of Texas.

We must be aware that as the climate system warms, we risk passing certain tipping points of rapid and irreversible change. In the United States, the effects are evident. Daily record high temperatures are being broken twice as often as daily lows. Our farms are threatened by rising temperatures, water scarcity, and pests. In the Northeast, extreme rainstorms and the risk of flooding have increased. In Alaska, villages are finding the land they call home literally melting out from underneath them as the permafrost thaws. In the West, the shrinking mountain snow pack and increasing droughts strain our water resource system.

Fortunately, after decades of warnings, President Obama is partnering with Congress to realize a new vision for America, an America freed from dependence on foreign oil and thriving as a leader of the new clean energy economy. The American Recovery and Reinvestment Act included more than $80 billion for clean energy investments to jump-start our economy and generate new clean energy jobs. The Cash for Clunkers program took gas guzzlers off the road. Fuel economy standards were raised for model year 2011 cars and trucks, saving drivers money and spurring companies to develop more efficient, affordable vehicles.

In June, the House passed the Waxman-Markey Clean Energy and Security Act. This is legislation that will put us on a pollution cutting path and, at the same time, create millions of new jobs, making America the global leader of the clean energy economy. The act will also create a National Climate Service that will provide decision makers with vital climate science information.

As we move forward, we must continue to stay abreast of the most recent findings and to ground our policy in the latest climate science.

Our witnesses today, Dr. John Holdren, the President's science adviser, and Dr. Jane Lubchenco, administrator of the National Oceanic and Atmospheric Administration, will help us do that.

Now I would like to turn and recognize the ranking member of the committee, the gentleman from Wisconsin, Mr. Sensenbrenner.

[The prepared statement of Mr. Markey follows:]

THE SELECT COMMITTEE ON
ENERGY INDEPENDENCE AND GLOBAL WARMING

Opening Statement for Edward J. Markey (D-MA)
"The Administration's View on the State of Climate Science"
Select Committee on Energy Independence and Global Warming
December 2, 2009

For many Members of Congress and the public, the concern about global warming may seem like a relatively new development. In fact scientists -- including those advising the U.S. government -- have issued warnings about the rising concentrations of carbon dioxide in the atmosphere throughout the last 4 decades.

After a report from his science advisory committee, President Lyndon Johnson noted in a 1965 special address to Congress that "a steady increase in carbon dioxide from the burning of fossil fuels" has altered the composition of the atmosphere. In 1978, Robert White, the first administrator of the National Oceanic and Atmospheric Administration (NOAA), warned that carbon dioxide emissions "can have consequences for climate that pose a considerable threat to future society."

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As we move forward, we must continue to stay abreast of the most recent findings and to ground our policy in the latest climate science. Our witnesses today - Dr. John Holdren, the President's science advisor and Dr. Jane Lubchenco, Administrator of the National Oceanic and Atmospheric Administration – will help us do that.

Mr. SENSENBRENNER. Well, thank you very much, Mr. Chairman.

And what we have just heard from the Chairman is a case of denial on what has happened recently. Sound science depends on sound policy—or sound science policy depends on sound science. When the science itself is politicized, it becomes impossible to make objective political decisions. Scientific policy depends upon absolute transparency. As policymakers, we should all be concerned when key climate scientists write in private correspondence that they found a trick to hide the decline in temperature data documented in climate studies.

Less than 2 weeks ago, some 160 megabytes of data, containing over 1,000 e-mails, including one from today's witness, Dr. John Holdren, and 2,000 other documents from the Climate Research Unit at the University of East Anglia in the UK were posted on the Internet. While the e-mails don't undermine everything we know about climate change, their contents are shocking. And in the words of Clive Cook, senior editor of the Atlantic Monthly, a columnist for National Journal, and a commentator for Financial Times, the stink of intellectual corruption is overpowering. The temperature records from the climate research are one of only three major data sets which considerably overlap and which have been used as the bedrock for the assessments by the Intergovernmental Panel on Climate Change and the United States Global Change Research Program.

The data set in question is the basis for virtually all peer-reviewed literature. The documents show systematic suppression of dissenting opinion among scientists in the climate change community, intimidation of journal editors and a journal who would deign to publish articles questioning the so-called consensus, manipulation of data and models, possible criminal activity to evade legitimate requests for data and the underlying computer codes filed under Freedom of Information Acts, both in the U.S. and in the United Kingdom, and demonstrates that many climate scientists and proponents of climate change legislation have vested interests, a clear conflict of interest.

Those with the most to gain from climate change have tried to dismiss these e-mails as out of context. So I am going to read a few examples.

From Kevin Trenberth, quote, the fact is that we can't account for the lack of warming at the moment, and it is a travesty we can't. The series data shows that there should be even more warming, but the data are surely wrong. Our observing system is inadequate, unquote.

From Phil Jones, quote, I have just completed Mike's nature trick of adding in the real temps to each series for the last 20 years—that is from 1981 onwards—and from 1961 for Keith's to hide the decline, unquote.

From Andrew Manning, quote, I am in the process of trying to persuade Siemens Corporation to donate me a little cash to do some CO_2 measurements here in the UK. Looking promising. So the last thing I need is news articles calling into question again observed temperature increases. I thought we had moved the database beyond this, but it seems like the skeptics are real diehards, unquote.

From Keith Briffa, quote, I tried hard to balance the needs of the science and the IPCC, which are not always the same. I worried that you might think I give the impression of not supporting you well enough while trying to report on the issues and uncertainties, unquote.

From Phil Jones, quote, I am getting hassled by a couple people to release the CRU station temperature data. Don't any of you three tell anybody that the UK has a Freedom of Information Act, unquote.

From Michael Mann, quote, this was the danger of always criticizing the skeptics for not publishing in the peer-review literature. Obviously, they found a solution to that. Take over a journal. So what do we do about this? I think we have to stop considering Climate Research as a legitimate peer-reviewed journal. Perhaps we should encourage our colleagues in the climate research community to no longer submit to or cite papers in this journal. We also need to consider what we tell or request of our more reasonable colleagues who currently sit on the editorial board, unquote.

From Phil Jones, quote, if anything, I would like to see climate change happen so the science could be proved right regardless of the consequences. This isn't being political; it is being selfish, unquote.

Now, these e-mails show a pattern of suppression, manipulation, and secrecy that was inspired by ideology, condescension, and profit. They read more like scientific fascism than scientific process. They betray economic and ideological agendas that are death to disconforming evidence.

Hopefully, this scandal is the end of declarations that the science is settled, and the beginning of a transparent scientific debate. The seriousness of this issue justifies additional consideration.

The majority did not permit us to invite a witness to this morning's hearing, and therefore, I am requesting a minority day of hearings and am filing with the Chairman a letter signed by all six of the Republican members of this Select Committee, pursuant to rule 11 J 1 of the House of Representatives to have a minority day of hearings.

And I yield back the balance of my time.

The CHAIRMAN. I thank the gentleman very much.

The hearing today is for the purpose of hearing from administration witnesses. In my 34 years here, whether it be a Democrat or Republican administration, I had no memory of another witness sitting with administration officials at the time of their testimony.

Mr. SENSENBRENNER. Would the gentleman yield?

The CHAIRMAN. I will be glad to yield.

Mr. SENSENBRENNER. When I was Chairman of Judiciary Committee I did not allow anybody to sit with Cabinet-level or Cabinet-rank level witnesses, but there were other people who sat with administration witnesses and, in many cases, contradicted them, including witnesses that were proffered by the Democratic majority on the Judiciary Committee.

The CHAIRMAN. Well, in the 15 years that I have chaired a committee here in the House, I have always offered as a courtesy to the Reagan administration, to the first Bush administration, and to the second Bush administration the courtesy of having their ad-

ministration officials sit and make their presentation. And that is how I have conducted myself since 1981, chairing committees. And I extended that courtesy through three Republican administrations. So that is my own personal history.

And I did not think it was appropriate to have another witness sitting with these representatives of President Obama, since I did not allow that to happen with President Reagan or the two Bush presidencies.

But I will be more than willing to discuss future hearings with the gentleman and the minority if they would like.

Let me now turn and recognize the gentlelady from South Dakota.

Ms. HERSETH SANDLIN. Thank you, Mr. Chairman. I don't have an opening statement. I will reserve for questions.

The CHAIRMAN. Thank you. Then let me recognize the gentleman from Colorado.

Mr. SALAZAR. Well thank you, Mr. Chairman.

Good morning. I am looking forward to hearing the testimony today. We have a complex problem before us today. And I am interested to hear where we are in the science. I also want to know what we can do better to adapt our communities and practices to prepare for the anticipated climate changes.

The information found in the recently released report entitled, "Global Climate Change Impacts in the United States," is quite comprehensive. However, I am glad to see that both of you in your testimony say that we need more regional-specific information to help decision makers plan in the future.

Colorado and the Third Congressional District has rich agricultural resources and millions of acres of forest. We also depend in large part on a limited amount of water for our survival. I am concerned about how we can effectively prepare for the changes you predict. As I mentioned, water is one of the natural resources my district heavily depends on. While we have a lot of snow in the mountains, the valleys see very little water.

I am very proud of the $5 million appropriation for the Arkansas Valley conduit that was approved this year. That is the first round of conduit funding, which will be used for the environment analysis and planning and design. The Arkansas Valley conduit is designed to provide clean drinking water to approximately 40 cities, towns, and water providers in the low Arkansas Valley. These communities are in dire need of a source of water that will help them comply with the Clean Drinking Water Act in a manner that they can afford. Every community that will receive water from the conduit is currently rated below the 85 percent level of average household income.

The roots of the Arkansas Valley conduit stretch back to 1962, when the conduit was authorized by Congress as part of the Fryingpan-Arkansas project. And the reason that I bring this up is it took over 45 years, close to 47 years, to get the funding for this critical project. And if it takes that long for something this critical, we need to better prioritize the needs and support for our communities.

I am a farmer. Agriculture is the cornerstone of my life and also the district that I represent. In my district, we produce wheat, po-

tatoes, barley, beef, and many other crops. Agriculture is one of the top three economies in the district. The demand to produce more food will only increase as the population increases. And according to the report I mentioned before, climate change has the potential to negatively affect growth and yield of many crops, as well as increase the populations and vigor of a variety of weeds and insect species. If this is true, how soon do we anticipate these changes and how do we accommodate them?

We have already seen the effects of warmer weather and drought in our forests. Over 2 million acres of forest in Colorado are dead because of the mountain pine beetle. This epidemic will change the landscape of Colorado for decades. We need to manage our forests for resiliency in the future so that they can withstand the changes in weather.

So I do look forward to your testimony today, and I want to thank you for being with us. I yield back.

[The prepared statement of Mr. Salazar follows:]

Opening Statement
Congressman John T. Salazar
Select Committee on Energy Independence and Global Warming
'The Administration's View on the State of Climate Science'

Tuesday December 2, 2009, 10:00 a.m.,

Thank you Mr. Chairman.

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The demand to produce more food will only increase as the population increases.

According to the report I mentioned before climate change has the potential to negatively affect growth and yield of many crops, as well as increase the populations and vigor of a variety of weed and insect species.

Is this true? How soon do we anticipate these changes? How do we accommodate?

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Over 2 million acres of forests in Colorado are dead because of mountain pine beetle.

This epidemic will change the landscape of Colorado for decades.

We need to manage our forests for resiliency in the future so they can withstand the changes in weather.

I look forward to hearing your ideas on how we should move forward and where to put our limited financial resources.

Thank you for your testimony and time today.

I yield back.

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The CHAIRMAN. Thank you. The gentleman's time has expired.

The Chair recognizes the gentleman from Arizona, Mr. Shadegg.

Mr. SHADEGG. Thank you, Mr. Chairman. And I apologize. I have another hearing, so I will have to leave for a portion of my time here. But I want to begin by noting something that I think everyone in the room knows, but nobody wants to acknowledge. It is that there is an elephant, a large elephant sitting in the middle of this room. You can ignore if you like. Members of the minority can ignore it if they like. Members of the majority can ignore it if they like. Members of the staff or the press or the audience can ignore it if they like. But that elephant is the credibility of the entire scientific community, which has told us that the science behind manmade global warming is resolved, make no mistake about it.

When you read in the e-mails, which have been made public recently, that that science was politicized, that its proponents were unwilling to release their data, that they were unwilling to have their theories tested, that they were threatened by anyone and everyone who dared to challenge them, when you realize they were that insecure, then you have to understand that their credibility, the entire credibility of the theory is placed on the line.

Now, that does not mean it cannot be rehabilitated. But it is interesting to me, those who have not simply accepted the claim of manmade global warming, man-caused global warming have been called deniers. I would suggest that when the White House reads of these e-mails and the Press Secretary for the White House steps forward and says they mean nothing, the science is already resolved, maybe the term deniers best applies to those in that position.

Public policy is a difficult business. It is hard for those of us who sit on this side of the dais to make decisions and to make those decisions in the best interests of the Nation. At times we are asked to call upon our citizens to sacrifice, to pay more in taxes, to lose jobs, to give up lifestyles, to pay more for energy. We simply cannot do that when the evidence we are supposed to be basing our decisions upon has been clearly politicized, when there is a grave question about its credibility.

Until we address the evidence—I am sorry, until we address the elephant in the center of this room and resolve the questions raised by the appalling e-mails which have been made public, it is impossible for this Congress to set public policy in this area and to make the people of America accept and give of the sacrifices they will have to give to make the changes called for by the legislation that is before this Congress.

Anyone who thinks that those e-mails are insignificant, that they don't damage the credibility of the entire movement, is naive. We cannot expect people in a free society to make sacrifices on anything other than hard evidence. Here that hard evidence has to be hard evidence that in fact global warming is caused by man and that the sacrifices called for in the legislation are necessary. These e-mails repeatedly have shown that the scientists involved and who authored them, the scientists who are behind global warming or the argument that global warming is caused by manmade factors, the e-mails demonstrate that they are afraid to reveal the facts, that they have been unwilling to have their theories tested, that

they have been unwilling to provide their data, and they are unwilling to have their theories openly challenged.

Now because their own defenses and justifications for hiding these facts and their data has changed so many times, we now learn that maybe the data does not even exist. It is critical for this Congress to find out and to get to the bottom of the question of what the elephant in the room is and what the real science is and whether money and politics has eroded the credibility of that science.

Thank you, Mr. Chairman. I yield back.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes the gentleman from Oklahoma, Mr. Sullivan.

Excuse me. I did not see the gentlelady from Michigan.

The Chair recognizes the gentlelady from Michigan, Mrs. Miller.

Mrs. MILLER. Thank you, Mr. Chairman.

I appreciate you having this hearing. I think it is an interesting title of the hearing. The state of the climate science I think is particularly interesting in light of what is happening. And I would like to associate myself with the remarks made by the ranking member and the others on the minority side here of the panel.

I come from the State of Michigan. We have the highest unemployment in the Nation. Everybody is well aware of that. As well, we derive about two-thirds of our electricity from coal. And for these reasons and others, I really looked very closely at the cap-and-trade legislation and finally decided that it would just be so devastating for Michigan's economy and our Nation that I could not support it.

But you know, we had been told that we had to pass this legislation because the debate was over; the science was absolute; the science is incontrovertible about climate change, and regardless of what it means economically to us, we need to do this to protect our environment and our very way of life. And you know, particularly hard hit with the cap-and-trade would be States like Michigan.

In fact, the Detroit News editorialized that the cap-and-trade legislation, as they said, would be a dagger through the heart of Michigan's economy. So when I saw this notice, this committee hearing notice, I was very enthusiastic because I thought we were going to be able to talk this morning about what many people are calling Climategate, which I think is an appropriate analogy, because it is totally a coverup, what is happening.

And the ranking member, I won't go through you any of the e-mails, I have a list of them here as well, but he certainly has articulated many of them already. But I thought we were going to have a hearing about that. And if we are not, I would mention that I had also respectfully sent a letter earlier this week to the chairman and the ranking member to ask this committee to have a hearing. I think it is important that the committee investigate these e-mails and what has happened in Climategate.

I think transparency is the most appropriate thing. And I think it is very important that we have transparency and that we look at these things, because certainly the central argument about manmade—manmade—climate change is certainly in question. I think the science is not settled, and the debate is raging around the

United States and around the globe right now, particularly on the eve of Copenhagen.

And I would simply just mention one other thing, if I could, Mr. Chairman. We did have a hearing just a couple months ago about a dozen fraudulent letters that were sent during the cap-and-trade legislation. And I thought that was an appropriate thing. But certainly if we could have a hearing about a dozen fraudulent letters, we could have a hearing in this committee about Climategate.

And thank you, and I yield back.

The CHAIRMAN. Thank you. The gentlelady's time has expired.

The Chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you.

I understand that those people who have been refusing to accept science for years are enjoying their moment talking about language from some e-mails that were taken out of context. I understand their enjoyment to continue to deny obvious facts.

And if you could take those e-mails and chop them up and put them in a C–130 and sprinkle them over the Arctic and stop the Arctic from melting, that would be a good thing, but that won't happen. If you could take those e-mails and chop them up into fairy dust and sprinkle them over the Greenland ice cap and stop the accelerated melting going on there, that would be a good thing, but that won't happen. And if you could take those e-mails and chop them up and sprinkle them over the oceans and stop the incredible ocean acidification that is so damaging, that would be a wonderful thing, but that won't happen.

The fact of the matter is plain and clear for anyone who is willing to dispassionately look at the evidence. And I would encourage, for those who want to look at the most recent evidence on this, to take a look at a group called the Copenhagen Diagnosis. They are found at www.Copenhagendiagnosis.com. It is an update of the IPCC information. And the update is, since 2007, the sequela of both ocean acidification and global climate change have been either accelerating or at least worse than was predicted in the IPCC report.

The global deniers are right; the 2007 IPCC report was not entirely accurate. It was not entirely accurate because this problem is worse than the last IPCC report indicated. Surging greenhouse gases are worse than predicted. Recent global temperatures demonstrate human-based warming. The acceleration of melting ice caps in the Arctic is worse than expected. The rate of decline in glaciers is worse than expected. The disappearance of the Arctic summer ice is worse than expected. The current sea level rise estimates are worse than expected in the IPCC 2007 report. So the point of the current science is that what we had in 2007 is indeed out of date; this problem is worse than expected.

And I will just comment on one thing that I learned. Sometimes you can learn things from silence as well as people talking. I was at my old school at the University of Washington last week, and we were talking about this issue. And this young man stood up, and he was a global climate change denier. And he was having a field day with some e-mail language that he thought showed some

massive conspiracy by the Trilateral Commission or something to take over the earth.

And I just said, look, if you are right and if there is no global warming, if you are so right, what are you going to do about ocean acidification? What do you say about that? And he was silent. And that silence speaks volumes. If people over here want to deny clear science about global warming, they cannot deny the fact that the oceans are becoming acidified, that no reputable science anywhere in the world recognizes it is happening caused by CO_2 going into the atmosphere and going into solution and acidifying our oceans, so I would just say the science is clear. I wish it was otherwise. Life would be easier. But this is the challenge of the ages. Thank you.

The CHAIRMAN. The gentleman's time has expired.

The gentleman from Oklahoma, Mr. Sullivan, is recognized.

Mr. SULLIVAN. Thank you, Mr. Chairman.

I appreciate you holding this hearing today, but unfortunately, we were not allowed a minority witness.

Yesterday I was pleased to sign onto a letter by Ranking Member Sensenbrenner and my Republican colleagues on this committee requesting a day of hearings to consider the scientific evidence for climate change; the observed and anticipated impacts of climate change; and the key areas of further research. I hope you will honor this request, as we are on the eve of the Copenhagen climate conference.

In light of the recent disclosure of e-mails between several prominent climatologists revealing possible deceitful manipulation of important climate data uncovered at the world's leading climate change unit at the University of East Anglia in England, I think it is imperative that we launch an investigation into this issue and reexamine all the scientific evidence surrounding climate change.

With the United Nations Climate Change Conference in Copenhagen set to begin in less than a week, we need to have all the facts before us as we consider whether this is in the United States' best interests to agree to a binding international climate treaty.

For the record, I am opposed to any climate treaty that does not recognize the right of every country to protect its own national energy interests and would place the United States at a competitive economic disadvantage worldwide.

