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THE CASE FOR CLIMATE CHANGE ACTION

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

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THE CASE FOR CLIMATE CHANGE ACTION

WEDNESDAY, OCTOBER 1, 2003

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

The Committee met, pursuant to notice, at 9:30 a.m. in room SR–253, Russell Senate Office Building, Hon. John McCain, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. JOHN McCAIN, U.S. SENATOR FROM ARIZONA

The CHAIRMAN. Welcome. Today's hearing will be the third in a series of hearings this Committee has held this year on the very critical topic of global climate change, an issue of worldwide importance.

The National Academy of Sciences has reported that "Greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability."

While the National Academy of Sciences statement allows that factors other than human activity may affect temperatures, there is broad scientific consensus that global warming is occurring, that human activity is causing it, and that its consequences are extremely serious. While these consequences are alarming to think about, and politicians are naturally inclined to postpone tough choices, no excuse for inaction on this issue is acceptable.

While Congress and the Administration continue to expend their efforts on justifying our inaction, many countries have already recognized the scientific consensus, some states have joined together to address the problems, and domestic businesses are taking their own actions to respond to global climate change.

Earlier this year, Senator Lieberman and I introduced S. 139, the Climate Stewardship Act of 2003, which proposes to establish a mandatory carbon dioxide reduction program along with an emissions trading system. We believe that a market-based approach, combined with mandatory caps and Federal oversight, offers the best way for the Nation to respond to a growing global environmental threat.

We requested the Energy Information Administration and the Environmental Protection Agency to conduct analyses of our climate change proposal. While EIA responded to our request, EPA did not. Based on the EIA's analysis, as well as an independent analysis performed by the Massachusetts Institute of Technology and the Tellus Institute, we intend to offer a modified approach when the Senate finally debates our climate change legislation, which we expect to occur later this month.

Specifically, Senator Lieberman and I will offer a substitute amendment, which will, among other things, eliminate the second target date for reductions of greenhouse gases. It also would require the effected sectors to reduce their greenhouse emissions to the year 2000 levels by the year 2010, which is approximately 1.5 percent below today's levels. The bill, as introduced, would have required additional reductions by the year 2016.

By modifying the bill, we expect to build additional momentum for the measure in the Senate. We've insisted on and secured an agreement for a vote on the measure, a vote that must take place in order for constituents to know where their Senators stand on one of the most important environmental issues of our time.

We have a number of witnesses with us today to help further inform the Committee about the results of leading-edge scientific research, discuss actions being taken by industry in response to this growing worldwide concern, and public reaction to recent environmental reports on climate change. We're also joined today by a representative from the European Union to discuss the EU's efforts to develop a "cap-and-trade system."

I welcome our witnesses here today and look forward to their testimony.

First, I'd like to ask Mr. Jos Delbeke—he's the Director for Air Quality, Climate Change, and Biotechnology, the Delegation of the European Commission, the European Union—to come forward.

Welcome, Mr. Delbeke, and thank you for giving us your perspective and giving your responsibilities on this issue. Thank you. And I understand that your testimony will be in the form of a statement of position. Just want to make that clear for the record.

Thank you, sir. Please proceed.

STATEMENT OF JOS DELBEKE, DIRECTOR, ENVIRONMENT DG, EUROPEAN COMMISSION, BRUSSELS

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

I'm grateful for this opportunity to give input to your meeting today. And there is a particular reason for that. The particular reason is that Europe is now embarking on the cap-and-trade regime, and will have been largely inspired by your successful experience on sulphur allowance trading. So we learned a lot from you, and we hope to continue that in the future.

Mr. Chairman, I also prepared a written statement, and I would like to ask you to incorporate it into the record of this hearing.

The CHAIRMAN. Without objection.

Mr. DELBEKE. I will deal with two major points, a few words on our climate change policy in Europe, in general, and then come to the cap-and-trade system and the specificities of that.