I am interested in learning from our panel today whether or not they would support an independent investigation into the climate change unit e-mails and whether or not these e-mails raise concerns about the integrity of the scientific process.

I yield back my time.

The CHAIRMAN. Great. The gentleman's time has expired.

All time for opening statements from the members has been completed.

[The prepared statement of Mr. Blumenauer follows:]

Statement for the Record
Rep. Earl Blumenauer

December 2, 2009

Mr. Chairman, thank you for holding this very important hearing. I look forward to learning from our distinguished witnesses this morning about the most updated scientific evidence for climate change. As Congress considers legislation to reduce greenhouse gas emissions, it's important for us to hear from our leading scientists on the issue.

I believe the last administration witness who testified about climate change in our Committee was EPA Administrator Stephen Johnson. I am struck by the difference between that hearing and this one. In March of 2008, Mr. Johnson testified that the EPA was struggling to deal with the Massachusetts vs. EPA Supreme Court decision and the complexity of the Clean Air Act. While he called climate change a "serious issue," his testimony did not discuss the scientific case for it, and in response to questioning from the Chairman, he refused to acknowledge that greenhouse gas emissions were a danger to public health. Despite overwhelming scientific evidence, from the National Academy of Sciences to the Intergovernmental Panel on Climate Change, Administrator Johnson and his colleagues in the Bush administration refused to recognize reality.

Today, we hear from this administration's top two scientists, Dr. Jane Lubchenco of NOAA and Dr. John Holdren of the Office of Science and Technology (OST). Their written testimony makes clear that this administration takes the issue of climate change seriously and that its actions will be informed by science. I was pleased to see Dr. Holdren's write in his testimony, "We know the primary cause of these changes beyond a reasonable doubt."

The Obama administration has put important resources into climate change science not only through NOAA and the OST, but other agencies throughout the federal government. As Dr. Lubchenco recognizes in her testimony, "...meeting the challenge of preparing for and responding to climate change will require an unprecedented level of coordination among federal agencies...We need to utilize our collective expertise to provide high-quality climate information and services that are user-friendly, responsive to management, and relevant to desired social, economic, and environmental outcomes." While they aren't here to testify today, numerous other agencies have been deeply engaged in determining the causes and consequences of global warming.

For example, the Department of Interior is on the front lines of protecting our nation's water, land, marine, fish, wildlife, tribal, and cultural resources from the effects of a changing climate. The realities of climate change are already requiring land managers within the Department to change how they manage the resources they oversee and to think about how to adapt to these changes. To ensure that adaptation strategies are

grounded in the best science, Department of Interior Secretary Ken Salazar has created a new climate change strategy for the Department through Secretarial Order #3289, entitled "Addressing the Impacts of Climate Change on America's Water, Land and other Natural and Cultural Resources. This Order establishes a new Department-wide strategy to address climate change, with an emphasis on science, adaptation and mitigation.

The Department of Interior is also making an effort to integrate their dual science and land management roles to address climate change. For example, scientists at the USGS, Fish and Wildlife Service, Bureau of Reclamation, Bureau of Land Management, and the National Park Service are working hard with land, wildlife and water managers who are responsible for more than 500 million acres of public lands and water that the Department oversees.

I am pleased that we've invited Dr. Lubchenco and Dr. Holdren here to testify today and I hope that we can continue this conversation with the administration as we move to address climate change.

The CHAIRMAN. We will now turn to our very distinguished witnesses.

STATEMENTS OF THE HONORABLE JOHN HOLDREN, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT; AND THE HONORABLE JANE LUBCHENCO, UNDER SECRETARY FOR OCEANS AND ATMOSPHERE, ADMINISTRATOR OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

The CHAIRMAN. Our first witness is Dr. John Holdren. He serves as assistant to President Obama for science and technology. He is the director of the White House Office of Science and Technology Policy, and cochair of the President's Council of Advisers on Science and Technology. He was a professor at Harvard. He was the director of the independent nonprofit Woods Hole Research Center. He is a member of the National Academy of Sciences. He has received the MacArthur Foundation prize, the Genius Award.

We welcome you, sir, before our committee.

Whenever you are ready, please begin.

Mr. SENSENBRENNER. Mr. Chairman, I would request that the witnesses be sworn before they testify today.

The CHAIRMAN. The committee will stand in brief recess.

[Recess.]

The CHAIRMAN. The ranking member of the committee has made a request to have the witnesses sworn in.

The Chair has a right to, at his discretion, to make that determination. And I do not think it is necessary. I think that the administration is going to testify truthfully before our committee today. And we will operate under that premise.

And we will begin the hearing with the testimony of Dr. Holdren, the President's science adviser.

STATEMENT OF THE HONORABLE JOHN HOLDREN

Mr. HOLDREN. Thank you, Chairman Markey, Ranking Member Sensenbrenner, members of the committee.

I do thank you for inviting me to testify on this timely and important topic today. I had planned to summarize in my brief oral statement the written statement that I provided to the committee addressing current and projected impacts of climate change, and also climate science research activities, needs, and products, as the letter of invitation requested.

But given the emphasis in some of the opening comments on the e-mails, I am going to divert from that program and say a few words about the e-mails, and then finish with the concluding part of my original oral statement.

The e-mails are mainly about a controversy over a particular data set and the ways a particular small group of scientists have interpreted and displayed that data set. It is important to understand that these kinds of controversies and even accusations of bias and improper manipulation are not all that uncommon in science, in all branches of science. The strength of science is that these kinds of controversies get sorted out over time as to who is wrong, who is right, and how much it matters by the process of peer re-

view and continued critical scrutiny by the knowledgeable community of scientists.

Of course, openness in sharing of data and methods is very important to this process. And as I think you all know, this administration is a strong proponent of openness in science and in government. And Administrator Lubchenco will have some things to say about public access to the climate data maintained by her agency and maintained by other agencies in the United States.

In this particular case, the data set in question and the way it was interpreted and presented by these particular scientists constitute a very small part of the immense body of data and analysis on which our understanding of the issue of climate change rests.

The question being addressed by these data was, have there been natural periods of warming in the past, in the last 1,000 or 2,000 years in particular, that have been stronger than the episode now being experienced? That is an interesting question. And because of the controversy around it at the time most of these e-mails were written, that is in the early 2000s, the National Academy of Sciences undertook a thorough review of all of the relevant data sets and all of the methods of analysis, not just the data set used by these particular authors or the methods used by these particular authors.

The National Academy's report on this matter was published in 2006, and it concluded that the preponderance of available evidence points to the conclusion that the last 50 years have been the warmest half century in at least the last 1,000 years and probably much longer.

There is and there will remain after the dust settles in this current controversy a very strong scientific consensus on the key characteristics of the problem. Global climate is changing in highly unusual ways compared to long experienced and expected natural variations. The unusual changes match what theory and models tell us would be expected to result from the very changes in the atmosphere that we know have been caused by human activities, above all burning fossil fuels and tropical deforestation.

Significant impacts on human well-being from these changes in climate are already being experienced. And continuing with business as usual in the fossil fuel burning and tropical deforestation activities that are the largest contributors to these changes in the atmosphere is highly likely to lead to growth of the impacts to substantially unmanageable levels. The details in support of those propositions are in my written testimony.

Let me turn to the closing part of my remarks. I have tried to indicate in the written testimony, and here, that we in fact know a great deal about global climate change, what its causes are, how it works, what its impacts are and are likely to become. But of course, there is more to learn. And the Federal Government is doing a lot in support of the research needed to learn more and its translation of that research into products our society can use to better cope with climate change. But there again, we need to do more.

With that said, I emphasize again that, in my judgment and that of the great majority of other scientists who have seriously studied this matter, the current state of knowledge about it, even though

incomplete, as science always is, and even though controversial in some details, as science almost always is, is sufficient to make clear that failure to act promptly to reduce global emissions to the atmosphere of carbon dioxide and other heat-trapping substances is overwhelmingly likely to lead to changes in climate too extreme and too damaging to be adequately addressed by any adaptation measures that can be foreseen.

The United States, as the largest contributor to the cumulative additions of anthropogenic, that is human-caused, greenhouse gases to the atmosphere since the beginning of the Industrial Revolution, and still today the second largest emitter after China, and as the world's largest economy and preeminent source of scientific and technological innovation, we have the obligation and the opportunity to lead the world in demonstrating that the needed emissions reductions can be achieved in ways that are affordable and consistent with continued economic growth; that create new jobs; and that bring further co-benefits in the form of reduced oil import dependence and improved air quality.

President Obama is going to Copenhagen to underline that his administration is fully committed to assuming this leadership role. The administration obviously will need the support of the Congress in delivering on this promise.

And I would like to thank you, Chairman Markey, and this committee for your own leadership in this critically important domain.

I thank you as well for your attention.

[The statement of Mr. Holdren follows:]

Testimony of
John P. Holdren
Assistant to the President for Science and Technology and
Director of the Office of Science and Technology Policy,
Executive Office of the President of the United States,
before
The Select Committee on Energy Independence and Global Warming
U.S. House of Representatives
on
The Administration's View of the State of the Climate
December 2, 2009

Chairman Markey, Ranking Member Sensenbrenner, Members of the Committee: I thank you for inviting me to testify today at this important and timely hearing. In what follows I will address all four of the questions posed in the Chairman's letter of invitation, although for convenience of exposition I will combine current and projected impacts of climate change (questions 1 and 2) into one section and research activities and products (questions 3 and 4) into another. Additional information on all four questions will be provided in the testimony that follows by my distinguished colleague, Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator Dr. Jane Lubchenco.

Current & Projected Climate Change Impacts in the United States and the World (questions 1 & 2)[1]

It is well established that climate is changing in the United States and 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 losing mass, and sea level is rising. We know the primary cause of these changes beyond any reasonable doubt. It is the emission of carbon dioxide (CO_2) and other heat-trapping pollutants from our factories, our buildings, our vehicles, and our power plants; from farming, cement manufacture, and waste disposal; and from deforestation and other forms of land-use change that move carbon out of soils and vegetation and into the atmosphere.

Impacts resulting from these changes are being felt today in this country and around the world. Over the past 50 years, the year-round, national average air temperature in the United

[1] The best compendium of observed and projected indicators of climate change and its impacts in the United States is the report on "Global Climate Change Impacts in the United States" released earlier this year by the U.S. Global Change Research Program (Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds. Cambridge University Press, 2009). The most authoritative global assessment, albeit limited to scientific findings through the end of calendar 2005, is the Fourth Assessment Report of the Intergovernmental Panel on Climate change, from which see especially "Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds., Cambridge University Press, 2007). An excellent update of scientific findings since 2005 about climate change and its global impacts was recently released by the UN Environment Program: "Climate Change Science Compendium", C.P. McMullen and J. Jabbour, eds., UNEP, 2009. Impacts on developing countries are especially well documented in the 2009 report, "The Anatomy of a Silent Crisis" by the Geneva-based Global Humanitarian Forum and in the 2010 World Development Report of the World Bank, "Development and Climate Change", issued last month.

States has risen by more than 2°F (1.1°C), and this increase has been accompanied by a 5% rise in average rainfall with an increasing fraction of the total occurring in heavy downpours. This means more of the precipitation is lost to storm runoff. In addition, the average interval between rainfall episodes is increasing in some regions, which leads to increases in the frequency and severity of droughts as well as floods.

The United States has, in fact, been experiencing an increase in the severity of floods, droughts, and heat waves, with consequences for human life and health, property, and agriculture. Wildfires in the Western United States have increased over sixfold in average annual area burned over the past 30 years, and vast areas of pines and spruce in the western United States have been decimated by pest outbreaks associated with longer breeding seasons for the pests and trees weakened by drought and heat stress. The strongest hurricanes appear to be increasing in number and power in a pattern correlated with rising sea-surface temperatures in the regions that spawn these storms. And global-average sea level has risen about 8 inches over the last century (experienced as more in some places and less in others because of sinking or uplifting of the land, as well as other factors); the consequence for the heavily populated coastal zones of the United States has been increased losses to beach erosion and damage from winter storms as well as hurricanes.

The global effects documented by the Intergovernmental Panel on Climate Change (IPCC), the UN Environment Program, the Global Environment Forum, and the World Bank are similar in character, although in many respects worse in degree because of the greater vulnerability and smaller adaptive capacity of countries in the developing world. Tropical forests in regions once too consistently wet to burn now suffer periodic devastating wildfires (significantly augmenting CO_2 emissions to the atmosphere in dry years). China and India both report increasing damage to agriculture from changing monsoons (in patterns attributable to global climate change). The rapid shrinkage of mountain glaciers threatens the reliability of water supply for hundreds of millions of people, as well as puts inhabitants of mountain regions at risk from lake-outburst floods that are a further consequence of glacial melting. And the geographic range of a number of tropical diseases appears to spreading poleward.

Notwithstanding the claims of some climate-change "skeptics" that climate change came to a halt over the past decade, the reality is that both the drivers and the symptoms of climate change have been growing more rapidly since 1997 than before. CO_2 emissions from fossil fuels (including gas flaring) and cement manufacture grew at an average of 1.4% per year from 1987 to 1997 and at an average of 2.2% per year from 1997 to 2007. Growth of the CO_2 concentration in the atmosphere averaged 1.45 parts per million volume (ppmv) per year from 1987 to 1997 and 2.0 ppmv per year from 1997 to 2007. The 11 hottest years in the global instrumental record maintained by the National Oceanic and Atmospheric Administration (NOAA) all occurred from 1997 onwards. The average temperature anomaly in the 11 years from 1998 through 2008 was 0.95°F (0.53°C) above the 20th century average, compared to 0.56°F (0.31°C) above the 20th century average in the 11 years from 1987 through 1997. The rate of sea level rise in the past decade has been twice the average rate during the 20th century. All of these increases have been near or above the high end of the projections for this period made by the IPCC in the mid-1990s.

The changes and impacts described in the foregoing are not projections. They are what have been observed to date, in a world that has warmed, on the average, only about 1.5°F (0.8°C)

since 1900. If global emissions of heat-trapping gases continue to grow on what is often termed a "business as usual" trajectory, mid-range estimates indicate that the global average surface temperature increase compared to 1900 will be around 3.6°F (2°C) by 2050 and 5.4 to 7.2°F (3-4°C) by 2100. Moreover, considerably greater increases in average temperature in this century cannot be ruled out because of uncertainties about the strengths of "positive feedbacks" in the climate system (such as CO_2 releases from warming seas and soils). And whatever the global-average increases turn out to be, we know on solid scientific grounds that the increases in mid-continent will be typically 40% more, and that those at high latitudes in the Northern Hemisphere larger still.

The 2009 report of the U.S. Global Change Research Program (USGCRP) on "Global Climate Change Impacts in the United States" found that in a "business as usual" global emissions scenario (the scenario labeled A2 in the 2007 report of the IPCC, entailing about a tripling of global greenhouse-gas emissions over the 21st century), the average-annual temperature increase in the United States would reach 4-6°F (2.2-3.3°C) by 2050 and 7-11°F (3.9-6.1°C) by 2090. In a different "business as usual" scenario assuming different economic, technological, and demographic predictions which lead to significantly lower emissions (IPCC B1, in which global emissions peak around 2050 at 30% above the 2000 level and fall by 2100 to about half the 2000 level), the average-annual temperature increase in the United States is projected to be 3-5°F (1.7-2.8°C) in 2050 and 4-7°F (2.2-3.9°C) in 2100. (The lower of these trajectories is still much higher than would be associated with trying to limit the global annual-average temperature increase to 3.6°F (2°C), the goal embraced by G-20 leaders in July.)

The least that can be expected in the way of impacts along either the A2 or B1 trajectory of increasing average surface temperatures is a worsening of the kinds of effects already being experienced – that is, further increases in floods, droughts, heat waves, and wildfires; changes in the frequency and intensity of weather extremes; continuing rise in sea level, most probably at an accelerating rate; increasing stress on water supplies in many regions already short of water; new and larger pest outbreaks afflicting crops and forests; still further stresses on agriculture and forestry arising from more frequent occurrence of ever higher temperature extremes; declines in coral reefs under the combined stress of higher water temperatures and continuing acidification of the surface layer of the ocean from absorption of part of the excess atmospheric CO_2; expanded geographic range of tropical pathogens and their vectors; and further changes in the geographic distribution of many other species of plants, animals, and micro-organisms accompanied, in all likelihood, by an increase in the rate of extinctions.

For the United States, the regional impacts projected by the 2009 USGCRP report under the IPCC's A2 and B1 scenarios included declining snowpack and associated stress on water resources in the Northwest; increased drought and water-availability problems in the Southwest and Great Plains; more heat waves, air-quality problems, and floods in the Midwest; shifts in marine species affecting fisheries in Alaska and the Northeast; increased damage from hurricanes and increased heat stress impacts on health in the Southeast; and increased coastal erosion and storm damage on all of the coasts. The higher the emissions, the worse these problems are expected to be.

But these more or less steadily increasing impacts are not the only possible outcome. Climate scientists worry about "tipping points" in the climate system, including ecosystems, meaning thresholds beyond which a small additional increase in average temperature or some

associated climate variable results in major changes to the affected system. Examples of tipping points of potential concern include the complete disappearance of Arctic sea ice in summer, leading to drastic changes in ocean circulation and climate patterns across the whole Northern Hemisphere; drastic acceleration of the rate of ice loss from the Greenland and Antarctic ice sheets, driving rates of sea-level increase that could reach 6 feet per century or more; ocean acidification from CO_2 absorption reaching a level that causes massive disruption in ocean food webs; and a flood of carbon dioxide and methane from warming tundra and thawing permafrost, accelerating the onset of all of the other impacts of concern.

While our understanding of the global climate system and our ability to project its future behavior have grown enormously over the past couple of decades, we cannot yet predict with confidence exactly where on a rising temperature trajectory these or other thresholds would be crossed. It seems clear, however, that the probability of crossing one or more of them goes up sharply as the global-average surface temperature increase compared to 1900 goes above 3.6°F (2°C). That is a major reason for the growing global consensus that worldwide efforts should limit heat-trapping emissions sufficiently to hold the average temperature increase to 3.6°F (2°C) or less.

Climate-Science Research Activities, Needs, and Products (questions 3 and 4)[2]

Investments in climate science over the past several decades have contributed to an improved understanding of global climate. To continue to assist the government and society as a whole with understanding, predicting, projecting, 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 USGCRP brings the essential capacities for research and observations together into a single interagency program. A fundamental component of success in delivering the information necessary for decision-making is coordination of the programmatic and budgetary decisions of the 13 agencies that make up the USGCRP.

The USGCRP was mandated by Congress in the Global Change Research Act of 1990 (P.L. 101-606) to improve understanding of uncertainties in climate science, expand global observing systems, develop science-based resources to support policymaking and resource management, and communicate findings broadly among scientific and stakeholder communities. Thirteen departments and agencies participate in the USGCRP. The Office of Science and Technology Policy (OSTP) and the Office of Management and Budget (OMB) work closely with

[2] This section of my testimony draws heavily from my previous testimony before the Committee on Commerce, Science, and Transportation on the topic of "Climate Services: Solutions from Commerce to Communities", July 30, 2009. Primary references on the structure and research priorities for the US Global Change Research Program are "Restructuring Federal Climate Research to Meet the Challenges of Climate Change," National Research Council, 2009; and "Informing Decisions in Changing Climate," National Research Council, 2009. Further elaboration of the science elements of the USGCRP can be found in the recent publication "Our Changing Planet: The U.S. Global Change Research Program for Fiscal Year 2010," a supplement to the President's Budget for FY 2010. The National Research Council report, "Satellite Observations to Benefit Science and Society: Recommended Missions for the Next Decade," 2008, is germane to my treatment of Earth observations and is mentioned there.

the USGCRP to establish research priorities and funding plans to ensure the program is aligned with the administration's priorities and reflects agency planning.

The 2010 Budget provides $2.0 billion for the USGCRP Climate Change Science Program (CCSP), an increase of $46 million or 2.3 percent over the 2009 level (excluding Recovery Act funds). USGCRP programs also received over $461 million in Recovery Act funding based on preliminary agency allocations, including $237 million for NASA climate activities. In addition to these sums, the Recovery Act included $170 million for two NOAA climate supercomputers. 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; an improved understanding of the non-CO_2 climate impacts of aviation; assessment of abrupt change in a warming climate; development and use of climate models on regional and decadal scales; 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 USGCRP Climate Change Technology Program (CCTP) is the technology counterpart to CCSP. 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 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 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 Department of Energy (DOE) science programs. Other agencies also received Recovery Act funding for CCTP-related technology development and deployment, including the Department of Defense (DoD, $139M), the Department of Transportation (DOT, $100M), the National Aeronautics and Space Administration (NASA, $31M), and the National Science Foundation (NSF, $2M).

Although the USGCRP supports a wide variety of research activities to gain more detailed predictive understanding of a changing climate, 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, the recent National Research Council (NRC) reports referenced at the beginning of this section of my testimony recommend change to the research activities and structure of the USGCRP that would, in large part, support the policy needs of the

approaching societal problems from climate change. They recommend "research on 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." 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 the capacity to observe changes in climate, climate variability and impacts of climate change; producing the sorts of integrated assessment of the pace, patterns, and regional impacts of climate change that will be needed by decision-makers 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. Besides enhancing research and modeling of the physical climate system, four areas of particular need for more comprehensive and coordinated treatment from USGCRP are Earth observations, adaptation research, integrated assessment, and climate services. I take up each briefly in turn.

Earth observations

Observations are taken from space, 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 into applications such as Earth System models. 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, 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 being 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), whose Sixth Plenary Session was hosted by the United States here in Washington on November 17-18. 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. With Recovery Act support in 2009, the National Science Foundation launched a new *in situ* observing system focused on ocean acidification and the role of the ocean in climate change and coastal ecosystem health.

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 NRC's Decadal Survey Report. Continuity of the weather observing 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 is playing 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. Improving the management of NPOESS in order to ensure continuity of weather and climate data is a high priority for the Administration's leadership team. A task force within the Executive Office of the President (including representatives from OMB as well as the National Security Council) has been meeting regularly with representatives from NOAA, NASA, and DoD, the three agencies partnering on the program, to identify the best way forward, and I will soon be making a recommendation based on the task force's findings.

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 eight years, 50% 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 of parameters and in places not achievable from space. They also serve as necessary benchmarks to validate the remote measurements made by satellites. In general, 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 multi-decade 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. Indeed, NOAA, NASA, and NIST are currently discussing approaches to better ensure the accuracy of satellite-based climate measurements with a scope from satellite instrument design to on-orbit calibration and performance evaluation. In addition, the NASA Earth Observing System (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. Owing to these challenges, the distinction between "research" and "operational" capabilities and assets must be considered in order to successfully deliver sustained climate-related measurements. Accordingly, we should work to overcome the limitations of the current "research to operations" construct with respect to climate observations, and instead recognize that climate observations require a sustained integrated "research **and** operations" approach. The institutional structures and capacity, and specific agency roles and responsibilities must be developed to deliver an integrated climate observing system.

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 variability and 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 will be central to this effort. Given the relationships between climate variability and change and extreme events, the community of researchers, engineers and other experts who work on reducing risks from natural and 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.

Recently President Obama issued an Executive Order on Federal Leadership in Environmental, Energy, and Economic Performance that calls for an integrated strategy towards sustainability and enhanced engagement in adaptation. As part of this effort, an adaptation science workgroup is currently developing a government approach for linking adaptation planning with the science and technology needed by decision-makers. The emergence of adaptation planning driven by public awareness and policy processes has created a demand for adaptation research – including the organization, transfer, and communication of information – within decision settings. Adaptation plans have been inspiring science to be more directly relevant to social and policy outcomes. There is an emerging paradigm shift from a view that decision support is contingent only upon highly accurate predictions, to a risk management approach where uncertainty is always a factor, and planning moves ahead through identification of vulnerabilities and policy trade-offs across a set of possible future conditions. Science focused on questions about adaptation will improve local and regional predictions, informing decision-making and integrating knowledge from social, ecological and physical research that can help to identify thresholds and tipping points.

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 different impacts are experienced in different ways in different places and for different sectors of the economy. Assessments serve a very important function in providing the scientific underpinnings of informed policy. They also serve as progress reports by identifying advances in the underlying science, providing critical analyses of issues, and highlighting key findings and key unknowns that can improve policy choices and guide decision-making related to climate change. Comprehensive assessments provide an opportunity to evaluate the social implications of climate change within the context of larger questions of how communities and the nation as a whole create sustainable and environmentally sound development paths.

Over the past decade, U.S. federal agencies, through the USGCRP, have undertaken two coordinated, national-scale assessment efforts to evaluate the impacts of global climate change on this country. Each effort produced a report to the nation: Climate Change Impacts on the United States, published in 2000; and Global Climate Change Impacts in the United States, published in 2009. A unique feature of the first report was that, in addition to reporting the current state of the science, it created a national discourse on climate change that involved hundreds of scientists and thousands of stakeholders to help the scientific community develop a problem-solving framework that integrates the information society wants and needs. A notable feature of the second report was the incorporation of information from the USGCRP's 21 topic-specific Synthesis and Assessment Products, many motivated by stakeholder interactions.

The next national assessment mandated by Section 106 of the 1990 Global Change Research Act is due in 2013. The vision for this climate change assessment is in a formative stage, but will include sustained, extensive stakeholder involvement to ensure full regional and sectoral coverage. It may also include targeted, scientifically rigorous reports that assess mitigation and adaptation strategies and their interactions. The best decisions about these strategies will emerge when there is widespread understanding of the complex issue of climate change—especially the science and its many implications for our nation.

The lessons learned from the previous assessment activities provide the main ingredients and structure for this next assessment. Understanding climate change impacts and adaptation requires a bottom-up approach—identifying impacts in a specific place or within an economic or industrial sector and aggregating information to larger scales. Therefore, the assessment, implemented through interagency efforts, will include workshops and studies that focus on regions and sectors, as well as a national synthesis component. OSTP is working with agencies and the USGCRP team to develop the scope and plan for the assessment due in early January.

In addition to the national assessment effort, individual agency programs further the development of assessment tools and models that help advance decision-making in particular sectors, as well as contribute to the national process. For example, DOE's Integrated Assessment Research Program is designed to evaluate the complex interactions of human and natural systems and to develop the integrated models and tools that will underpin future national and regional decision-making on options for mitigation and adaptation.

Climate services

Coordinated, timely and authoritative climate information and services are needed to assist decision-making across public and private sectors. Local planners may need information on likely changes in extreme events, such as floods and droughts, heat waves and freezes; farmers and farm cooperatives may need 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 may need information on likely changes in sea level, storminess, and estuarine temperatures; water resource managers may need information on likely changes in snowpack and runoff, and changes in the frequency and intensity of floods and droughts; community health planners may need information on changes in locations of heat and cold waves and heavy precipitation events tied to disease outbreaks; industry may need information on changes in extremes that might affect their businesses and shipping; those preparing environmental impact statements may need information on how changes in a given location affect environmental outcomes; those doing economic analyses may need 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. To be successful, the delivery of climate services will require sustained federal agency partnerships, comprehensive *in situ* and space-based observing assets, data handling and information generation capabilities, and effective means of delivering relevant information to end-users. No single agency has the ability to deliver full end-to-end climate services, but, with strategic investments, the federal agencies will collectively be able to do so.

Through the USGCRP, the Nation's science agencies have made significant investments in climate-related observations, research, modeling, and assessment programs that provide a strong foundation for a move toward effective services. For example, NOAA, NASA, NSF, and DOE currently have substantial, but incomplete, observing and data handling capabilities; these agencies currently take advantage of DOE's leadership class computing to improve climate models at global and regional scales; and agencies such as the Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA) have useful well-targeted information development and delivery capabilities. OSTP is developing an interagency process to assess our national capabilities for delivering climate services.

Concluding Remarks

As I have tried to indicated in this testimony, we know a great deal about global climate change – what its causes are, how it works, what its impacts are and are likely to become – but there is more to learn; and the Federal government is doing a lot in support of the research needed to learn more, and its translation into products our society can use to better cope with climate change, but we need to do more.

That said, I want to emphasize that in my judgment and that of the vast majority of other scientists who have seriously studied this matter, the current state of knowledge about it (even though incomplete, as science always is) is sufficient to make clear that failure to act promptly to reduce global emissions to the atmosphere of carbon dioxide and other heat-trapping substances

is overwhelmingly likely to lead to changes in climate too extreme and too damaging to be adequately addressed by any adaptation measures that can be foreseen.

It goes almost without saying that the United States, as the largest contributor to the cumulative additions of anthropogenic greenhouse gases to the atmosphere since the beginning of the Industrial Revolution and still today the second-largest emitter after China, and as the world's largest economy and pre-eminent source of scientific and technological innovation, has both the obligation and the opportunity to lead the world in demonstrating that the needed emissions reductions can be achieved in ways that are affordable and consistent with continued economic growth, that create new jobs, and that bring further co-benefits in the form of reduced oil-import dependence and improved air quality.

President Obama is going to Copenhagen to underline that the United States is fully committed to assuming this leadership role. The Administration obviously will need the support of the Congress in delivering on this promise, and I'd like to thank you, Chairman Markey, and this Committee for your own leadership in this critically important matter. I thank you as well for your attention to this testimony.

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

Our second witness is Dr. Jane Lubchenco. Dr. Lubchenco is the Under Secretary of Commerce for Oceans and Atmosphere, and the administrator of the National Oceanic and Atmospheric Administration. She has been a distinguished scholar on these issues. She is one of the most highly cited ecologists in the world, a member of the National Academy of Sciences, and similarly a recipient of the MacArthur Fellowship, as was Dr. Holdren.

We welcome you, Dr. Lubchenco. And whenever you are ready, please begin.

STATEMENT OF THE HONORABLE JANE LUBCHENCO

Ms. LUBCHENCO. Thank you, Chairman Markey, Ranking Member Sensenbrenner, members of the committee.

I greatly appreciate the opportunity to testify today. I appreciate your interest in the science of climate change and the spectrum of climate sciences and services needed in this country and abroad to make critical decisions for now and for the future.

As President Obama said to the National Academy of Sciences, science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before.

As head of NOAA, one of the Nation's premiere science service and stewardship agencies, with responsibilities for both oceans and atmosphere, I strongly support a focus on science-based decision-making. Science can help inform the understanding of opportunities and challenges presented by climate change.

Through sustained Federal and extramural partnerships and collaborations, the Nation has made very significant progress in our understanding of climate change. The core capabilities needed to understand the state of the climate and make projections about future climate and associated impacts include integrated and comprehensive observing systems on land and the oceans, the atmosphere and space; research into the physical system and its interconnectedness to the human ecological and biogeochemical systems, modeling from intra-seasonal to multi-decadal to centennial time scales; and a means to assess and communicate the climate information about current and future impacts.

Three entities, the Intergovernmental Panel on Climate Change, the IPCC, the U.S. Global Change Research Program, and the National Academy of Sciences have all published several peer-reviewed syntheses of the latest climate science findings and associated impacts. NOAA scientists have played a significant role in all of these assessments. For example, NOAA played a lead role in the development of the USGCRP's Global Climate Change Impacts in the United States report, a landmark assessment report that Dr. Holdren and I proudly announced just this last June. And NOAA scientists made up 73 percent of the Federal authors in the IPCC's Fourth Assessment Report for working group one, the basis of the physical understanding of climate. Since the IPCC process began in the late 1980s, a wealth of global scientific information has cumulatively provided stronger and stronger evidence that the earth is warming and that humans are primarily responsible.

As stated in the Global Change Impacts 2009 report, global warming is unequivocal and is primarily human induced. This warming can be seen in increases in global average surface air and ocean temperatures, widespread melting of snow and ice, rising sea levels, and changes in many other climate-related variables and impacts. Most of the observed increases in global temperatures since the mid-20th century are due primarily to human-induced concentrations in heat-trapping greenhouse gases.

When I served on the very first National Academy of Sciences study on policy implications of global warming in the 1980s, we talked about what human-induced climate change might look like at some point in the future. Today we know that it is happening now. We are already seeing the effects of climate change on our landscapes, our neighborhoods, our farms, as well as our forests, oceans and mountains. We are able to measure these changes through significant advances in our observing systems over the last 20 to 30 years, many of which are the result of NOAA's responsibility and innovation, and through collaborative global and national efforts to provide systematic and widespread monitoring of the climate system and associated environmental and social changes.

As a result, we have a much better understanding of present and expected impacts of climate change. Widespread climate change impacts are occurring now and are expected to increase. I emphasize that climate change is not a theory. It is a documented set of observations about the world.

A key element of the U.S. Global Change Research Program emphasizes the importance of multiple independent analyses and data sets to quantify uncertainties. And therefore, we have the benefit of this policy when it comes to global change analyses. The NOAA data used in the IPCC report are openly available. They are used heavily in the IPCC results of temperature change similar to other major global data sets maintained by other U.S. agencies, such as NASA, and that maintained by other countries, such as the United Kingdom.

So what do these data sets, what do these observations tell us about climate change? What do we know with certainty about trends to date, and what do we think is highly likely in the future?

Global average surface temperature has risen by 1.5 degrees Fahrenheit since 1900 and is projected to rise another 2 to 11.5 degrees by 2100. The current atmospheric carbon dioxide concentration is estimated at about 385 parts per million, which is higher than the highest point in the last 800,000 years. Temperatures in the next couple of decades will be primarily determined by past emissions of greenhouse gases, but increases thereafter will be primarily determined by future emissions.

Current observed global emissions of carbon dioxide emissions are beginning to exceed even the upper range of the 2007 IPCC scenarios. There is strong agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global greenhouse gas emissions will continue to grow over the next few decades.

As we continue to learn more about the climate system, I would like to reiterate the importance of looking at the earth system holistically, and understanding the interconnected nature of the

ocean, atmosphere, and terrestrial systems. In particular, I would like to emphasize the importance of continuing our work to better understand the oceans and the potential impacts of climate change on them.

I believe we have been championing the notion that we do not have, but urgently need, a strong focus on ecosystem-based science to inform decisions about adapting to climate change. An ecosystem-based approach also provides a broad array of potential tools for adaptation to climate change. Climate change interacts with and exacerbates other changes, ranging from overfishing to nutrient pollution to invasive species and habitat destruction. Removing one or several of these stresses is likely to enhance the resilience of the system to other stresses.

Equally important is the need to acknowledge that we are likely to see surprises as human actions disrupt many fundamental biogeochemical and ecological processes. The now routine appearance of dead zones, areas of low or no oxygen on the coasts of Oregon and Washington during the summertime, is an example of an unanticipated change with possibly serious consequences.

What does managing with the expectation of surprises look like? These are rich areas for future research and management alike.

And finally, ocean acidification, which I call the equally evil twin of climate change, provides yet another major threat to coastal and ocean ecosystems. Getting a better handle on rates of change in ocean chemistry and the consequences to marine biota are high priorities. The seemingly persistent hypoxic events off the Pacific Northwest coast and this increasing corrosiveness of the water because of acidity are two examples of potential consequences from increasing CO_2 in the atmosphere.

In addition, climate change can exacerbate other human-induced stresses to aquatic systems, such as those caused by nutrient-loading invasive species and overfishing. As water resources are stressed, coastal areas are at increasing risk from sea level rise, inundation, and storm surge. North Atlantic fish populations are shifting north due to warmer oceans. And the threat to human health increases due to heat stress, air quality, and water-borne diseases.

We must continue to enhance our scientific capacities, including research, observation, modeling, predictions, projections, and assessments to ensure that we are providing policy and decision makers, planners, and the public with the best possible science-based information to take on the challenges and opportunities posed by climate change.

Thank you again, Mr. Chairman, for the opportunity to provide you with this review and update of the climate change science and ocean acidification. NOAA looks forward to continuing to provide national and international leadership, in collaboration with our partners, to ensure the solid foundation of climate science and service necessary to inform critical decisions about our future as a Nation and a global society.

The CHAIRMAN. Thank you.

Now I know you want to give us a brief demonstration of the science. And if you would like, could you please do that at this time? And then we will go to questions.

Ms. LUBCHENCO. Okay. Thank you very much. I appreciate that. What I would like to do is just start here briefly and then move over and describe what I would like to share with you. I greatly appreciate the opportunity to not only present the oral testimony that I did but to provide a demonstration of some basic scientific concepts of ocean acidification.

Ocean acidification is a global scale change in the basic chemistry of the oceans that is underway now as a direct result of the increases of CO_2 in the atmosphere. We are just beginning to understand the impacts of ocean acidification on life in the ocean. The moniker osteoporosis of the sea gives you a hint about some of its impacts.

The basic chemistry of ocean acidification is understood and is not controversial. Here are three basic concepts: Number one, the chemistry of the oceans is dependent upon the chemistry of the atmosphere. More CO_2 in the atmosphere means more CO_2 in the ocean. Number two, as CO_2 from the air is dissolved into the ocean, it makes the oceans more acidic. The resulting changes, number three, in the chemistry of the oceans disrupt the ability of plants and animals in the sea to make shells and skeletons of calcium carbonate. And those chemical changes also dissolve shells that are already formed.

So who in the oceans is affected by this? Any plant or animal that has a shell or a skeleton made of calcium carbonate. The hard parts of many familiar animals, such as oysters, clams, corals, lobsters, crabs such as those on this table, and those on the posters, are made of calcium carbonate. Many microscopic plants and animals at the base of the food chain also have calcium carbonate shells or skeletons. Some of these microscopic plants and animals are so abundant that when they die, they form massive deposits as they accumulate on the sea floor. The famed White Cliffs of Dover are a familiar example of calcium carbonate or chalk deposits, the skeletons of microscopic organisms.

More acidic ocean water is corrosive to all of these calcium carbonate shells and skeletons, but let me focus on two quick examples. Number one, corals, that provide the fundamental structure for the world's treasured coral reefs, make their skeletons with calcium carbonate. More acidic ocean water makes it harder for corals to make their hard parts. If the ocean becomes too acidic, coral reefs may well disappear.

Pteropods, number two, also called sea butterflies, are small-shelled animals about the size of a lentil bean. They occur in the millions off the coast of my home State of Oregon, but also throughout the world's oceans. They are a key or the primary source of food for juvenile salmon and many other fish around the world. Pteropods are particularly susceptible to increasingly acidic ocean water, as you will see in a moment. And I mention them in part because they illustrate the broader consequences of disruption of one part of the ocean ecosystem reverberating throughout other parts of the system, potentially affecting jobs, food security, tourism, and more.

The severity of ocean acidification's impacts is likely dependent in part on the interaction of acidification with other environmental stresses, such as rising ocean temperatures, overfishing, and pollu-

tion from the land. Early evidence suggests that some species are better able to thrive in increased acidity, but the adaptability of most organisms to increased acidity is unknown.

While our understanding of ocean acidification's impacts are still unfolding, the basic science of how the ocean is acidifying and the effects of increased acidity on some marine organisms is well known. And I would like to now demonstrate two of the basic concepts that I just mentioned. The ocean does a great service by absorbing tremendous amounts of carbon dioxide from the atmosphere. And in fact, the oceans have absorbed already about a third of the carbon dioxide that humans have contributed to the atmosphere over the last two centuries. This greatly reduces the impact of these heat-trapping pollutant gases on the earth.

But the carbon dioxide that is absorbed by oceans changes the chemistry of sea water, making it more acidic and more corrosive. When carbon dioxide dissolves in water, it forms carbonic acid, making the water more acidic. And to illustrate how this occurs, I brought a vessel of water, some common laboratory blue dye that changes color as the acidity in the solution changes, and some dry ice, which is simply compressed, frozen carbon dioxide. So I will first squirt some of this dye into the pitcher of water, swirl it around a little bit. Actually, I was going to do that in this, wasn't I? I will put it in here. Okay. I am just going to add a little more dye here. So this dye——

The CHAIRMAN. Why don't you move that microphone over?

Ms. LUBCHENCO. Do we need the microphone? Can I project without it? So I squirted a little bit of this dye into the water. You can see the blue color, which indicates this solution is a neutral level of acidity. And to demonstrate that the water absorbs carbon dioxide and that it then becomes more acidic, I am just going to drop a few chunks of this dry ice, frozen carbon dioxide, into the water. And you can see that the water changes color from blue to yellow, telling you that it has become more acidic.