As you know, Europe is fully committed to the multilateral process, to the U.N. Climate Change Convention, and to the Kyoto Protocol. And the EU ratified, together with all the member states already, in May 2002, the Kyoto Protocol. We are already implementing the commitments in view of having a good start and everything in place as of the first of January of 2008.

The target of the EU is minus 98 percent at the 1990 level. Today, we are at minus 2.3. A major part of that reduction comes thanks to policies and measures in the fields of energy and transport. A minor part of that comes thanks to the restructuring of the economy following the German reunification. Recently, however, our emissions of greenhouse gases are up again, and so we fully realize that we need reinforcement of our policies we have already in place and new ones to be developed.

For that reason, we developed a European Climate Change Program in which we involved all stakeholders and which gave also a new dimension in our environmental policy at large in Europe. And the new dimension is that we are very determined to go for low-cost measures, and very determined to develop more market-based instruments in our policies.

While we do that, and while we fully realize how costly climate policy can be, when we call for low-cost measures, we have calculated for Europe that we can keep down costs to below .1 percent of GDP in 2012.

What kind of measures have we developed already? We are doing a lot in the field of renewable energy. We double our share by 2010. We do a lot of biofuels and transport and cogeneration of heat and power, on energy efficiency of buildings and passenger cars, on the emissions of fluorinated gases, including mobile air conditioning, emitting emissions from landfills and so on.

Important to know is that also in the field of research we are fully committed to new breakthroughs that may happen in the field of hydrogen and carbon sequestration, and we are happy to cooperate with your country in this respect.

Let's turn now to the EU's allowance trading scheme, the cap-and-trade system, which is really the pillar of our new climate policy.

We have finalized our legislation, in July 2003—that means a couple of months ago—and important to note is that we had unanimity on that bill. We call it the Directive in Europe in the Council of Ministers.

As of the first of January of 2005, that bill would allow us to install the largest multi-country cap-and-trade scheme in the world, because it will apply to the 15 member states of the EU, 15 member states that we have today, plus the 10 new acceding member states, plus probably Norway and Iceland, with which we have cooperation agreements in the field of energy and transport.

This legislation implements our obligations that we have taken on under the Kyoto Protocol. And important is that it goes a step further than what we have undertaken in Kyoto, namely that our trading obligations are translated up to obligations for each company covered by the scheme. It's a mandatory scheme for all major companies from the power sector and energy-intensive sectors, such as steel, oil refineries, cement, lime, glass, pulp and paper, et cetera. And we count we have more or less 10,000 companies in the scheme. That would cover up to 40 percent of Europe's greenhouse gas emissions, and cover plus/minus half of its GDP.

The scheme, Mr. Chairman, is mandatory. We have a lot of experience with voluntary schemes, but those schemes did not deliver enough results. So we thought we could establish a scheme that is mandatory and, if we do it well, make it much simpler to implement. So that's why we have a strict compliance regime incorporated into the bill that would create automatic financial sanctions for companies not fulfilling their obligations, up to 100 euros per ton of CO_2 under the period under Kyoto.

We would start, as I said, in 2005. That means that we would have a learning-by-doing phase before the Kyoto period starts, because, as I indicated, this is a very new instrument that we learned from you, Mr. Chairman, in the United States, and there is a lot to learn for our European companies in that. So we hope to be completely ready to have the implementation scheme compatible with Kyoto as of January 1, 2008.

It starts with CO_2 only, and not the five other gases which are mentioned in the Kyoto Protocol. But we have foreseen possibilities to gradually extend the regime, as you have also been considering that, if I understand it well, under the sulphur-allowance scheme.

The allocation that we are undertaking is free of charge, but there is a possibility for member states to auction a percentage of the allowances—namely, up to 5 percent. Important to know is that the member states are responsible for allocation according to very clear criteria incorporated into the directive. Member states will then have to submit their allocation plans to the Commission, and the Commission will scrutinize them before the system starts. The Commission actually, to facilitate that process, is now drafting guidelines to be as clear as possible about what the Commission has in mind and what kind of precise rules are going to be followed.