I have used tap water to demonstrate this concept, but the same phenomenon happens with sea water as with tap water. As it absorbs carbon dioxide, the carbon dioxide changes into carbonic acid and becomes more acidic. Over the last two centuries, the oceans have now become 30 percent more acidic because of the CO_2 that they have absorbed from the atmosphere.

The second demonstration that I want to do for you involves—I am just going to set this aside. Thank you—illustrates another very important principle. And that is that calcium carbonate, which is the basic building block of all of these calcifiers, oysters, clams, mussels, oysters, those are all made of the same stuff as chalk.

Now, chalk in the olden days when I was growing up, most chalk that we would use in school was pretty pure calcium carbonate. Today other substances have been added to it to make it less dusty, less breakable, et cetera. So if you want to try this at home, you need to get almost pure chalk, which is what this is.

What I am going to do is to show you what happens to chalk or other types of calcium carbonate when it is in regular water, when it is in water; half water-half vinegar solution, which is more acidic. As you know, vinegar is a weak acid. So I have combined water and vinegar there. And in this container, this is all vinegar. And

so we have an increase in the amount of acidity from normal water; half water-half vinegar; and pure vinegar.

And what I want you to notice is that when we put calcium carbonate, chalk, into the water, the same would happen if you put it into sea water, nothing happens. This is the way the ocean has been for a long time. Shells are fine in water. They don't dissolve.

If you put chalk into half water-half vinegar, you can see some bubbling start to happen. That is the calcium carbonate that is beginning to dissolve in the weak acid and releasing carbon dioxide, bubbles of carbon dioxide.

And if we put the chalk into pure vinegar, you can see that it starts bubbling much more quickly, much more rapidly, and is in fact dissolving much more rapidly. So here we have just a couple simple demonstrations that illustrate some very basic principles of what happens in oceans as they absorb the carbon dioxide that we have put into the atmosphere.

I want to be crystal-clear here: The ocean will never be as acidic as vinegar is. I have used it here simply as a visual demonstration of what happens when you increase the level of acidity in a solution, what happens to calcium carbonate shells.

To show you what actually happens in seawater, the seawater that is projected to be affected by increased CO_2 by the end of this century, I have a video clip. And I want to tell you a little bit what it shows and then start the clip.

The first 10 seconds will show you a living, swimming pteropod, one of these small animals that I spoke of earlier. It is a beautiful creature about the size of a lentil bean. It is incredibly important as a food source for juvenile salmon, for mackerel, for pollock, for herring. They are very, very abundant in oceans throughout the world. After that, you will see what happens to a pteropod in seawater that is the same chemically as seawater that is projected by the end of the century.

So let's start the video clip, if we could, please.

And you will see first, once we get to it, impacts of ocean acidification. This is a swimming pteropod, a sea butterfly, swimming through the ocean. It is a small-shelled mollusk. This is the way it looks naturally. This is a pteropod shell that you will see time-lapse photos of what happens to the shell in seawater after 45 days projected for the year 2100.

And, finally, this last clip is an animation illustrating from the year 1765 to 2100 the effect of increasing ocean acidity on the availability of the calcium carbonate mineral that pteropods, corals, and other organisms need to create their shells and skeletons. This is under a business-as-usual emissions scenario. And the change in color from purple to blue to yellow to red indicates increasing ocean acidity and decreasing availability of the calcium carbonate that is needed for shells and skeletons.

Ocean acidity has increased by 30 percent since the beginning of the Industrial Revolution just over 200 years ago. This increase is 100 times faster than any change in acidity experienced by marine organisms for at least 20 million years.

By the middle of this century, it is expected that coral calcification rates will decline by a third. And, at that point, erosion of corals will outpace new growth, making many coral reefs

unsustainable. And by the year 2100, vast areas of the ocean, ultimately shown here in red, will have reached levels of acidification where pteropods, corals, and other important marine species will likely be severely compromised.

So, in conclusion, our understanding of the impacts of ocean acidification is relatively new. Roughly two-thirds of the published research has come to light since 2004, which is why you probably haven't heard a lot about this issue.

Thanks to Congress's action in passing the Federal Ocean Acidification Research and Monitoring Act, more attention will be given to this subject, particularly by scientists at NOAA and our partners at the National Science Foundation and in academia.

Nonetheless, our fundamental scientific understanding of the basic chemistry of ocean acidification is sound. More CO_2 emitted into the atmosphere will increasingly lead to more CO_2 being absorbed by oceans. That will make oceans more acidic.

And we are now beginning to understand the ocean's very capacity to absorb CO_2 from the atmosphere is being degraded by ocean acidification. These mechanisms can only be addressed by decreasing the amount of CO_2 that enters the atmosphere. The dramatic impacts that ocean acidification can and will have on marine ecosystems are clear.

Thank you, Mr. Chairman.

[The statement of Ms. Lubchenco follows:]

WRITTEN TESTIMONY OF
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UNDER SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE
AND NOAA ADMINISTRATOR
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U.S. DEPARTMENT OF COMMERCE

HEARING ON
"THE ADMINISTRATION'S VIEW ON THE STATE OF CLIMATE SCIENCE"

BEFORE THE
SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING
U.S. HOUSE OF REPRESENTATIVES

December 2, 2009

Introduction

My name is Dr. Jane Lubchenco and I am the Under Secretary of Commerce for Oceans and Atmosphere and the Administrator of the National Oceanic and Atmospheric Administration (NOAA). Thank you for the opportunity to testify before you today on the state of climate science. On behalf of the Administration, I thank the House Select Committee on Energy Independence and Global Warming for its interest in the state of climate science and the spectrum of climate science and services needed in this country and abroad to make critical decisions now and in the future. I am pleased to be joined today by Dr. John Holdren, an esteemed fellow scientist and Director of the White House Office of Science and Technology Policy.

In the short time that President Obama has been in office, he has made it clear that our choices will be informed by scientific knowledge and that he considers addressing climate change to be a high priority. As he said to the National Academy of Sciences, "Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before." The President has also made it clear that he believes that good government depends upon good science. As head of NOAA, one of the nation's premier science, service and stewardship agencies with responsibilities for the oceans and the atmosphere, I certainly support a focus on science-based decision-making. Science can help inform an understanding of the opportunities and challenges presented by climate change.

It was evident how relevant these topics are to the broader global community during our recent interactions with international colleagues at the World Climate Conference -3 in Geneva in early September. As head of the U.S. delegation, I had the opportunity to interact with numerous heads of state, ministers, and leaders of international organizations. The focus of the meeting was the need to develop a Global Framework for Climate Services. There was strong agreement that services must be informed by relevant and credible science and must engage the users at all steps in the process. Much of what we do as a Nation on climate services will undoubtedly be useful to the international community and vice versa.

Climate science encompasses an immense breadth of topics ranging from those that are well-understood and amply-documented (e.g., increases in greenhouse gases) to those on the cutting edge of knowledge (impacts of sea level rise, ocean acidification, melting of sea ice and ice sheets, role of aerosols, etc). The IPCC's periodic assessment of the state of climate science provides regular updates of changes in the level of scientific certainty with respect to different topics. The National Academy of Science (NAS) and the United States Global Change Research Program (USGCRP) provide international as well as national assessments that complement the international assessments.

Through sustained federal and extramural partnerships and collaboration, the nation has made significant progress in our understanding of climate change. The core capabilities needed to understand the state of the climate and make projections about the future and associated impacts include: observing systems (ecosystems, ocean, land, atmosphere, space); research of the biological, chemical and physical systems and their interconnectedness to human, ecological, and biogeochemical systems; modeling of global and regional climate changes from intra-seasonal to multi-decadal time scales; and a means to assess and communicate the climate information on current and future impacts.

More work lies ahead, however, to more fully understand the needs of society to address the challenge of a changing climate and to deliver useful climate-relevant information that can inform decision-making. In 2007, NAS released a report entitled "Evaluating Progress of the U.S. Climate Change Science Program: Methods and Preliminary Results," which highlighted existing gaps in federal programs ability to provide global climate change information. This report recognized that good progress has been made to determine many aspects of global climate change however, "progress in synthesizing research results or supporting decision-making and risk management has been inadequate."

State of the Science

I appreciate this opportunity to review and provide an update on the strong foundation of climate science – the very foundation upon which our nation and the world rely upon while deliberating about new directions to curb heat-trapping emissions and forge a clean energy to ensure a prosperous future for our children and generations to come. Two entities — the Intergovernmental Panel on Climate Change (IPCC) and the USGCRP — have published several peer-reviewed syntheses of the latest climate science findings and associated impacts. United States scientists, including those from or supported by the Departments of Agriculture, Energy (DOE), the Interior, Health and Human Services, and Transportation, as well as the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and NOAA, have played a significant role in both of these groups.

Since its inception about 20 years ago, the IPCC has produced assessments of the state of understanding of (i) the science of climate change, (ii) the impacts of climate change and climate change vulnerability, and (iii) mitigation of climate change. Each of these areas is the subject of a separate scientific assessment, and there is also a synthesis summarizing findings across all

three. The IPCC's reports have become the gold standard for authoritative scientific information on climate change because of the rigorous way in which they are prepared, reviewed, and approved.

The USGCRP began as a presidential initiative in 1989 and was mandated by Congress in the Global Change Research Act of 1990 (P.L. 101-606), which called for "*a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.*" During the past two decades, the United States, through the USGCRP, has made the world's largest scientific investment in the areas of climate change and global change research. These advances have been documented in numerous assessments commissioned by the program and have played prominent roles in international assessments such as those of the IPCC.

Both the IPCC and the USGCRP have produced the two most recent assessments of climate science to date. The IPCC Fourth Assessment Report (IPCC 2007) is a climate science assessment prepared by 152 leading scientists from around the world who served as its authors. It was then reviewed and re-reviewed by more than 600 experts and dozens of governments.

In 2009, the U.S. government released a landmark report entitled *Global Climate Change Impacts in the United States* (GCCI 2009). It contains a comprehensive assessment of the state of knowledge about the impacts of climate change in the United States, region by region and sector by sector. This report provides concrete scientific evidence that demonstrates unequivocally that the climate is changing, and we are seeing its impacts in our own backyards in every region in the country.

Since the IPCC process began in the late 1980s, a wealth of global scientific effort has cumulatively provided stronger and stronger evidence that humans are primarily responsible for warming global temperatures. This has led to the latest key finding in the GCCI 2009 report: *Global warming is unequivocal and is primarily human-induced.*

This warming can be seen in increases in global-average surface air and surface and subsurface ocean temperatures, widespread melting of land snow and ice and sea ice, rising sea level, and changes in many other climate-related variables and impacts. Most of the observed increases in global temperatures since the mid-20th century are primarily due to human-induced increases in heat-trapping greenhouse gases (IPCC 2007, GCCI 2009).

At one time, we talked about what human-induced climate change *might* look like at some point in the future. The latest science says that it's happening now. We are now seeing the effects of human-induced climate changes on our landscape, our neighborhoods, schoolyards and farms, as well as our forests, beaches and mountains. We are able to measure this through significant advances in our observing systems over the last 20-30 years – many of which are NOAA's responsibility and innovation – and through collaborative global and national efforts to provide systematic and widespread monitoring of climate and associated environmental and social change; this has led to much better understanding of present and expected impacts of climate change: *Widespread climate-related impacts are occurring now and are expected to increase (GCCI 2009)*

In addition to observing the changes we have long anticipated, we are also seeing that some changes are happening faster than previous assessments have indicated (GCCI 2009). Our latest scientific assessments also tell us that our options for reducing overall climate change and avoiding the worst of the projected changes are likely to have more positive impact now than if we were to implement them later. For example, sizeable early cuts in emissions would significantly reduce the pace and overall amount of climate change (GCCI 2009).

Latest Key Findings

Highlights of the latest climate science findings at the global to regional scale and by sector, referencing peer-reviewed literature, are described below:

Highlights of climate change occurring globally -- Some details on magnitude of current and expected climate change, and greenhouse gas (GHG) emissions:

- Global average surface temperature has risen by about 1.5°F since 1900 and is projected to rise another 2°-11.5°F by 2100 (IPCC 2007 and GCCI 2009).
- The current atmospheric carbon dioxide concentration is estimated at around 385 ppm, which is higher than the highest point in at least the last 800,000 years[1] (GCCI 2009).
- Temperatures in the next couple of decades will be primarily determined by past emissions of greenhouse gases, but increases thereafter will also be primarily determined by future emissions (GCCI 2009).
- Current observed global emissions of carbon dioxide emissions are beginning to exceed even the upper range of IPCC past scenarios (IPCC 2007; GCCI 2009).
- There is significant evidence and agreement that under current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades (IPCC 2007).
- Longer ice-free season in the ocean and on lakes and rivers
    - End-of-summer Arctic Sea ice has fallen at a rate of 11percent per decade over the last 3 decades (GCCI 2009).
    - Arctic sea ice extent during the 2008 melt season (measured in September) dropped to the 2nd-lowest level (4.67 million km^2 / 1.80 million mi^2) since satellite measurements began in 1979. The record low was set in 2007 (4.28 million km^2 / 1.65 million mi^2) (NCDC Global State of the Climate, 2008).
    - While the summer sea ice minimum in 2009 was not as low in 2007 or 2008, there is continued loss of older sea ice compared to five years ago (Arctic Report Card 2009).
    - Large scale wind patterns and high Arctic species, such as walrus and polar bears, are expected to be impacted by continuing loss of sea ice (Arctic Report Card 2009).
- Changes in snowmelt and snow cover
    - Runoff in snowmelt-dominated areas is occurring up to 20 days earlier in the West and up to 14 days earlier in the Northeast.

[1] Over the past 800,000 years, atmospheric carbon dioxide has varied within a range between 170 and 300 ppm.

- Seven of the last ten Northern Hemisphere winters featured above-average snow cover, including two of the four largest winter snow cover extents since observations began in 1967. Nine of the last ten Northern Hemisphere springs have featured below-average snow cover, including two of the four smallest spring snow cover extents (NCDC Global State of the Climate, 2009).

- The 2008 global combined land-and-ocean surface air temperature was tied (with 2001) for the 8th warmest on record (since 1880: 8th of 129). The ten warmest years have occurred within the last twelve years. The global combined land-and-ocean surface air temperature for 2008 was warmer than all years prior to 1998 in the dataset (i.e., warmer than each year from 1880-1997) (NCDC Global State of the Climate 2008).
- The amount of sea level rise likely to be experienced during this century depends mainly on the expansion of ocean volume due to warming and the melting of glaciers and polar ice sheets. Complex processes control discharges from polar ices sheets and some are already contributing to sea level rise. In addition regional affects from changes in ocean circulation and geological and human processes that affect the elevation of the land above sea-level can either add to or subtract from the global mean sea level rise projected to be as high as 3.5 feet in some scenarios of increasing heat-trapping greenhouse gases (GCCI 2009).
- In addition to influencing global temperatures, increasing carbon dioxide is gradually acidifying the ocean. Approximately one third of carbon dioxide emitted into the atmosphere by human activities has been absorbed by the ocean. Further increases in ocean acidity are expected to continue to affect the ability organisms to calcify. Under these scenarios, coral calcification rates are likely to decline more than 30 percent under a doubling of atmospheric carbon dioxide concentrations (GCCI 2009).

Highlights of climate change impacts in the United States:

Climate changes are already underway in the United States (and elsewhere) and are expected to grow including (GCCI 2009):

- Temperature rise
  - U.S. average temperature has risen more than 2°F over the past 50 years and is projected to rise more in the future (GCCI 2009).
  - Under a higher emissions scenario, the U.S. as a whole is projected to warm 7-11°F by the end of this century, while under a lower emissions scenario, temperature increase would be approximately 4-6.5°F. Stabilizing emissions at still lower levels would yield lower temperatures – potentially limiting it to around 2°F higher than present (3.5°F higher than pre-industrial) (GCCI 2009).
- Precipitation Patterns Changing
  - Precipitation has increased an average of about 5 percent over the past 50 years. Projections of future precipitation generally indicate that northern areas will become wetter, and southern areas, particularly the West, will become drier (GCCI 2009).
  - In the U.S., the amount of rain falling in the heaviest downpours has increased approximately 20 percent on average in the last century and this is expected to continue, with the largest increases in the wettest places (GCCI 2009).
  - Extreme events such as heavy downpours and droughts are likely to reduce crop yields because excesses or deficits of water have negative impacts on plant growth (GCCI 2009).

- Sea level rise
  - Global sea level has risen approximately 8 inches this century (IPCC 2007, GCCI 2009).
  - During the past 50 years, sea level has risen up to 8 inches or more in some locations along the U.S. coast (GCCI 2009).
  - Some recent estimates suggest that future global sea level rise may substantially exceed the IPCC estimates that do not include rapid ice flow and that sea level rise might be between 3-4 feet this century (GCCI 2009).
  - Sea level rise will not be uniform around the globe. Because of local differences in ocean circulation and in the amount of subsidence or uplift, a 2-ft global sea level rise would result in 2.3 ft at New York City, 3.5 ft in Galveston, TX, and only 1 ft in Neah Bay, Washington State (GCCI 2009).
- Increase in heavy downpours
  - In the U.S., the amount of rain falling in the heaviest downpours has increased approximately 20 percent on average in the last century and this is expected to continue, with the largest increases in the wettest places (GCCI 2009).
- Glaciers have been retreating worldwide for at least the last century and the rate of retreat has increased in the past decade (GCCI 2009).
- Thawing permafrost damages roads, runways, water and sewer systems, and other infrastructure (GCCI 2009).

Climate Change impacts critical resources and sectors of our economy:

- *Widespread climate-related impacts are occurring now and are expected to increase.* Climate changes are already affecting water resources; energy and transportation infrastructure; agriculture; ecosystems; and human health. These impacts vary from region to region and will grow under projected climate change (GCCI 2009).

  - *Climate change will stress water resources.* Water is an issue in every region but the nature of the potential impacts varies. Drought, related to reduced precipitation, increased evaporation, and increased water loss from plants, is an important issue in many regions especially in the West. Flood and water quality problems are likely to be amplified by climate change in most regions. Declines in mountain snowpack are important in the West and Alaska where snowpack provides vital natural water storage.

  - *Crop and livestock production will be increasingly challenged.* Agriculture is considered one of the sectors most adaptable to changes in climate. However, increased heat, pests, water availability, diseases and weather extremes will pose adaptation challenges for crop and livestock production.

  - *Coastal areas are at increasing risk from sea level rise and storm surge.* Sea level rise and storm surge place many U.S. coastal areas at increasing risk of erosion and flooding, especially along the Atlantic and Gulf coasts, Pacific Islands and parts of Alaska. Energy and transportation infrastructure and other property in coastal areas are very likely to be adversely affected.

- *Threats to human health will increase.* Health impacts of climate change are related to heat stress, water-borne diseases, air quality, extreme weather events, and diseases transmitted by insects and rodents. Robust public health infrastructure can reduce the potential for negative impacts.

- *Climate change will interact with many social and environmental stresses.* Climate change will combine with pollution, population growth, overuse of resources, urbanization, and other social, economic and environmental stresses to create larger impacts from any of these causes alone.

- *North Atlantic Fish Populations Shifting as Ocean Temperature Warm.* About half of 36 fish stocks in the Northwest Atlantic Ocean, many of them commercially valuable species, have been shifting northward over the last four decades, with some stocks nearly disappearing from U.S. waters as they move farther offshore, according to a new study by NOAA researchers. For example, Southern species like Atlantic Croaker may become common in New England waters. Fish species can respond to changes in ocean temperature in a variety of ways. The stock can move poleward to avoid warmer water temperatures, or move into deeper waters than they have previously been found. If fish cannot change their geographic or depth distribution, there may be changes in growth, reproduction and mortality rates. As a result, the size of the population may increase or decrease depending on the temperature preference of the species. Most species in the study were found to be responding to warming ocean temperatures in one of these ways (Nye et al., 2009).

The Earth's Changing Climate Necessitates Adaptation

The prospects of such climate changes have profound implications for a global society, underscoring the need for scientific information to aid decision-makers in developing and evaluating options for mitigating future human-induced climate change as well as alternatives for adapting to a changing climate.

Across the United States, decision-makers at all levels of government are considering options for how to best prepare their communities for the impacts of a changing climate. While climate change negotiations have primarily focused on mitigation of greenhouse gases, it is also critically important that we incorporate adaptation into our strategy. A bold strategy to reduce heat-trapping emissions is necessary to avoid the worst consequences of climate change, but even then some degree of future climate change will continue to occur despite mitigation efforts. We are already seeing the impacts of climate change on the ground and in our own backyards. In Alaska, for example, temperatures are warming at twice the rate of the rest of the United States, causing sea ice and permafrost melt, and threatening vulnerable infrastructure, ecosystems, and native communities (GCCI 2009). The Southwest is becoming drier, leading to user conflicts about water resource management (GCCI 2009). Sea level rise is occurring in the Gulf of Mexico, threatening the ports, 72 percent of which are at or below a 4-foot sea level (GCCI 2009). These impacts affect people, places, and natural resources and action is needed to protect our environment, economic livelihood, human health, and national security from the impacts of

climate change.

Adaptation is not a new concept. Humans have adapted to changing conditions in the past. For example, farmers have to predict the optimum planting date for maximizing crop yield and profits. In the future, however, adaptation will be particularly challenging because the rate of change is escalating and is moving outside the range to which society has adapted in the past. The precise amounts and timing of these changes cannot be known with certainty. Because of this uncertainty and the high potential for surprises, adaptation plans will need to be robust, flexible, and able to evolve over time.

Climate scientists have developed a suite of global climate models to project climate change impacts on temperature, precipitation, sea level rise, and some aspects of extreme weather events (e.g., IPCC 2007). Long-term climate data have been collected through extensive monitoring and observing systems, and impacts such as changes in stream flow, snowpack, and urban heat islands are currently being studied. However, meeting the challenge of preparing for and responding to climate change will require an unprecedented level of coordination among federal agencies, along with our nongovernmental and international partners. We need to utilize our collective expertise to provide high-quality climate information and services that are user-friendly, responsive to management, and relevant to desired social, economic, and environmental outcomes. In addition, we need to translate global modeling projections to scales that are more meaningful to regional, state, and local decision makers. To best prepare their communities, decision-makers will need to be supported with access to the best climate information that science can provide and tools that can inform and guide their decisions. There are still gaps remaining in our scientific understanding of global climate change and its impacts, including strategies for building resilience of our people, places, and natural resources. For example, we need more climate information and projections at the local level where the impacts of climate affect each one of us. In addition, there are some impacts of climate change, such as ocean acidification on marine life, about which there are important knowledge gaps.

Despite these challenges, in many instances, decision-makers, resource managers, and urban planners throughout the United States are already beginning to develop and implement strategies for climate change adaptation. For example, Boston built one of its sewage treatment plants at higher ground to accommodate sea level projections over the next 50 years (GCCI 2009). Chicago is planting green roofs to cool its buildings and reduce the effects of urban heat waves (GCCI 2009). King County, Washington upgraded the specifications for a new regional wastewater treatment facility to include water reclamation capacity in response to the observed and projected declines in mountain snowpack (CCAP 2009). The State of California recently released a draft climate adaptation strategy that identified how state agencies can plan for climate impacts on multiple sectors, including public health, biodiversity and habitat, ocean and coastal resources, water management, agriculture, forestry, and transportation and energy infrastructure (CA Natural Resources Agency 2009). Several other cities, counties, and states have developed comprehensive plans that address adaptation, and in many cases, federal agencies such as NOAA, NASA, the U.S. Army Corps of Engineers, the U.S. Geological Survey (USGS), and the Environmental Protection Agency provided the data, sponsored the research, or enabled the services that supported their development.

The federal government can play an important role in building the institutional capacity to adapt to climate change. Climate change can and must be incorporated into our existing management, planning and decision-making frameworks as we look to the future. At the federal agency level, our science must be accessible, relevant, and timely. This will require two-way communication, which often begins with providing opportunities for decision-makers, resource managers, and planners to articulate their needs to the scientific community in order to ensure that the scientific community focuses on addressing the most relevant issues to decision-makers. The examples cited in the paragraph above show that this communication has already begun, but more is clearly needed. Through enhanced communication and cooperation, we will make effective steps towards preparing for climate change.

Conclusion

Thank you again, Mr. Chairman, for the opportunity to provide you with this review and update of climate change science. NOAA looks forward to continuing to provide national and international leadership, in collaboration with DOE, NASA, NSF, USGS and other federal agency partners. Contributions from all federal agencies and all countries are necessary to ensure the solid foundation of global climate science and service to inform critical decisions about our future as a nation and a global society.

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

I think you all brought us back to our sophomore and junior years in high school with some of these elemental explanations of how our planet works.

And I think, to a very large extent, you have explained to us why just about everyone under the age of 25 wants us to do something about this problem, because they have recently been in science classes, in high schools, grammar schools, colleges all across the country. So they might be a little bit more familiar with this than people who are a little bit older. But I think that is why we call them the green generation, because they are reflecting the science that is being taught them today across our country and across the planet.

So let me begin by recognizing myself for a round of questions, and I will begin with you, Dr. Holdren.

Reconstruction of global temperatures over the last millennium show a dramatic rise over the course of this century. That has produced a so-called "hockey stick" graph, which is being questioned in some circles.

Can you clarify for us the evidence that supports the significant rise in temperatures over the past century?

Mr. HOLDREN. Sure.

When one talks about reconstruction of past temperatures, one is talking about using a variety of indicators of what the temperature of the Earth was in the period before we had adequate thermometer measurements to meaningfully determine the average surface temperature of the Earth. Those methods include the analysis of bubbles in ice cores, analysis of tree rings, of fossil pollens, of sediments, and a variety of other so-called paleoclimatological indicators.

The hockey-stick metaphor came about when an analysis of the last 1,000-plus years of temperature, based on a variety of reconstructions available at that time from these different proxies—the ice cores, the tree rings, the sediments, the fossil pollens, and so on—came out with a temperature trace that, with some bumps, was relatively flat for most of the last 1,000 years and then rose rather sharply in the 20th century, indeed, then, extremely sharply. So the thing had the shape of a hockey stick: a long relatively flat section and then a steep rise.

This was the particular graphic that led to a considerable amount of controversy at the end of the 1990s and the beginning of the 2000s as to whether the particular approaches to developing that graph used by the group of scientists who did it and published it in the journal Nature in 1998 were absolutely correct. There was a flurry of activity at that time, a flurry of controversy about whether their statistical methods were right, whether they had used the right proxies, whether they had interpreted them correctly.

It is important to understand that there were a variety of other research groups around the world doing proxy analyses and getting similar results—with some variations, because proxies are difficult to interpret. The different proxy measures typically relate to different specific areas in the world where the proxy indicators have been preserved. And you need to merge them together in a way

that ultimately makes sense and is scientifically rigorous, and that is very challenging.

But, in the end, as I mentioned before, the effective resolution of the controversy was when the National Academy of Sciences conducted a major study looking at all the proxy data sets, all the methods that had been used to interpret them. Their results, published in 2006, led to the conclusion which I mentioned before. In fact, it was even a little stronger than the conclusion I mentioned before. They said it was highly likely that the temperature increase of the 20th century was unprecedented in the last 2,000 years.

There was some greater degree of bumpiness in some of the proxy records than the 1998 Nature publication had included. So it was kind of a warped hockey stick, but still a hockey stick.

The CHAIRMAN. Okay. Thank you, Dr. Holdren.

And, Dr. Lubchenco, there has been a, kind of, a series of stories going around, making the rounds, that the planet is actually not warming but cooling, and that evidence over the past decade indicates that we are in a cooling period and not in a warming period, historically.

What would your response to that be?

Ms. LUBCHENCO. If you look carefully at the climate records, the warming that has occurred is not gradual, it is jerky. And you get periods of time where there are steep increases and other times where it is relatively flat, other times where there are slight dips. And the key point here, I think, is to really understand global trends you need to look at long enough periods of time that you get a clear signal. It is quite possible to have a decade in which you see very little change, but if you look at the entire century, you see some remarkable changes.

And, in fact, if I could have the slide that I brought—I was hoping someone would ask this question, so thank you, Mr. Chairman, for doing so. And what you will see on this slide are the actual temperature data from, if it will boot, from—thank you.

You see here, on the far right, data from the last decade—whoops, that is not what it was supposed to do. Can we do that again?

Okay. So what I wanted to do—yes, okay. So let's just do—yes, stop right there. Can you go back one? There you go.

Okay. So this is the most recent data trend. And if you take just that period of time, there is no discernible, no obvious trend in that. If you then go and take a longer interval of time—next one, please—and keep going back through time, you see more and more information that gives you a better sense of what the actual, real overall trend is.

And so, in that entire record, it is possible to have some ups and some downs. The point is that the overall record is an upward trajectory.

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

My time has expired. The Chair recognizes the gentleman from Wisconsin.

Mr. SENSENBRENNER. Well, thank you very much, Mr. Chairman.

I want to go back to the e-mails that ended up being placed in the public record. And I don't want to get to whether or not they were legally placed in the public record; the question is whether or

not they were accurate. Because if they were accurate, it is profoundly disturbing, and it does end up putting into question all of the science of climate change.

Now, the data from the Climate Research Unit at the UEA in England is one of only three major data sets, but they considerably overlap. And they have been used as a basis for the IPCC report, as well as the U.S. Global Change Research Program. And that means that these two booklets that were passed out this morning, you know, at best, need to have a thorough review in the light of this information that has been disclosed. And, at worst, it is junk science, and it is a part of a massive international scientific fraud.

Now, Dr. Holdren, you have been in the middle of a lot of this. And I have a couple of questions based upon your statements before you joined the Obama administration.

You gave an interview in August of 2006 with BBC News in the UK. And you said that a sea-level rise of up to 13 feet was in the realm of possibility. However, that is 11 feet higher than what the IPCC has estimated over this period of time, which is somewhere between seven and 23 inches.

Now, with respect to the hockey-stick theory, which the chairman has referred to, that has been pretty much discredited in the scientific community. And yet, in your October 13th e-mail, which is now in the public record, you aggressively attacked the two scientists that put this together, a Dr. Willie Soon and a Dr. Sallie Baliunas, for that.

Now, I think it is pretty clear that, in both cases, you were wrong. And I guess I would like to know if you are concerned, now that you are in the White House and representing all of the public, whether you are concerned about the misrepresentation of the state of science with respect to global warming.

And I would also like to know if you still support the principal critic of those who trashed the hockey-stick theory, and that is a Dr. Michael Mann, knowing of his efforts now to hide his data and to encourage his colleagues to shut out journals like Climate Research to publish works contrary to his own bias.

Mr. HOLDREN. Congressman, let me try to take those in the order you asked them.

And the very first part of your statement, with respect I would disagree with you that this current uproar calls into question all of climate science. I do not believe that it remotely does that——

Mr. SENSENBRENNER. Well, sir, I didn't say that. I said it ought to be looked at again. And, you know, there is increasing evidence of scientific fascism that is going on. And I think, as policymakers who are making decisions about the state of the American economy for the next several generations, that we ought to have accurate science. And it appears there is enough question on whether the science we have is accurate. That has to be resolved, and I wish we could have done it in this hearing, but the chairman wouldn't let us. But go ahead.

Mr. HOLDREN. I very much agree that we need to resolve the current issue. It is important to understand what has really gone on here, to get to the bottom of it. As I indicated before, that has been one of the strengths of science over the years, the capacity to get

to the bottom of the controversies that emerge. And I believe we will get to the bottom of this one.

But the key point is, however this particular controversy comes out, the result will not call into question the bulk of our understanding of how the climate works or how humans are affecting it.

You mentioned an interview of mine a few years ago in which I talked about the possibility of a sea-level rise in this century as much as 13 feet. That was based upon scientific, peer-reviewed publications that appeared in the early 2000s that indicated that, over geologic time in periods of natural climate change, there had been episodes in which the rate of sea-level rise increased by as much as two to five meters per century, and that this could not be ruled out at the temperatures for which we were heading in the 21st century as a result of our activity——

Mr. SENSENBRENNER. But you are still 11 feet above what the IPCC is recommending.

Mr. HOLDREN. Sir, if you will——

Mr. SENSENBRENNER. My time is almost up, and I would just like to, you know, say that there is an awful lot of scientific McCarthyism, meaning name-calling, going on. Because I quote from your e-mail of October 13th, 2003, saying, "Doing this will reveal that Soon and Baliunas are essentially amateurs in the interpretation of historical and paleoclimatology records of climate change."

You know, you are not dealing with their issue, you are calling them names. And I think we ought to get to the bottom of this without having the name-calling. And I wish that you, as the President's science advisor and a former employee of one of the most distinguished universities in the world, would be able to get beyond the name-calling and get to it.

My time is up, and I yield back.

Mr. HOLDREN. I would be happy to answer all of the congressman's questions, if I am allowed.

The CHAIRMAN. You will be given enough time, but let me turn right now and recognize the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. It is continually stunning to me that people can sit and watch the evidence before their eyes of what the seas are going to look like in a century that might melt pteropods and somehow blow that off and be more interested in e-mails from London. It is interesting to me.

And the only way I have been able to understand is it is that some people believe there is a massive global conspiracy that is intent on world domination associated with phonying up information about pteropods and the fact that the Arctic is melting.

So I just want to ask you if you are part of that massive international conspiracy. Are either one of you members of the Trilateral Commission, SPECTRE, or KAOS? I just need an answer.

Mr. HOLDREN. Congressman Inslee, I am not a member of any of those organizations, and I do not believe that there is a conspiracy.

It would be an amazing thing, indeed, if the academies of science of virtually every country in the world that had one and if the Earth and planetary sciences departments in every major university that had one around the world were all engaged, together with

the United Nations Environment Programme, the Intergovernmental Panel on Climate Change, and all the other bodies that have reviewed this matter, in a conspiracy.

That really defies imagination, that the great bulk of the scientific community all around the world looking at these matters has come to the same conclusion.

Mr. INSLEE. Well, I will just tell you how I look at this. The National Academy of Sciences has looked at this in great detail, in great summary, from a wide variety of data sets, not just from the individuals who wrote the e-mails but, in fact, from a wide variety of data sets, including information generated by NASA and NOAA and a whole host of United States agencies. And they concluded that, in fact, both there are changes in the atmospheric climate and that there is increasing acidification, or at least NOAA has, associated with CO_2.

If that is true, isn't it fair to categorize, as much as we want to get people to use the right language in their e-mails, that this is a tempest in the teapot coming out of England? Isn't that a right characterization of this?

Mr. HOLDREN. Well, I think we need to wait until all the facts are in to find out exactly what some of these e-mails mean, in terms of how the scientists in question behaved. I mean, I would point out that scientists are human, and, from time to time, they experience frustration, anger, resentment. And, from time to time, they display defensiveness and bias and even misbehavior of some kind. They are like any other group of human beings, they are subject to human frailties.

I think the facts are not entirely in on this particular case as to how much and what kinds of frailty might have been displayed here.

But the key point is that, when we get to the bottom of it, no matter how it comes out, the great bulk of the data on which our understanding of the climate system rests will not have been affected. And our basic understanding of where we are, where we are headed, and by how much we would need to change course to avoid really unfortunate consequences will not have changed.

Mr. INSLEE. And let me ask you, is there anything about these e-mails that affect ocean acidification at all, Dr. Lubchenco?

Ms. LUBCHENCO. Congressman, I haven't read all of the e-mails, but I have seen nothing in them, in those that I have read, about ocean acidification. It really is not an area that is something that that particular research group was focused on.

And, in my view, the e-mails really do nothing to undermine the very strong scientific consensus and the independent scientific analyses of thousands of scientists around the world that tell us that the Earth is warming and that the warming is largely a result of human activities.

Mr. INSLEE. So, let me, if I can—I have some concerns about the state of our science that are reflected in the fact that everything that I am reading suggests that the predictions were not sufficiently dire as to what we are experiencing.

Now, I am not a scientist, as you are, but it seems to me the evidence that I am seeing come in—I am looking at this Copenhagen Diagnosis report I made reference to in my opening statement—

that the Arctic ice sheets are melting much more fast in the summer than we anticipated, that there has been a 40 percent greater than average ice sheet melt than predicted in the IPCC report in 2006, that we have seen an increasing rate in sea rise than was expected.

And, to me, just my lay approaches, the evidence seems to be coming in, in the last 24 months, either on the direst end of the spectrum that was considered or outside of that spectrum. Is that a fair characterization of a huge data set, or what are we to make of this?

Mr. HOLDREN. Well, let me, Congressman, take the opportunity of this particular question to answer part of Congressman Sensenbrenner's, because he referred to the IPCC's finding in its fourth assessment report about sea-level rise.

In that report, the IPCC made clear that they were only considering the thermal expansion of seawater and a small contribution from the melting of mountain glaciers in their sea-level rise estimate for the 21st century, leaving out deliberately the mechanism thought to have caused the more rapid rises in sea level that have occurred from time to time in the geologic past.

And the reason they left out those mechanisms that are capable of causing more rapid sea-level rises, they explained in their report, was that we do not yet understand those mechanisms well enough to model them and arrive at the sort of quantitative conclusion that the IPCC was emphasizing. And, in addition, we didn't know at that time, we didn't have enough data to know whether, on balance, the Antarctic ice sheet, the larger of the two, was gaining mass or losing mass.

Since that IPCC report, there has been a great deal of additional work on these questions. We now know that both the Antarctic and the Greenland ice sheet are losing mass. We know that the rate of sea-level rise today is more than twice the rate of sea-level rise averaged over the 20th century.

And the current best estimates of the peak sea-level rise to be expected in this century are one to two meters. That is not as high as my number from 2006. The advancing science has ruled out the high end of that range. But it makes me wrong in 2006 by about a factor of two. And it makes the IPCC wrong by a much larger factor, by which their numerical estimate understated the possible rise of sea level in the century we are now in.

Mr. INSLEE. Doctor.

Ms. LUBCHENCO. Congressman, let me just add to that that the scientific assessment process that the IPCC uses or that National Academy of Sciences uses are inherently conservative. And scientists are, by and large, fairly reluctant to make statements that they can't back up without good data.

And I think the sea-level rise example is a classic case in point. Scientists knew when they were projecting a 23-inch sea-rise increase by the end of the century that there were important factors that they couldn't account for, but they couldn't include them because they didn't understand them well enough. And so they erred on the side of caution.

And I think we see this over and over in many of the IPCC conclusions. They are inherently conservative. And so, when the re-

ality plays out, it is sometimes more than what was predicted because of that need to have agreement and levels of certainty.

Mr. INSLEE. Thank you.

The CHAIRMAN. Great. The gentleman's time has expired. The Chair recognizes the gentlelady from Michigan.

Mrs. MILLER. Thank you very much, Mr. Chairman.

And I have listened very closely. I think it is all very interesting listening to you all and some of the other questions, as well, from members of the panel here.

I am not a scientist, but I don't question that the Earth climate is changing. You know, we used to have dinosaurs, and there is still a lot of debate about what happened to the dinosaurs. Then we had the Ice Age; there was a lot of debate about what happened during the Ice Age.

I was noticing an article in one of our papers just the other day. They are doing some studies in Lake Superior along the Pictured Rocks, and they are indicating that they think a couple of thousand years ago the water levels there could be anywhere as much as 50 or 60 feet higher than they are currently.

So the climate of the world is never static. It is never going to be static. The climate is going to change. And, for me, the question is, as you say, the science is—I am paraphrasing what Dr. Lubchenco said—that the science is incontrovertible, that it is unequivocal, that the climate change is human-induced or human-produced. And that is the question that I am struggling with.

That is why I think all of these e-mails coming out are very interesting. I think it is unfortunate that anybody that questions the ideology, the absolute science that man is creating all of this is somehow—that we don't care about the planet, I mean, it is ridiculous. And I think it is unfortunate that that happens. But, whatever.

I do think that the question, as I say, for me is whether or not it is human-induced, particularly when this Congress has been travelling down a path with cap-and-trade legislation that is going to, in my opinion, decimate the American economy and that of my State.

I think that we look at these e-mails—and, you know, it is an attempt, in many cases, just to silence any dissent, which I think is very unfortunate. And I will just read one. I am not sure if the ranking member read this previously.