A final word, Mr. Chairman. The EU's scheme is not a closed scheme. I know that some have said the EU is now establishing its scheme on its own. That's true, but it is not closed. It has two important provisions to make bilateral agreements with states who have ratified the Kyoto Protocol so as to recognize each other's company-based emissions trading schemes.

The second possibility is that we have joint implementation and clean development mechanism projects under the Kyoto Protocol that may bring in credits into Europe's scheme, and also that is, in principle, allowed. We are elaborating, however, the modalities of how to do that.

So we have learned that, in particular, global companies in the sectors I mentioned are very much interested into these modalities, because they see the European scheme as a start for what they would like to see one day as a global trading scheme that is company-based.

As a conclusion, Mr. Chairman, the EU is going, and is showing, I hope, that it is already implementing all provisions of the Kyoto Protocol. And I stress "all," because emissions trading in Kyoto was not the favorite subject of the Europeans at that time. So we go ahead with that, and, indeed, we are convinced that such market-based mechanisms are very much capable of keeping down costs to companies and to the economy.

Our legislation is completed, so we are now implementing. And the public sector is preparing for the allocation plans, for other modalities that have to be sorted out. The private sector is already preparing, because thousands of companies and businesses and brokers are now elaborating their business plans in view of January 1, 2005.

And the European Union, let me repeat that, looks forward to open its schemes to other major players in the world.

Thank you very much, Mr. Chairman.

[The prepared statement of Mr. Delbeke follows:]

PREPARED STATEMENT OF JOS DELBEKE, DIRECTOR, ENVIRONMENT DG, EUROPEAN COMMISSION, BRUSSELS

Climate Change: How the European Union Implements the Kyoto commitment

Mr. Chairman and members of the Committee, I am grateful for the opportunity to provide input to this meeting today.

I am a Director at the European Commission in Brussels, the executive arm of the European Union.

In July 2003, the Council of Ministers of the European Union adopted with unanimity a Directive (bill) to introduce a CO_2 cap-and-trade scheme as of 2005. It constitutes the legal base for the largest multi-country cap-and-trade scheme implemented in the world. Its scope is wide as it will cover close to 40 percent of the EU's greenhouse gas emissions, mainly from power generators and large industries.

The EU has been inspired by the positive experience in your country the Sulphur Allowance Trading scheme based on Title IV of the 1990 Clean Air Act Amendments. It is therefore a special pleasure to be given the opportunity to provide input to a process in which the United States Congress may again lend support to a market-based instrument to tackle the issue of global climate change.

Before turning to the EU allowance trading scheme in more detail let me however provide you with the bigger picture of Europe's Climate Change policy.

The European Union is fully committed to the multilateral process to combat global climate change. It has ratified the Kyoto Protocol in May 2002 and is now in the midst of the implementation process.

As part of the European Climate Change Program, and in addition to the EU allowance trading scheme, the following initiatives are underway to:

- increase the share of renewables in the EU's electricity generation from 14 to 22 percent in 2010 (emission reduction potential 100 to 125 Mt CO_2eq.)
- promote high quality co-generation of power and heat (65 MtCO2eq.)
- improve the energy performance of buildings (35–45 Mt CO_2eq.)
- improve energy efficiency and energy demand management
- reduce the average CO_2 emission of a new car by 25 percent in 2008/2009, with respect to 1995, (75–SOMt CO_2eq.).
- increase the share of bio-fuels in the road transport sector to 5.75 percent (35–40 MtCO_2eq.)
- reduce the emission of fluorinated gases, including a gradual phaseout of certain fluorinated gases in mobile air conditioning systems. (23 MtCO_2eq.)
- reduce methane emissions from landfills (41 Mt CO_2eq.)

Except for the voluntary commitment of the automotive industry, all of these initiatives are being implemented through binding EU legislation.

The EU also values and participates in initiatives, including the development of hydrogen technologies and geological carbon sequestration, to accelerate the introduction of technologies necessary to combat climate change over the next decades.