But here is one. You know, there weren't e-mails during the Dinosaur Age, by the way, either, or the Ice Age. But here is an e-mail saying, "I think we need to stop considering the Climate Research journal as a legitimate peer-reviewed journal. And perhaps we should encourage our colleagues in the climate research community to no longer submit to or cite papers in this journal."

How ridiculous. How unfortunate that here is this Climate Research journal that, if they question the incontrovertible science, that they are, you know, just dismissed and made to feel as though, you know, they can't even question this. I think it is a travesty.

And I do recognize that the e-mails are an inconvenient truth, perhaps are an embarrassment, particularly on the brink of Copenhagen. But I think one of the most important jobs of the Congress is to exercise its oversight responsibilities. And because of these e-

mails, because, in my opinion, there is at least a debate, a debate on whether or not climate change is human-induced or man-produced—for instance, I was just reading the other day that, in Indonesia, where the peat moss is naturally composting, that that is the third-largest producer of carbon dioxide in the planet, more so than many other kinds of things. I am not sure how our cap-and-trade legislation is going to address that. You know, as I say, the climate is never going to be static.

So, with that, Mr. Chairman, I guess I would just use my time here again to ask that this committee consider a hearing into this climate-gate debate that is exploding around us.

And I would also ask of Dr. Holdren, who made a comment—you said that you thought that the uproar should be resolved. And I guess I would just ask you, how? Do you think we could do that without completely being dismissive of anyone that would ask such a question, in light of all of these e-mails? And how would you think it could be resolved with the best transparency and with the interests of the American people and our economy, certainly, at heart?

Mr. HOLDREN. Absolutely, I think it can be resolved. And I think it can be solved without name-calling and without being dismissive. Notwithstanding occasional exceptions, there is a long history of respectful and civil debate among scientists who have differing views on many of the details of virtually any issue.

In this particular case, one already sees a very substantial amount of activity of scientists who are going to be looking at these data, who are going to be looking to try to understand what the e-mails are really saying, who are going to reexamine the questions that were at issue then.

I think there is no question that this will happen whether or not this committee or any other holds a hearing on the subject. That is the way the science community works. When results are called into question, scientists flock to the scene, as it were, in order to figure out what was really going on there and what the best approximation to the truth we can get at at the current state of understanding is.

And that is current constantly changing. One needs to understand that, as new information becomes available, anybody who is a good scientist looks at the new information in the context of the old information and tries to develop a better picture of what is happening. I believe that that will happen here.

Ms. LUBCHENCO. Congresswoman, may I offer a comment?

Mrs. MILLER. Certainly.

Ms. LUBCHENCO. Could I draw your attention to page 6 of this document? There is a figure here that I think addresses the very important question that you asked earlier. And that is, what is the human contribution to global climate change, and how do we know if humans are having an influence?

You are absolutely correct that climate has changed a lot in the past. We have good evidence of that. We have been able to model those changes and understand more through time about what the natural changes are and what factors are influencing them.

This particular figure shows what the climate would be doing without the additional carbon dioxide that humans have put into

the atmosphere, along with other greenhouse gases. And that is what is shown in this blue—the dark blue band. This is 1900 to 2000.

Mrs. MILLER. If I could, I know my time has expired. Let me just ask you, does that graph take into consideration what is happening in Indonesia? And do you consider what is happening in Indonesia man-induced?

Ms. LUBCHENCO. There are many sources of carbon dioxide, some of which are natural and some of which are a result of changes in land-use practices, so they are affected by human activities, as well as burning of fossil fuels.

And these kinds of analyses take into account our current understanding of the sum total of emissions from multiple sources. And they tease apart what is the human contribution from what would be happening naturally. And there is clear evidence that what is happening now is strongly influenced by human activities.

Mrs. MILLER. I am not sure if that was a yes or no, but my time has completed. Thank you very much.

The CHAIRMAN. The gentlelady's time has expired.

The gentleman from Oklahoma, Mr. Sullivan.

Mr. SULLIVAN. Thank, Mr. Chairman.

And thank you both for being here.

I was going to ask first about the e-mails too. Do you think the scandal—and there seems to be a culture of corruption in the scientific community right now on these e-mails and manipulation of data, for a purpose to get their own results, do you see that as a problem, yes or no?

Ms. LUBCHENCO. Congressman, I don't believe that the exchanges that you saw are typical of the broader scientific community.

Mr. HOLDREN. I would add that I, too, do not believe that these e-mails are remotely sufficient to demonstrate a culture of corruption in the scientific community. They are e-mails from a relatively few people involved in a particular controversy that was attended by a good deal of frustration and anger. And as to exactly what went on in the way of manipulation of data, I think that remains to be seen.

To the extent that there was manipulation of data that was not scientifically legitimate—and I emphasize that scientists manipulate data all the time in order to make them comprehensible and consistent. But if there was manipulation of data that was not scientifically legitimate, yes, I regard that as a problem, and I would denounce it.

And I think, again, that the merit of the scientific system is that, over time, it tends successfully to unearth those kinds of instances, to unmask them, and to correct them. That is what I assume will happen here.

Mr. SULLIVAN. Well, since we do now know that some people are manipulating data and are trying to pervert the system for this final analysis, do you both support an independent investigation into this?

Mr. HOLDREN. I am not sure an independent investigation, if you mean by the Congress of the United States, is the right way to get at scientific truth. I think the scientific community has well-estab-

lished mechanisms for doing that, and I believe they have already been set in motion by these disclosures.

We will find out what went on there. It is not clear, at this point—I haven't read all the e-mails either. It is not clear, at this point, what some of them mean. I would point out, for example, that the term "trick" is often used in science to describe a clever way to get around a difficulty that is perfectly legitimate. The use of the word "trick" does not, in itself, in science demonstrate that there was manipulation.

I think we need to hear all sides of the story before we decide what happened there. If it turns out there was improper manipulation, again, I would denounce it, and I would be grateful that the scientific process had run its course and disclosed it. If this committee or others want to have hearings that end up calling as witnesses people, scientists who are involved in trying to sort that out, I think, of course, that is fine.

Mr. SULLIVAN. Now, both of you are scientists. What is the—we were talking about manmade and natural causes of CO_2. If you could just, really quickly, simply break down how much is manmade and how much is natural, percentage-wise?

Mr. HOLDREN. Well, first of all, what you need to understand is the natural flows of carbon dioxide in and out of the atmosphere—out of the atmosphere by photosynthesis and by absorption in the oceans, back into the atmosphere from outgassing from the oceans and by the decomposition or combustion of organic matter—have largely been in balance for a long time.

They are currently in the range of something like seven or eight times the human input. But the problem is that the natural input and uptake has been in balance and the human input has driven the system out of balance and is leading to an accumulation of additional carbon dioxide in the atmosphere.

This is extremely well-understood scientifically. Nobody disputes this particular point in science.

Mr. SULLIVAN. But it is at least seven or eight times greater than the manmade cause.

Mr. HOLDREN. Yes, but it is in balance. It is in and out. And so, the fact that the flows are greater——

Mr. SULLIVAN. Here is one on these sea creatures and everything. It says that the ocean absorbs approximately 25 percent of the CO_2 to the atmosphere from human activity each year. So if seven or eight times more is naturally caused, if you eliminate the human beings from the Earth and all human activity, would ocean acidification still occur? It wouldn't?

Mr. HOLDREN. It would for the time required to take the excess out of the atmosphere that has accumulated there. In other words, the oceans are not yet in equilibrium with what we have done to the atmosphere, but they will get there.

Ms. LUBCHENCO. Congressman, I think what you are asking is, if humans were not putting more carbon dioxide into the atmosphere, wouldn't the oceans already be absorbing some? And the answer is yes, but they would also be using some of the carbon dioxide, and it would be in balance.

What is different now is that humans have contributed now about 30 percent of the carbon dioxide that is in the atmosphere.

And some of that has been taken up by oceans, making them more acidic.

Mr. SULLIVAN. But isn't one of the ocean one of the biggest emitters?

Ms. LUBCHENCO. The oceans and the land both release CO_2 and take it up. And that process has been in balance over millennia, and that continues. What is happening is that humans are adding more to the atmosphere and more to the oceans. So the total amount of CO_2, it is being redistributed because of our activities.

Mr. SULLIVAN. So if 97, 96 percent of the emissions are natural and 4 percent are manmade, we have a responsibility for that 4 percent. But even if we eliminated it, isn't it a little arrogant to think that we could manipulate the entire process?

Ms. LUBCHENCO. We have manipulated the entire process. I think that is the point.

Mr. SULLIVAN. Oh, I know you have, on the numbers and stuff.

Ms. LUBCHENCO. So human activities have——

Mr. SULLIVAN. You have said that you guys can make any data—I know that. I see it in my opponents with polling data. I know how that works. But——

Ms. LUBCHENCO. These are not data that somebody has pulled out of the air or out of their heads. They are measurements.

Mr. SULLIVAN. You also have said that fish have moved to warm spots, and they are moving—it is in the Atlantic. You said the fish are moving?

Ms. LUBCHENCO. Yes, sir.

Mr. SULLIVAN. Okay. Don't they always move to a warmer spot?

Ms. LUBCHENCO. What is changing in the oceans is where it is warm.

Mr. SULLIVAN. But doesn't that—it does change. I mean——

Ms. LUBCHENCO. Many fish move. Most fish and many other species stay in the type of water in which their physiological performance is the best.

What we are seeing now is that, because oceans are warming overall, the places—if you look at a place on the coastline, for example, in California, the places that used to be a certain temperature are now warmer. And so, species that used to live there are moving northward to stay in the temperature zone that they would have been in previously. So species are moving in response to the changing distribution of heat in the ocean.

Mr. SULLIVAN. And, Doctor, you said in your testimony, or you stated before that sea levels——

The CHAIRMAN. The gentleman's time has expired——

Mr. SULLIVAN. Thank you, Mr. Chairman.

The CHAIRMAN. You can complete your question, if you would like.

Mr. SULLIVAN. Oh. At sea levels, with the data you have interpreted, will rise 11 feet by the year——

Mr. HOLDREN. No, I did not say that. I said that was a possible outcome, an upper limit on the amount of sea-level rise based on understanding of the processes that was available at the time.

It is now considered that the upper limit on sea-level rise in this century is about two meters or a little over six feet. And that is what I now say because that is what the current science says.

The CHAIRMAN. The gentleman's time has expired.

Six feet does sound like a very large increase in the water levels of the planet.

The gentlelady from Tennessee, Mrs. Blackburn.

Mrs. BLACKBURN. Thank you, Mr. Chairman.

And I want to thank each of you for submitting your testimony in advance.

We have had multiple hearings this morning for the Energy and Commerce Committee, so I have been upstairs in a mammogram hearing over the controversy that came there.

And I do have a statement, Mr. Chairman, that I will submit for the record.

The CHAIRMAN. Without objection, it will be included.

[The statement of Mrs. Blackburn follows:]

Opening Statement for Congresswoman Blackburn
"The Administration's View on the State of Climate Science"
Select Committee on Energy Independence and Global Warming
December 2, 2009

Mr. Chairman:

I want to thank you for holding this hearing, and I want to thank the witnesses for coming to testify before this committee.

The main point I want to discuss is the reliability of the data for climate change research.

A few years ago, the Energy and Commerce Committee examined one of the main "poster boys" of global warming evidence, the infamous Hockey Stick Graph.

Hearings on the issue revealed that data used for the graph had not undergone appropriate statistical analysis and the graph contained serious shortcomings in methodology and in the peer-review process.

Now, recently uncovered emails between the author of the hockey stick, Dr. Mann, and other scientists reveal their attempts to manipulate data to show that global warming is a unique and dramatic change in the 20th century.

These emails also highlight the real problem in the climate change science controversy: full and open honest debate on the science.

Mr. Chairman,

Many scientists have serious doubts about predictions of drastic global warming and climatic responses.

And often their contributions to peer-reviewed journals were declined simply because they did not conform to the current scientific consensus on global warming.

And now we have evidence that efforts were made to silence those who had data contradicting global warming theories and intentional actions by scientists to hide the data they used to advance their global warming agenda.

I look forward to Dr. Holdren's explanation of his emails included in this controversy and his opinion on the use of data from the Climate Research Unit.

I yield the balance of my time.

Mrs. BLACKBURN. And since I didn't give that, I will just take all of my time in questions. How is that?

But, Dr. Holdren, I wanted to talk with you. I was delighted that you were here. Some of the e-mails that have come out recently from CRU indicate some animosity, I guess would be the best way to describe it, in research for the medieval warm period, the research by Dr. Soon.

And I wanted to see if you would elaborate on your intentions in those e-mails.

Mr. HOLDREN. The great bulk of scientists who have looked at these questions concluded a long time ago that the medieval warm period was a regional phenomenon and not a global phenomenon.

The arguments by Soon and Baliunas, to the contrary, fared very badly in the scientific community, in terms of the rigor and validity of their arguments. And that is the reason that they were often disparaged in discussions of this matter, in particular because they continued to espouse the view that the medieval warming period was a global phenomenon long after evidence to the contrary became persuasive to everyone else.

One of the characteristics one expects of scientists is to change their mind when data and analysis show that they were wrong the first time. I changed my mind about the maximum sea level possible in the 21st century when the analysis and the data changed. And that is what we expect from others. When that doesn't happen, a degree of frustration and anger often materializes because of a concern that people are simply muddying the water by repeating discredited hypotheses.

Mrs. BLACKBURN. Okay. Well, let's apply that statement, then, looking at the climate change data that has been lost. And do you think that the climate change data has been compromised since there was original data lost by CRU?

Mr. HOLDREN. Yeah, I think that is unfortunate. Whenever any original data are lost, that is a misfortune. It is unfortunate that it happened. I wish it had been prevented.

I think the robustness of all of the data sets we have available to us is sufficient to survive that loss, but I do regret the loss.

Mrs. BLACKBURN. Well, if further review on all of this shows that the IPCC report in 2007 used corrupted or tainted data, what do you think they ought to do about it? Should they be willing to go back and say, "You know, we are going to have to change our mind on this because we used corrupted data or we didn't give the whole picture or science; if you look at the whole thing, it proves us wrong"?

Mr. HOLDREN. To the extent that it is shown that data were corrupted and influenced conclusions of the IPCC, of course those conclusions should be revised. And the IPCC, in every successive report that it produces, which is roughly every 5 years, revises a whole variety of conclusions it reached in the previous assessment because new information has become available.

It is, of course, unfortunate if the new information that becomes available is that data that were previously used were corrupted. But, in terms of the outcome, the revision of the findings based on new information is the same. Scientists do that all the time. The IPCC does it, and they will do it. If it is determined that any con-

clusion of the IPCC was based on data that were corrupted, you can be sure that those conclusions will be revised in the next assessment.

Mrs. BLACKBURN. We have done some hearings, I think it was in 2005, we did some hearings in the Energy and Commerce Committee on the hockey-stick theory and Dr. Mann's hockey-stick theory. And I know Dr. Wegmann and the National Academy of Sciences have made comments that Dr. Mann didn't use proper statistical methods in his research on that. What is your opinion there?

Mr. HOLDREN. I think there is reason to believe that some of the statistical methods that Dr. Mann used were not the best for the purpose. The Academy pointed that out. And it, nonetheless, concluded that his basic finding that the last 50 years were the warmest half-century in the last 1 to 2,000 years was nonetheless robust.

And, again, I would point out that arguments about what are the best statistical techniques to use are pervasive in the scientific community. And it is no surprise that one has a difference of opinion. It is no surprise that a scientist may have made a mistake in the method chosen to analyze a particular data set. Again, the key thing about science is not that scientists are always right; it is that they fix their mistakes over time.

Mrs. BLACKBURN. Well, let me ask you this. I know that some of the scientists who have come before us and they advocate limiting greenhouse gas emissions also have stated they think that maybe the global temperatures have stopped rising over the past 10 years even though the greenhouse gas emissions have increased.

So how do you go about explaining that discrepancy, when you look at what is natural, what is manmade, what is cyclical, how do you explain that?

Mr. HOLDREN. Well, first of all, I think, Congresswoman, before you came in, Dr. Lubchenco explained a diagram that is on the board that actually addresses that question.

And the key point is that the climate and the surface temperature of the Earth fluctuates all the time for a wide variety of reasons, most of them natural. What we are seeing is superimposed on those natural fluctuations a long-term trend of increasing global average surface temperature of the magnitude and of the sort expected to result, according to both theory and models, from the increases in carbon dioxide and other heat-trapping substances that humans have imposed on the atmosphere.

If you look at the actual temperature data—and I have in front of me the NOAA data set for the global average surface temperatures through 2008—what you see is that 9 of the 10 warmest years in the 140-year thermometer record, the period of time since 1880 when we have had enough thermometer measurements around the land and the ocean to meaningfully define a global average surface temperature, 9 of the 10 warmest years in that period occurred since 1998. 1998 itself was the second warmest year in the record; 2005 was the first warmest. All 15 of the warmest years in the 140-year record occurred since 1990.

You look at the numbers, you do see a bump, as you see up there on the screen in the far right, where, in the last few years, there is no discernible upward trend. But this is completely consistent

with having natural fluctuations, natural ups and downs superimposed on a long-term warming trend associated with greenhouse gases.

The CHAIRMAN. The gentlelady's time has expired.

Mrs. BLACKBURN. Mr. Chairman, can I ask one other part on the question?

The CHAIRMAN. We will have a second round. The gentlewoman went 8 minutes on the—8 minutes and 15 seconds.

Mrs. BLACKBURN. Thank you, Mr. Chairman.

The CHAIRMAN. The Chair recognizes the gentleman from Washington State.

Mr. INSLEE. Dr. Holdren, you have testified several times, listening to you, that, given the extensive review by the National Academy of Science and using information based from NOAA, NASA, and a whole host of other data sets, that there is no reason to revise their fundamental conclusion that humans are contributing to changing climate, and NOAA not to change a fundamental conclusion that the oceans are becoming more acidic.

Mr. Sensenbrenner suggested that there is some scientific fascism, and that is a quote. Is there any evidence of fascism in the NOAA organization, of scientific fascism associated with this?

Mr. HOLDREN. I am not even sure exactly what that term would mean, but I don't—I am not aware of any cabals, conspiracies, misbehavior in the characterization and use of data in NASA or NOAA.

Mr. INSLEE. Well, I tell you, it is troublesome to me the people who put the men on the moon, the people who discovered water on the moon, the people who are doing great research figuring out how the oceans are becoming acidic, some of whom are my constituents, it is disturbing to me that people would come to this chamber and call them fascists. I have to tell you, I have a problem with that. I don't think that is right.

These men and women are doing the best they can to provide us data and conclusions to the best of their ability. And they, through their professional work, have reached a very, very strong consensus on these scientific issues, who are working for Uncle Sam. And I think that is wrong to say that about them.

And there is a little emotion in my voice because I have seen in my neighborhood what this phenomenon is doing. I would like to be able to catch salmon, and my grandkid—who celebrated his first birthday Sunday—to catch salmon that live on pteropods maybe 50 or 60 years from now. And when people watch what I watched and say that this is just a big scientific fascist conspiracy that are ginning this stuff up, I have a problem with that.

I will just ask you, Dr. Lubchenco, I was at a pier in Seattle about 6 months ago when a NOAA ship docked. And it had a bunch of NOAA scientists on it who were investigating the rate of acidification off the Pacific coast.

And when they were explaining to me their findings, their jaws were kind of agape, because what they told me is that the rate of acidification was stunning to them, particularly in the shallow waters off our Pacific coast. They explained to me, as I understand this correctly, the waters are more acidic the lower in the water

column they have been, but now very acidic levels are becoming very close, within 150, 200 feet of the surface.

And this was shocking to them. And the only explanation they had was that CO_2 was going into the atmosphere and disturbing the equilibrium of this process. It has been going on for eons.

Could you tell us about what your information is about that?

Ms. LUBCHENCO. Mr. Congressman, I think the rate of change in ocean acidification has surprised many people.

And it is absolutely the case that off the west coast of the United States, where winds blow along the coastline and push the surface waters away from the coast, which pulls up cold, nutrient-rich, low-oxygen, and lower-pH water to the surface, that that is where we are seeing some of the greatest increases in acidity happening around the world.

And it is of deep concern because those areas, as you well know, are historically very, very rich. Our wonderful productive fisheries off that area are, in large part, a consequence of this upwelling.

Mr. INSLEE. I appreciate that.

I want to ask, is there anybody in this room, including the two witnesses and my Republican colleagues and my Democratic colleague, is there anybody in this room who has information to suggest that the oceans are not becoming more acidic? Has anybody got information like that? Anybody?

Has anybody got an explanation why the oceans are becoming more acidic, other than the fact that there is massive amounts of carbon dioxide going into the atmosphere? Has anybody got an explanation for that?

I haven't heard any, and yet people are trying to gin up this controversy because—you know why? It is not because they are not intelligent. It is because they are afraid that we can't solve this problem. And I think if we had a little more confidence in ourselves and our ability to solve this problem, we would open our minds to the scientific information that is becoming available to us.

And this idea of equilibrium—I will just try one more—I don't know why it is so hard for people to understand the idea of equilibrium. To me, it is like this. Is this a fair metaphor? A guy goes to a doctor. He says to the doctor, "I gained 10 pounds." "Well, have you changed your behavior at all?" "Yes. I have started eating a huge banana split at lunch and dinner every single day." And he goes, "Well, it is obvious. You have been eating more food." And he goes, "No, no, it's not the banana split. Look at all the other food I have eaten. It is the other stuff. That is 85 percent of my caloric intake."

That is 85 percent of the CO_2 that is going into the atmosphere. Don't look at the banana split, don't look at the coal-fired plants, don't look at the cars. Is that kind of a metaphor for what we are facing here?

Mr. HOLDREN. Not bad.

Mr. INSLEE. Not bad, huh, for an amateur.

Thank you very much.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes the gentleman from Wisconsin.

Mr. SENSENBRENNER. Well, thank you very much, Mr. Chairman.

I do appreciate Mr. Inslee's metaphor. But let me say that the controversy over the leaked e-mails and their contents cannot be ignored, because it goes to the very basis upon which this debate has gone on for the last several years. And I see an awful lot of attempts by people in this room to shove that concern under the rug. I am telling you now, it will get worse rather than getting better.

And I will define what I mean by "scientific fascism." These e-mails trash the scientific conclusions by those who have disputed Dr. Mann's hockey-stick theory. There are information in the e-mails that the publication, Climate Research, in which they were published, ought to be boycotted because they weren't doing the politically correct thing. And I understand that the editor of Climate Research ended up getting fired as a result.

Now, there is intimidation in the scientific community by people who wish to be contrary to what the conventional wisdom is. And we are being asked as a Congress to make major changes in American society in energy use and on how much the out-of-pocket cost is to every person in this country as a result of this debate.

And we in Congress better get it right. The scientists may be able to change their story and do more research on it, but, once Congress passes a law, it will be as difficult to repeal the consequences of that law as putting milk back into the cow.

We know all about cows in Wisconsin. Now, the denial has not stopped, because 6 weeks ago, on October 27th, Michael Mann wrote an e-mail that says in part, as we all know, this isn't about truth at all; it is about plausibly deniable accusations. We need to know the truth here before we can legislate in the name of the American people.

Now, Dr. Holdren, given the fact that you were involved in the e-mail traffic that has been released from the University of East Anglia in England and the discrediting of the Soon, and I am mispronouncing, Baliunas, study on the hockey stick theory, and it has been considerably discredited, how can you be objective on this when you are testifying before Congress, advising the President, and speaking to the American public?

Mr. HOLDREN. First of all, Congressman Sensenbrenner, let me say that science is rough. Scientists are brutal in criticism. Anybody who has ever taken a doctoral exam in natural science understands that very well. So there is nothing unusual about strong language in criticizing results of others that one has concluded are deeply wrong.

Mr. SENSENBRENNER. But you are defending the results of others that have since been proven right.

Mr. HOLDREN. Let me finish answering the question——

Mr. SENSENBRENNER. How can you be objective?

Mr. HOLDREN [continuing]. If I may. We are all, when we testify, doing so on the basis of the best information available to us at the time as scientists. The notion that one cannot be objective because one has concluded that a particular study by particular people was deeply flawed, and that was my conclusion from reading the study by Soon and Baliunas, that it was deeply flawed, and that has been the conclusion of the great bulk of the rest of the community, that being so, I cannot be expected to be unbiased as to the merit of

that particular study. I am biased by study. I am biased by having read it, studied it, and understood what is wrong with it.

Mr. SENSENBRENNER. And I respect your opinion on that. But it seems to me that other people ought to look into this.

Now, I want to ask you a question that you can answer yes or no. You are the science adviser to the President. And I would like to ask you to guarantee Congress that you will provide the public, including us, access to all documents prepared with government funding relating to science change. And that includes studies that the IPCC has either gotten or utilized, so that nobody can wiggle out of this by saying that the IPCC is exempt from this because they are an international body. Will you give us that information and then allow the public, including other scientists, to be able to see it? After all, the taxpayers have paid for it.

Mr. HOLDREN. I am not sure what all you are asking, Congressman, but I am absolutely in support of the public and the taxpayers having access to the results of research that they paid for. The only constraints on that are research classified for national security reasons or research that is incomplete. It is a problem where people insist on the release of data that scientists have not yet even finished assembling, because this leads to interpretations immediately on the basis of an incomplete picture.

But once research is complete and is published in the peer-reviewed literature, or is submitted as a report for use by government policymakers, I do believe that all of the data behind that, all of the methods, all of the analysis should be made available to the Congress, the public, the taxpayers, yes.

Mr. SENSENBRENNER. You will be getting a few letters from us to that effect.

The CHAIRMAN. The gentleman's time has expired.

Let me put up two charts here. The first chart is just a chart reflecting what Dr. Lubchenco and you, Dr. Holdren, have referred to, which is this dramatic spike which has been created in the amount of CO_2 in the atmosphere. This seems to be an incontrovertible fact. No one actually denies this. It is measurable. And it correlates almost directly with the industrialization of not only our country, but Europe and increasingly in China and India, as the amount of CO_2 emitted globally has increased. And in fact, in 2009 the trend is that this will be a warmer year than last year was. And so the spike is going back up again, if all data up until the end of November continues on for the concluding month of this year. So we can see this trend. And it has gone unabated since the rise of the industrial era.

Now I will show you another chart. This is a chart of the number of 40 home run hitters in Major League Baseball from 1920 until today. Now, the average was 3.3 players were averaging over 40 home runs per year, from 1920 until the 1990s, which is why Ted Williams and Willie Mays and Babe Ruth were so famous that they could hit more than 40 home runs. Then, all of a sudden in the 1990s, there was a huge spike in the number of people hitting more than 40 home runs. Now Major League Baseball said, well, you know, perhaps the players are getting stronger. Others said, well, perhaps the baseballs are juiced.

But once a steroid testing program was put in place over the last 3 years, an amazing thing has happened. There was a precipitous drop in the number of 40 homerun hitters back to normal levels. An artificial substance injected into players, a huge increase in the number of home runs. But once it was removed, we went back to normal levels again. Now, some people of course are arguing that the new normal was people hitting more than 60 home runs and 70 home runs. Huh? Well, it turns out that the testing program brought it down dramatically once we dealt with the reality of the science of what was going on in baseball.

Well, here we have the same trend, but we have yet to inject the solution, that is the reduction in the amount of CO_2 being emitted by the United States, by Europe, and by other parts of the world. That is our challenge. It is incontrovertible. Artificial substance put into man or nature causes big differences. And so these spikes are very, very coincidental, huh?

Now, there were deniers in Major League Baseball. They said, oh, no, steroids has nothing do with it. And by the way, Major League Baseball wanted to go along with it in the same way that the coal industry, the oil industry, other fossil fuel industries want to go along with the myth that nothing really abnormal is happening. But the consensus of the science in the world, the National Academy of Sciences of every country in the world is that this spike in CO_2 is manmade and that it is causing dramatic changes in our oceans, to our glaciers, in the Arctic, in the villages of Alaska that see their permafrost melting and their villages falling into the ocean, and droughts being created around the world. And all of this evidence is basically so massive that there is no way to avoid it.

And so what the minority has decided to do, what the deniers, what the oil and coal industry want to do is to use the few e-mails of a few people who are doubting this science, which is a consensus around the country, as a way of trying to cast doubt, the same way Major League Baseball did, on the undeniable correlation between the injection of these artificial sources into the atmosphere are having on our planet.

And so, you know, we can continue this pretense and we can use a small number of e-mails, I suppose, to have a larger debate. But I think that it would be better for us to accept the science, to accept this curve, to basically deal with the reality that the minority has no answer for why it has spiked so dramatically, why it is going back up again this year. They sit over here using a couple of e-mails as a reason why we should stop all efforts to deal with this catastrophic threat to our planet. And so since no alternative theory has been presented—at least baseball said, well, the players are getting stronger, huh, that was their answer, but everyone who was looking at it was saying, how can they be so much stronger than the players just 5 years ago? Well, that is the same thing that is happening with this CO_2 trend. Okay? There is no explanation for it, other than that it is manmade.

And by the way, you can say, well, it is not that big. What is the difference? A degree or two. Well, a kid has a temperature of 98.6 normally. Well, you add a couple of degrees temperature to that child, and they are at 100.6. The doctor says, well, you have been at that new normal for 14 days now, so don't worry about it,

ma'am, your son Joey, he is going to be fine. The new normal is 100.6. Well, who would ever accept that as an answer because it was only a 2-degree change in the child ?

Well, that is what we have got here for the planet. A 2-degree change in the overall temperature of our planet is just as catastrophic as it would be for a small child who had received no medical attention because the doctor had concluded, or a small number of doctors would say the child can live with the new normal of 2 degrees higher. What parent would ever run that risk of not giving treatment to that child? And that is what we are talking about here.

Yes, there is a normal temperature for the planet. But you add on 2 more degrees, 3 more degrees, it is catastrophic. You get the consensus, as Dr. Holdren is saying, that there is a 6-foot rise in the sea level of our planet; that is not frightening enough for the other side. They want to know why it is not 11 feet anymore. Well, 6 feet has such catastrophic consequences for Alaska, for the Everglades, for Boston, for Cape Cod, for Southern California, that it is almost unimaginable what changes would have to take place in our country. Okay?

So what is the answer? Again, we keep saying, what are you saying is the answer to why this is spiking so dramatically? Where is your evidence? Just by casting doubt with a few e-mails on a consensus globally and a century-wide study of this subject——

Mr. SENSENBRENNER. Would the gentleman yield?

The CHAIRMAN. No, I will not yield at this time—is not going to deal with this issue. Okay? These scientists are our best people in our country. And they are joined by thousands of others, not only here but across the world, in their construction of their analysis. There is no alternative theory that the minority is proposing other than that which we know has been funded by the oil and coal and other industries that want to continue business as usual.

Now, we have tried to construct in the Waxman-Markey bill an alternative way in which these issues could be dealt with. And they of course don't want to deal with that issue because they would prefer their denial.

What I am going to say to you, Dr. Holdren, if you could, is I would like you to go through the other points that you would like to make in response to the questions that were raised by Mr. Sensenbrenner in his opening question of you.

Mr. SENSENBRENNER. You are a little bit over.

The CHAIRMAN. Which I have allowed all of the minority members to do so. And it is the courtesy I have extended to each minority member, I am going to extend to myself.

Dr. Holdren.

Mr. HOLDREN. Well, thank you, Mr. Chairman. I think actually we have gone through the main points in the further discussion of sea level rise. And I wouldn't have anything further I feel I need to add.

The CHAIRMAN. Okay, thank you, Dr. Holdren, very much.

Mr. Sullivan, do you have any additional questions?

Mr. SULLIVAN. No, I don't.

The CHAIRMAN. You do not. Okay. Well, then I will allow any written questions that would be posed to the witnesses to be made by members who were not here.

We thank our two witnesses for their testimony here today. It is extremely valuable at this time in our planet's history for the two of you to be working for our country and for the world. It is an honor for us to have you here today. We thank you for your distinguished service.

With that, this hearing is—the gentle—Dr. Lubchenco, would you like to be recognized?

Ms. LUBCHENCO. The gentle doctor? Mr. Chairman, thank you very much for this opportunity. I especially appreciate the extra time to do this demonstration. And I might draw everyone's attention to sort of the final results of the status of the chalk in the three different solutions just to bring the message back.

The CHAIRMAN. Would you summarize the status in the three jars?

Ms. LUBCHENCO. The chalk that is in the water only has not changed at all. The chalk that is in the half water-half vinegar is dissolving. And the chalk that is in the total vinegar has dissolved quite substantially, and will continue to do so.

The CHAIRMAN. We thank the expert testimony that we received today. Again, there is a part of us that really needs to go back to sophomore and junior year in high school so we can get a briefing once again on the essential science that affects our planet. We thank you for everything that you have done here today. With that, this hearing——

Mr. HOLDREN. And we thank you, Mr. Chairman, and we thank the committee.

The CHAIRMAN. We thank you. This hearing is adjourned.

[Whereupon, at 12:15 p.m., the committee was adjourned.]

THE SELECT COMMITTEE ON
ENERGY INDEPENDENCE AND GLOBAL WARMING

December 23, 2009

Dear Dr. John Holdren:
Following your appearance in front of the Select Committee on Energy Independence and Global Warming, members of the committee submitted additional questions for your attention. I have attached the document with those questions to this email. Please respond at your earliest convenience, or within 3 weeks. Responses may be submitted in electronic form, at aliya.brodsky@mail.house.gov. Please call with any questions or concerns.

Thank you,
Ali Brodsky

Ali Brodsky,Chief Clerk
Select Committee on Energy Independence and Global Warming
(202)225-4012; Aliya.Brodsky@mail.house.gov

1) *Given that EPA's Endangerment Finding is largely based on the IPCC's finding and those findings were based on data that is now subject to questions of scientific integrity, do you believe that EPA should have delayed its Endangerment Finding?*
   - *Should EPA regulate while significant questions of scientific integrity are outstanding?*

Before finalizing its endangerment finding last month, EPA considered the East Anglia CRU e-mails and appropriately concluded that they do not alter the core findings of climate science underpinning its endangerment finding. EPA discussed these issues in its response to comments, which can be found at http://www.epa.gov/climatechange/endangerment.html. See also http://www.epa.gov/climatechange/endangerment/downloads/RTC%20Volume%2011.pdf .
This conclusion was echoed by twenty-five prominent U.S. scientists in a recent letter to Congress: "The body of evidence that human activity is the dominant cause of global warming is overwhelming. The content of the stolen emails has no impact whatsoever on our overall understanding that human activity is driving dangerous levels of global warming." (See http://www.ucsusa.org/assets/documents/global_warming/scientists-statement-on.pdf .)

It can be added that reviews of climate-change science by other qualified bodies, such as expert committees of the U.S. National Academy of Sciences and the national science academies of other countries, have reached substantially the same conclusions about climate change as the IPCC has reached: namely, that the global climate is now changing in ways that are unusual in comparison to natural variations; that emissions of heat-trapping pollutants from human activities are largely responsible for these unusual changes; that the changes are already doing harm to human health, property, and ecosystems; and that much larger harm is likely to ensue if the offending emissions are not greatly reduced.

2) *On March 19 of this year, Ben Santer wrote that, "If the RMS is going to require authors to make ALL data available - raw data PLUS results from all intermediate calculations - I will not submit any further papers to RMS journals."*
   - *Do you believe that raw data supporting journal articles should be available? Isn't the availability of data an important element of transparency?*
   - *Would you support legislation that required journals publishing federally-funded research to make their raw data available to the public?*

On his first full day in office, President Obama issued the Memorandum on Transparency and Open Government, deeming government information a "national asset" and calling for greater transparency, participation, and collaboration in government. These principles apply to scientific information gathered by or on behalf of the federal government. Accordingly, the March 2009 Executive Order on Scientific Integrity directed that "[e]xcept for information that is properly restricted from disclosure . . . each agency should make available to the public the scientific or technological findings or conclusions considered or relied on in policy decisions."

The Open Government Directive recently issued by the Office of Management and Budget implements these Presidential directives. First, it directs that "with respect to information, the presumption shall be in favor of openness to the extent permitted by law and subject to valid privacy, confidentiality, security, or other restrictions." Second, it directs each agency to create a strategic plan for transparency that "identifies high value information not yet available and establishes a reasonable timeline for publication online in open formats with specific target dates." Data.gov currently has more than 114,000 data sets in its catalogs, and the majority of these are geosciences-related data which are relevant to climate research.

I believe that the goal of increasing access to data produced with Federal support can be achieved without new legislation. In fact, several agencies have already taken the initiative to put data-sharing policies into practice. For example, the NIH requires that any applicants for grants over $500,000 to include data-sharing proposals in their applications; DOE and NSF explicitly state that they expects investigators to share data with other scientists; and the NOAA has stated its commitment to making all raw physical climate data available in as timely a manner as possible.

In January 2009, the National Science and Technology Council released the report "Harnessing the Power of Digital Data for Science and Society." An explicit goal in this report is to maximize digital scientific data access and utility. Two recommendations in this report are key to realizing this goal. First, the report recommends that all Federal agencies develop and publish policies for data preservation and access. Second, proposals and projects that will generate scientific data should include a data-management plan that describes provisions for protection, access, and preservation.

Leading journals (e.g., *Science*) that publish earth and climate science articles have policies that already strongly mandate data access and sharing. All data necessary to understand, assess, and extend the conclusions of a manuscript submitted to *Science* must be available to any reader of *Science*. After publication, all reasonable requests for materials must be fulfilled. Science also supports the efforts of databases that aggregate published data for the use of the scientific community. For example, climate data, published in *Science*, should be archived in the NOAA climate repository or other accessible public databases.

3) *Do the newly released e-mails raise any concerns for you? Specifically, do they raise concerns about the integrity of the scientific process?*

While some of the e-mails may reveal poor judgment and careless formulations by their authors, there is no basis for doubting the core findings of climate change science. With respect to the scientific process, moreover, the fact is that the great majority of the data on which important conclusions in climate science rest have been made available, and the papers and arguments disparaged by some of the e-mail writers were considered by the IPCC and discussed and cited in its reports.

4) *Notwithstanding your skepticism and dismissal of the contents of the released e-mails, they have raised a great deal of concern and questions by scientists, policymakers and American taxpayers.*
   - *Before proceeding with any climate change legislation in Congress that establishes a cap-and-tax system - which is widely acknowledged to have a drastic economic impact on the lives of Americans - would you support an independent and exhaustive investigation into the e-mails?*
   - *Who do you recommend conduct this investigation and why?*

A number of independent and reputable groups of scientists and journalists have already studied the e-mails and have announced conclusions along the lines I have outlined here: some human frailties are on display in these e-mails, but nothing of a character that calls into question the methods or the conclusions of the IPCC and the climate-science community more broadly (see, e.g., http://www.factcheck.org/2009/12/climategate/, http://www.ucsusa.org/assets/documents/global_warming/scientists-statement-on.pdf, http://www.ametsoc.org/policy/climatechangeclarify.html, http://www.climatesciencewatch.org/index.php/csw/details/setting_the_record_straight_ap-factcheck/).

The principal scientific controversy to which most of these e-mails related, moreover, was exhaustively reviewed the U.S. National Academy of Sciences in a report released in 2006 (National Research Council, *Surface Temperature Reconstructions for the Last 2,000 Years*, National Academy Press, 2006, 156 pp), which concluded that the methods of analysis used by the "hockey stick" authors were scientifically respectable; that their key conclusion that the last 50 years have been the warmest in many centuries is likely to be correct; and that this conclusion is not, in any case, a major part of the evidence on which current scientific understanding of global climate change is based.

Given, then, that the e-mails do not call into question our fundamental scientific understanding of the climate challenge, I do not see a need for further investigation of the e-mails before Congress acts to address that challenge.

5) *In an August 2006 interview with BBC News, you said that if the current pace of change continued, a catastrophic sea level rise of 4 meters (13 feet) was within the realm of possibility. However, the IPCC's 2007 report projects that sea level rise between now and 2100 will range between 7 and 23 inches.*[1]
   - *Your projection of sea level rise was over 11 feet higher than even the worst case scenario projected by the IPCC. Do you now accept the IPCC's much lower projection?*

[1] (References: http://news.bbc.co.uk/2/hi/science/nature/5303574.stm ; http://www.iop.org/EJ/article/1748-9326/2/2/024002/erl7_2_024002.html).