The European Union has to meet its 8 percent reduction target under the Kyoto Protocol, equivalent to annual cuts of some 336 Mt CO_2eq. The latest figures available indicate that the European Union (EU–15) has reduced total greenhouse gas emissions by 2.3 percent since 1990. The major part of this reduction is due to policies and measures targeted at reducing greenhouse gas emissions, while a minor part was due to a one off reduction resulting from the economic restructuring following German reunification. Recently, emissions have been increasing slightly again and this underlines the need to continue our efforts and further reinforce existing policies.

Since 2000, the European Climate Change Program has been in place to identify, analyse and prepare such policies and measures in all major sectors, in particular emissions trading, energy, transport, agriculture & forestry, and research. Stakeholder consultation, involving EU Member States, businesses, experts and NGOs, is viewed as essential for the success of the European Climate Change Program. The backdrop of an internationally agreed and legally binding target has helped considerably to establish the Program as an ambitious force for policy and technological innovation.

The overall conclusion of the European Climate Change Program is that there are ample low-cost reduction measures—that is, below 20 £ per tonne of CO_2eq—to meet our Kyoto commitments. The total estimated cost of Kyoto compliance of less than 0.1 percent of GDP represents only a small fraction of total economic output in the EU. No indications were found that the standard of living of EU citizens would be hampered.

The EU allowance trading scheme is the major cornerstone of our Climate Change Program and will play a crucial role in the EU's implementation strategy for the Kyoto Protocol. As the legislation has been adopted, the EU allowance trading scheme will be up and running in 25 countries across Europe as of 1 January 2005. This will be "the onset of the EU carbon economy", as a leading European Parliamentarian has referred to it. It also marks a major change in EU environmental policy in general, showing far greater reliance on market-based instruments because of their attractiveness in terms of cost-effectiveness.

Let me provide you with the overall picture of the EU scheme. It will be implemented in multi-annual phases, with the first phase running from 2005 to 2007 and the second (in parallel to the Kyoto Protocol) from 2008 to 2012. It will cover over 10,000 plants in electricity and energy-intensive industry. Initially the coverage will be limited to carbon dioxide emissions. Nevertheless, the scheme will encompass more than a third of total EU greenhouse gas emissions and close to half of EU CO_2 output. Just as the Congress is considering expanding the SO_2 cap-and-trade program in the U.S. to cover other pollutants, we intend to extend the coverage of the EU scheme over time. We have, however, not made concrete decisions yet as to which sectors and gases will come in at what stage.

Allowances will mainly be allocated free of charge, although Member States may auction a small percentage of allowances if they wish. The number and methods for allocating allowances are determined in periodic allocation plans at the Member State level. For companies failing to deliver a sufficient number of allowances, financial sanctions of £40 per ton of CO_2 (*i.e.,* about £147 per ton of carbon) and £100 per ton of CO_2 (*i.e.,* about £367 per ton of carbon) will apply automatically. The experience of the Sulphur Allowance scheme demonstrates the importance of a robust enforcement regime for the environmental and economic success of a program.

Finally, and very importantly, the EU scheme is not a closed scheme. It has inbuilt provisions to create links to the outside world. Firstly, the EU may conclude bilateral agreements for mutual recognition of greenhouse gas allowances with countries running similar trading schemes and having ratified the Kyoto Protocol. This allows to extend the benefits of trading to other jurisdictions. It is an open invitation to countries around the world to cooperate with Europe in the multilateral effort to combat climate change. Contacts are already developing with several OECD countries.

Secondly, the Commission has initiated an additional legislative process to create a link to the Kyoto Protocol's project-based mechanisms—"Joint Implementation" and the "Clean Development Mechanism". This initiative aims to allow companies to use credits from these mechanisms for compliance. Details of this link will be discussed and decided in the legislative institutions in the months to come.

The EU allowance trading scheme, with its possibility of linking with schemes in other jurisdictions, is the way in which the EU promotes the vision of an international emission trading scheme in greenhouse gases. Such an international scheme would prove highly beneficial for globally active multinationals of which there are many in Europe as well as the United States.