- *If so, why do you think you were wrong? Are you at all concerned about misrepresentation of the state of the science with respect to global warming?*

The sea-level-rise projections cited here from the 2007 IPCC report were explicitly labeled in that report as incomplete, as they did not include any contributions that might be made to future sea-level rise by rapid loss of ice from the Greenland and Antarctic ice sheets. (The relevant column in the table summarizing sea-level rise figures is prominently labeled "Model-based range excluding future rapid dynamical changes in ice flow"; see, e.g., Table TS.6 in *Technical Summary, Report of Working Group I of the Intergovernmental Panel on Climate Change*, Intergovernmental Panel on Climate Change, 2007, p 70.) The text explains that these "dynamical changes" were not included because the published literature at the time provided insufficient basis for modeling such phenomena quantitatively. Most of the potential for rapid sea-level rise in the 21st century, however, resides precisely in these hard-to-model phenomena.

My comments to the BBC in 2006 were based on two scientific papers from 2005 that developed estimates of the possible rate of sea-level rise in the 21st century not by modeling of the physical phenomena involved but by study of paleoclimatological records bearing on how rapidly sea level increased in two periods of natural warming that occurred over the course of the last 20,000 years (R. Alley, P. Clark, P. Huybrechts, and I. Joughin, "Ice Sheet and Sea-Level Changes", *Science*, vol. 310, pp 456-460, 2005; J. Hansen, "A Slippery Slope: How Much Global Warming Constitutes 'Dangerous Anthropogenic Interference'?", *Climatic Change*, vol. 68, pp 269-279, 2005). These analyses concluded that rates of sea-level rise due to slippage and disintegration of the Greenland and Antarctic ice sheets – the "dynamical changes" the IPCC did not consider in their numerical estimates – in these two past periods of rapid warming ranged from 2 to 5 meters (6.6 to 16.5 feet) per century; and they concluded as well that rates of increase in this range cannot be ruled out for the 21st century under continuation of the rates of warming now being experienced. My comments for the BBC were based on dropping the extremes of this range and saying that 3 to 4 meters (9.9 to 13.2 feet) could not be ruled out.

Subsequent and more detailed analyses in the peer-reviewed scientific literature (see, e.g., S. Rahmstorf, "A Semi-Empirical Approach to Projecting Sea-Level Rise", *Science*, vol. 315, pp 365-370, 2007; W. Pfeffer, J. Harper, and S. O'Neel, "Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise", *Science*, vol. 321, pp 1340-1343, 2008; U.S. Climate Change Science Program, *Abrupt Climate Change*, U.S. Geological Survey, Reston, VA, 2008, 459 pp) have indicated that the upper limits of sea-level rise in the 21st century are more likely to be in the range of 1 to 2 meters (3.3 to 6.6 feet), and this is the range I have been quoting in my publications and presentations on climate change since these new analyses appeared.

6) *As science advisor to the Obama Administration, will you guarantee Congress that you will provide the public with access to all documents prepared with government funding relating to climate change?*

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. 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. On behalf of these agencies, the USGCRP maintains a U.S. Global Change Research Information Office (GCRIO) that provides open access to data, information, and all reports on climate change

research, adaptation/mitigation strategies and technologies, and global change-related educational materials. These reports are freely accessible on the USGCRP website at http://www.globalchange.gov .

The USGCRP's position on public access to data related to global change research is clear: the USGCRP requires complete and open sharing of the full suite of data sets; preservation and documentation of all data; and a clearinghouse process to prevent the purging and loss of important data sets. The USGCRP's guiding principle is that as soon as data might be useful to others, the data are released, along with their appropriate documentation.

7) *Can you assure the Committee that you won't support claims by some scientists that research obtained with taxpayers' dollars on climate change is not subject to disclosure because the IPCC is an "international body?"*

The Data Distribution Centre (DDC) of the IPCC provides access to data and model results used in IPCC analyses. The DDC is overseen by the IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis, currently co-chaired by scientists from the United States and Brazil, and jointly managed by the British Atmospheric Data Centre in the United Kingdom, the World Data Center for Climate in Germany, and the Center for International Earth Science Information Network at Columbia University in the United States. Data are provided to the DDC by these and other centers, including those of NOAA and NASA, as well as collected from the published literature. The DDC provides open web access to four types of data: observed climate data sets; global climate model data; socio-economic data and scenarios; and data and scenarios for other environmental changes. For example, anyone can go to the DDC site (http://www.ipcc-data.org/index.html) and directly download annual globally averaged temperature data from the year 1850 to 2009.

Although I would want to defer to the Department of State for an authoritative reading on legalities relating to data developed under international agreements, the situation with respect to IPCC data as just described would seem to take care of any concerns about the availability of data from the IPCC system.

8) *As the president's chief science advisor, will you support my efforts to make public all relevant data, codes and documentation regarding major temperature data at NASA and NOAA?*

As noted in my answer to question (2), above, the March 2009 Executive Order on Scientific Integrity directed that "[e]xcept for information that is properly restricted from disclosure . . . each agency should make available to the public the scientific or technological findings or conclusions considered or relied on in policy decisions"; and the subsequent Open Government Directive issued by OMB directs that "with respect to information, the presumption shall be in favor of openness to the extent permitted by law and subject to valid privacy, confidentiality, security, or other restrictions", as well as directing each agency to create a strategic plan for transparency that "identifies high value information not yet available and establishes a reasonable timeline for publication online in open formats with specific target dates." I fully support these goals and directives, as does the leadership of NASA and NOAA.

NASA and NOAA both already provide open access to their standard climate products as long as they are not classified, privileged, exempt, or otherwise protected under Federal law.

- NASA provides full and open sharing of Earth science data obtained from their Earth observing satellites, sub-orbital platforms, and field campaigns as soon as such data become available. There is no period of exclusive access to NASA Earth science data and, following a post-launch check-out period, all data are made available to the user community. This open access also applies to all of NASA-generated standard products, their source codes for algorithm software, coefficients, and ancillary data used to generate these products.

- At NOAA, all raw physical climate data available from their various climate observing systems and the output data from their climate models are openly available in as timely a manner as possible. The timeliness of such data depends on how quickly the data are received and the complexity of the associated quality-control procedures that ensure data are valid. The latest versions of all derived data sets are made available to the public. NOAA also provides access to all of its major climate-related model simulations.

Both NASA and NOAA are also participating in international and national groups whose goal is to increase the accessibility of data worldwide, such as the Global Earth Observation System of Systems, Global Climate Observing System, World Meteorological Organization, Intergovernmental Oceanographic Commission, and International Council of Science (ICSU). In 1958, ICSU created the World Data Center (WDC) for archiving and distributing data collected from the observational programs of the 1957-1958 International Geophysical Year. Originally established in the United States, the WDC system has since expanded to other countries and to new scientific disciplines, including the climate sciences. The WDC now comprises 50 centers in 12 countries. NOAA hosts five WDC centers and NASA hosts one. Also, to better help scientific users and the public access data more readily, NOAA recently established the Global Observing Systems Information Center (GOSIC). GOSIC (see http://gosic.org) provides access to international climate-related datasets as easily and readily as possible.

9) In an October 13, 2003 email, you defend Dr. Michael Mann's hockey stick theory and aggressively attack Dr. Willie Soon and Dr. Sallie Baliunas for questioning his work.

- *Do you stand by this criticism now that the "hockey stick theory" has been discredited?*
- *Why did you so aggressively attack Drs. Soon and Baliunas?*
- *Do you still support Dr. Mann in light of the recently disclosed emails, knowing of his efforts to hide his data and encourage his colleagues to shut out journals like Climate Research for publishing works contrary to his bias?*

The "hockey stick theory" has not been discredited. To the contrary, the exhaustive review of this issue released in 2006 by the U.S. National Academy of Sciences (cited above in my answer to question 4) provided authoritative support for the basic approach and core findings of the "hockey stick" authors. I criticized Soon and Baliunas not because they were questioning Mann's work but because the analyses they provided in support of their position were deeply and obviously flawed. I based that judgment on having studied in detail their papers and those of Mann *et al.* myself.

My judgment was shared, as it turned out, by a great many fellow scientists who also took the trouble to read these papers, including the authors of the 2006 National Academy of Sciences review; the members of IPCC's Working Group I (on the science of climate change) who considered the Soon-Baliunas analysis but found it unconvincing; and the editor-in-chief

and half of the editorial board of the journal *Climate Research*, who resigned in embarrassment over that journal's having published a paper as obviously flawed as that of Soon and Baliunas.

10) During the hearing, you testified that, "I would point out, for example, that the term 'trick' is often used in science to describe a clever way to get around a difficulty that is perfectly legitimate. The use of the word 'trick' does not, in itself, in science demonstrate that there was manipulation."

- *In the email exchange, the word 'trick' is not used on its own. Dr. Phil Jones wrote: "I've just completed Mike's Nature trick of adding in the real temps to each series for the last 20 years (i.e. from 1981 onwards) and from 1961 for Keith's to hide the decline." Given the full sentence quote, do you believe that Dr. Jones' email raises any concerns?*
- *Please provide examples of correspondence prior to November 1, 2009, by climate change scientists where the word 'trick' is used in the manner you described during your testimony.*

I cannot speak for the authors of emails other than my own as to what was intended by particular formulations. Dr. Jones has offered his own explanation of his statement and its context (http://www.uea.ac.uk/mac/comm/media/press/2009/nov/CRUupdate), and his contention that there was nothing inappropriate in what he did has been supported by a number of others who work in the applicable field of research (see, e.g., http://www.csmonitor.com/Environment/Bright-Green/2009/1215/Climategate-global-warming-and-the-tree-rings-divergence-problem). I trust this will be looked at carefully in the independent review of the whole matter that is being conducted by the University of East Anglia. In any case (and as noted above), whether or not some of the stolen emails reveal poor judgment or careless formulations , the key findings of climate science, as reflected in the reports of expert committees and in thousands of peer-reviewed publications, are robust.

I also note that the editors of the journal *Nature* on December 3 made the same point about the term "trick" that I had made in the hearing the day before: that in science it is "slang for a clever (and legitimate) technique" (*Nature*, vol. 462, 545, 3 December 2009). Here are some examples from climate-science blogs and peer-reviewed articles:

> "Now for the important trick. To do the sort of analysis that I wish to do, we have to create a nested factor for each 12 months for each station....." Steven McIntyre (a statistician who has been one of the foremost critics of the "hockey stick" analysis), at http://climateaudit.org/2008/06/28/hansens-reference-method-in-a-statistical-context/

> "Note that CETA (Peck and Teisberg, 1991, 1999) also uses this trick to speed up computations (Peck, personal communication, 1998)." Richard Tol, "Climate coalitions in an integrated-assessment model", *Computational Economics* vol. 18: 159–172, 2001.

> "The computational MRA 'trick', leading to algorithms with 0(N) complexity[2], is based on the remark that WH(X) in Eq. (7) can be rewritten as..." A. Davis et al., "Anisotropic multi-resolution analysis in 2D: Application to long-range correlations in cloud mm-radar fields", *SPIE*, vol. 372, - 0277 786/99, 1999, pp 194-207.

QUESTIONS SUBMITTED FOR THE RECORD TO
DR. JANE LUBCHENCO
UNDER SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE
AND NOAA ADMINISTRATOR
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

FOLLOWING THE DECEMBER 2, 2009, HEARING ON
"THE ADMINISTRATION'S VIEW ON THE STATE OF CLIMATE SCIENCE"

BEFORE THE
SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING
U.S. HOUSE OF REPRESENTATIVES

1. Given that EPA's Endangerment Finding is largely based on the IPCC's finding and those findings were based on data that is now subject to questions of scientific integrity, do you believe that EPA should have delayed its Endangerment Finding? Should EPA regulate while significant questions of scientific integrity are outstanding?

Answer: There is no reason to doubt the thorough, heavily scrutinized, peer reviewed science and research that led scientists from around the world to agree that the "warming of the climate system is unequivocal" (IPCC, 2007).

2. On March 19 of this year, Ben Santer wrote that, "If the RMS is going to require authors to make ALL data available - raw data PLUS results from all intermediate calculations - I will not submit any further papers to RMS journals."

2a. Do you believe that raw data supporting journal articles should be available? Isn't the availability of data an important element of transparency?

Answer: NOAA has a full and open data policy and is committed to scientific integrity. NOAA believes strongly in the peer review process to help ensure the highest data and research quality. I believe other scientific organizations share this principle, as well as the principle that other researchers are able to reproduce the results.

2b. Would you support legislation that required journals publishing federally-funded research to make their raw data available to the public?

Answer: I believe the goal of increasing access to data produced with federal support can be achieved without new legislation. In fact, several agencies have already taken the initiative to put data-sharing policies into practice. For example, the National Institutes of Health requires any applicants for grants over $500,000 to include data-sharing proposals in their applications; the National Science Foundation explicitly states it expects investigators to share data with other scientists; and NOAA has stated its commitment to making all raw physical climate data available in as timely a manner as possible.

In January 2009, the National Science and Technology Council released the report "Harnessing the Power of Digital Data for Science and Society." An explicit goal in this report is to maximize digital scientific data access and utility. Two recommendations in this report are key to realizing this goal. First, the report recommends that all federal agencies develop and publish policies for data preservation and access. Second, proposals and projects that will generate scientific data should include a data-management plan that describes provisions for protection, access, and preservation.

Most leading journals (e.g., *Science*) that publish earth and climate science articles have policies that already strongly mandate data access and sharing. All data necessary to understand, assess, and extend the conclusions of a manuscript submitted to *Science* must be available to any reader of *Science*. After publication, all reasonable requests for materials must be fulfilled. *Science* also supports the efforts of databases that aggregate published data for the use of the scientific community. For example, climate data, published in *Science*, should be archived in the NOAA climate repository or other accessible public databases.

3. Do the newly released e-mails raise any concerns for you? Specifically, do they raise concerns about the integrity of the scientific process?

Answer: No, these emails do nothing to undermine the very strong consensus and the independent scientific analyses of thousands of scientists around the world that tell us the Earth is warming, and that this warming is largely a result of human activities. Excerpts from private email exchanges taken out of context do not offer a reason to doubt the immense body of thorough, heavily scrutinized, peer reviewed science and research that led scientists from around the world to agree that the "warming of the climate system is unequivocal" (IPCC, 2007). State-of-the-art research incorporates a variety of data sets, evidence and analysis, and cross references many pieces of information to ensure its conclusions are unbiased and dependable.

It is largely because of the rigorous and diverse scientific process that we can be so confident in the conclusions found in published research including the Intergovernmental Panel on Climate Change (IPCC) reports and the other peer reviewed science on which we base our understanding of the climate system. The peer review process is a critical and thorough process. It includes multiple rounds of comments and reviews from a wide range of experts, including scientists who were not involved in the study being reviewed, to ensure the accuracy and dependability of the research and its conclusions. The scientific process, which itself is carefully documented and open to scrutiny, is designed specifically to be open and inclusive to prevent results being driven by any one person or agenda.

4. Notwithstanding your skepticism and dismissal of the contents of the released e-mails, they have raised a great deal of concern and questions by scientists, policymakers and American taxpayers. Before proceeding with any climate change legislation in Congress that establishes a cap-and-tax system - which is widely acknowledged to have a drastic economic impact on the lives of Americans - would you support an independent and exhaustive investigation into the e-mails? Who do you recommend conduct this investigation and why?

Answer: A number of independent and reputable groups of scientists and journalists have already studied the e-mails and have concluded that while some human frailties are on display in the e-mails, none are of a magnitude or pervasiveness that calls into question the methods or the conclusions of the IPCC and the climate-science community more broadly. In addition, formal investigations of the implications of the e-mails and what if any corrective actions are indicated are already underway at the University of East Anglia, Pennsylvania State University, and the IPCC – the main institutions with which the writers of the most criticized and questioned e-mails are associated. Please also refer to my answer to question number 3.

5. On June 24, 2003, Mick Kelly wrote in an email: *"NOAA want to give us more money for the El Nino work with IGCN. How much do we have left from the last budget? I reckon most has been spent but we need to show some left to cover the costs of the trip Roger didn't make and also the fees/equipment/computer money we haven't spent otherwise NOAA will be suspicious. Politically this money may have to go through Simon's institute but there overhead rate is high so maybe not!"* In light of this admission of fraud, would you support an investigation into the scandal surrounding the leaked emails?

Answer: I am not familiar with the source of this email, but I have asked my team to look into it and report back.

6. In your testimony, you state that President Obama "has made it clear that our choices [regarding climate change] will be informed by scientific knowledge…" If the data behind the science is deemed to be tainted or manipulated, would you and/or President Obama change your position to reflect that?

Answer: We strongly believe that decision making should be informed by the best available scientific knowledge. The climate science available to date is using the methods or the conclusions of the broad scientific community, including the IPCC and the U.S. Global Change Research Program. As the science continues to evolve – and is reviewed and debated using the widely accepted scientific (peer review) process – decisions will, too, evolve to reflect any new information.

7. In your written testimony, you mention your meetings with leaders of international organizations during your trip to Geneva in early September for the World Climate Conference-3. You wrote: "There was strong agreement that services must be informed by relevant and credible science and must engage the users at all steps in the process."

7a. Did you interact with anyone from the University of East Anglia (UEA) at the conference?

Answer: To the best of my knowledge, I do not recall interacting with anyone from the University of East Anglia at the conference.

7b. Do you consider the UEA scientists' methods relative to climate change to be in line with your definition of "credible science"?

Answer: The University of East Anglia (UEA) is a respected research institution with standards and oversight that maintain, internationally, a strong reputation. I am not aware of any specific evidence that demonstrates the illegitimacy of any research papers published by UEA scientists. Datasets and analyses from other institutions show similar rates of warming to the rates shown in UEA data. The conclusions of the IPCC reports are based on many data sets including UEA's Climatic Research Unit, NOAA and the National Aeronautics and Space Administration (NASA).

8. You mention in your written testimony about temperatures in the United States. Last year, NASA published a top ten list of the hottest years on record. The top year was 1934. And of the top ten, six were before World War II. What is your opinion on this?

Answer: NOAA data for the contiguous United States (the region referenced in the NASA study) indicate that 1934 ranks among the top 5 warmest years on record, with 1998 the warmest followed by 2006, 1934, 1999, and 1921. Three of the ten warmest years of the record occurred before World War II and 2009 was the 13th consecutive year with the contiguous U.S. temperature above the 20th Century average. Differences in how NOAA and NASA process and analyze U.S. temperature data are responsible for the differences in a given year's calculated average temperature and resulting ranks. Both datasets agree that: (1) the temperature trend in the United States is positive, about one degree Fahrenheit during the 20th Century; (2) the 1930s were warm, but not as warm as the 1990s or 2000s; and (3) the 2000-09 decade was the warmest observed in the U.S. record.

9. Recent research, including papers published this year in peer-reviewed journals, indicate that there is no correlation between atmospheric CO2 concentration and ocean pH levels, and that recent acidification is within natural variations of pH, synchronous with the Interdecadal Pacific Oscillation. Have you read these 2009 papers authored by Dr. Wei and Dr. Liu in the Geochimica et Cosmochimica Acta? If so, what is your scientific opinion of these papers?

Answer: I am advised by NOAA scientists that the paper by Wei and Liu (2009), and references therein, explains that pH in coastal waters of the Great Barrier Reef of Australia is more variable than the open-ocean as these areas are exposed to changes in river runoff and inter-annual climate variability. The long-term trends of ocean acidification in the open-ocean are more easily observable because local impacts from land sources (e.g., floods) are less apparent in the middle of the oceans. However, the long-term data at this site show a clear trend towards decreasing pH since the 1940s. As the authors state in their summary, this trend "indicates that the trend towards ocean acidification over the past 60 years in this region is mostly the result of rapidly increasing of levels of atmospheric CO_2 contributed by human activities." The decreasing pH trends are indeed consistent with other decreasing pH trends in open-ocean and coastal regions, although the magnitude of the trends vary from place to place depending on local conditions (see Feely *et al.*, Oceanography, 22(4), 36–47. 2009 for a summary of the global trends and projections for the future).