The legal foundation having been set, Europe is now preparing for the launch date of the scheme on 1 January 2005. Member States are now drafting national implementation laws (a necessary step for any EU Directive). Member States will very soon elaborate first drafts of their national allocation plans and consult with industry, NGOs and civil society. Before the end of the year, the Commission will issue guidance on the implementation of the common allocation criteria agreed in the Directive. And the Commission will scrutinize the national allocation plans which are to be submitted to Brussels by the end of March 2004. Common guidelines for monitoring and reporting of emissions by companies at European level will be agreed this fall. And we work on the legal framework and the development of electronic allowance registries.

In parallel to the preparations being made in the public sector, thousands of businesses have started preparing their compliance strategies in the allowance market and are assessing how to benefit from the economic opportunities the program will offer.

In conclusion, Europe is fully committed and works with priority to respect the multilateral commitment it has taken on with respect to climate change. In doing so, we increasingly rely on market-based instruments such as the implementation of the world's largest multi-country cap-and-trade scheme. The EU looks forward to many countries joining us in this journey.

The CHAIRMAN. Thank you very much, sir.

You mention in your statement that the estimated cost of Kyoto compliance is less than 0.1 percent of GDP. How does that fit in with estimates from here in the United States that if the United States were involved in a similar program, that it would be a huge and devastating impact on our economy? I don't quite understand the contradiction there.

Mr. DELBEKE. Well, Mr. Chairman, when we embarked on this exercise, we were asked to do that exactly for that reason, because we were told that the costs could be very high, and, indeed, they could be very high. But when we were starting low-cost measures, including emissions trading, we were discovering for ourselves how vast the possibilities are for companies to improve their energy efficiency. In most cases, we learned through their participation in this study—it was a stakeholder involvement, but also businesses, experts, member states, et cetera, were present—that they were gradually discovering for themselves that if you have squeezed out some 5 to 10 percent energy efficiency in many different parts of the economy, that that is possible. So the art is to squeeze them out where they are available at the lowest cost.

And, for example, we know that we have subsidy schemes in place in Europe for the coal sector and the energy field, in general, where we could do a major exercise in scaling them down, what we have been doing currently over the last decade. They are still there, but far less important than what they were at the beginning of the exercise.

The CHAIRMAN. Could you send us the basis for your estimates of the impact on the economy and the rationale for it? It would be very helpful when we discuss it here, on proposed impacts.

This isn't exactly on the subject, but the heat wave in Europe this summer was a prominent topic in the American media, not to mention the European media. Can you comment on observation or analysis of the European Commission regarding the correlation between that and patterns of global climate change? Or was that just a one-shot experience?

Mr. DELBEKE. Thank you, Mr. Chairman.

Indeed, we are very much willing to convey all information to you about the economics we did, and that is, indeed, available already on the website of the European Commission Climate Change Unit.

The CHAIRMAN. Thank you very much.

Mr. DELBEKE. But I can confirm to you that the heat wave in Europe and the way water has appeared in the news over the last couple of years has become a very dominant theme in the minds of the day-to-day people. We have had the flooding in Central Europe and in Eastern Europe, and we have had the heat wave and the drought last summer. So people are very, very much aware about how the appearance of water is becoming very irregular. And people talk about it and make the link with climate change.

That's why I think the policies we have been discussing have been supported by an overwhelming majority in the Parliament, in the Parliaments of the members states, because people feel that something is happening. They are aware of the research that has been worldwide, including from the IPPC, and they would like to contribute their little bit to the solution of the problem, and would look very much forward of other parties in the world to do the same.

The CHAIRMAN. Thank you. And, again, your economic estimates will be very helpful to us, because the major opposition to the very modest proposal that Senator Lieberman and I have is the economic consequences. And so I think it would be very helpful in the debate to use your analyses of cap-and-trade, and so I think it would be very helpful. And you've been very helpful to us today.

Senator Lautenberg?

STATEMENT OF HON. FRANK R. LAUTENBERG, U.S. SENATOR FROM NEW JERSEY

Senator LAUTENBERG. Mr. Chairman, thank you very much for holding this hearing. I want to commend you and Senator Lieberman for initiating some action to deal with the problem.

I was in Antarctica a couple of years ago, and went to the South Pole. I was shocked to learn that so much of the world's fresh water is stored in a single place. In the evening you could almost hear the ice groaning as it shifted. When we see the reduction of the ice cap there and the magnitude of that reduction, to me it says, "Sound the alarm. Let's get something going here."

We all have experienced the potential aberrations from climate change. I happen to have been in Europe, Mr. Chairman, for a short stay this summer. The temperatures in Italy at that time were over 100 degrees, and incredibly uncomfortable.

Mr. Delbeke, thank you for being here. With the cap-and-trade program that we have, what influence might U.S. participation have? It certainly would enlarge the marketplace, the negotiating place, but what do you think the—how important an impact do you think it would have if the U.S. joined in the world marketplace?

Mr. DELBEKE. Thank you very much.

On the last question, I think the impact would be tremendous, because there are effects related to the environment and effects related to the economy and the competitiveness. I will not hide that despite the fact that our overall costs are down—but, of course, and below .1 percent of GDP—that the impact in different sectors may be, indeed, more important than the .1 percent they may suggest. So we have distributed effects.

And in technology-intensive sectors and in the field of new energy technologies and new technologies that allow to embody energy-efficiency requirements more strictly, we see a lot of positive news following our climate agenda. But there are also energy—part of the energy sector, part of the energy-intensive industry—taking products like steel and aluminum, et cetera, where energy use is vast—where our companies are very much worried about their competitiveness, knowing that this allowance trading is going to start on January 1, knowing that they'll have to be very competitive in the global markets, and they convey to us constantly to make the point to its major players in the world, including you, that it would be most helpful if a global environmental problem is being sorted out with a global effort that would minimize distortions also in the markets in which they operate.

So, I think a possible decision by the United States to go for the act that you are discussing those days would be tremendously welcome in Europe and, indeed, in the rest of the world, as well.

May I also indicate that the political environment within which we have been discussing the new laws and directives, that not everybody in Europe is 100 percent enthusiastic because of this distributive effect, but that everybody was prepared to get started to have the system up and running that will be the architecture for future emission reductions over decades. So testing out that architecture and being pragmatic has been a very important element that was creating a coalition that was vast, from green NGO's up to companies who feel responsible for what is happening in the world.

So getting started, having this on January 1, 2005, if not perfect, at least getting started and optimize and review elements that may have to be reviewed because this or that elements was underestimated, has been a strong element around the political—or present in the political debate that we have had around this directive.

Senator LAUTENBERG. This may be a little outside your field, but has there been a lot of review with your contacts about the impact of nuclear energy generation versus fossil fuel-generated energy? Because it's more popular in Europe than it is here, and I just wonder whether you've done an analysis about that.

Mr. DELBEKE. Thank you very much.

This has, indeed, been an element; in particular, because several member states of the EU have already decided to phase out nuclear as part of their energy mix. And that will undoubtedly have an impact in the fuel mix and the greenhouse gas emissions related to energy use.

So nuclear has not been advocated as the way out of the problem, but has been incorporated into the debate in saying, well, look, if we are going to phaseout the nuclear installations, as we have today in Europe, in important countries such as Germany or the Netherlands or in Scandinavian countries, et cetera, this will have an impact. And an emissions trading regime would help us very much to have that impact again incorporated into the economy in an as smoothly a way as possible.

And, of course, I could mention, as well, that in the current emissions trading scheme that is adopted by the council, nuclear installations are not covered, because they do not have emissions of CO_2. So they have a slight comparative advantage compared to power installations that do have emissions of CO_2 and that are covered by the cap-and-trade system that we are developing. So, in strict terms, they are not part of the equation, but, of course, in overall economic terms, they have a slightly beneficial treatment, because they do not fall under the scheme.

Senator LAUTENBERG. Thank you.

Thanks, Mr. Chairman.

The CHAIRMAN. I think, Mr. Delbeke, in the laws of unintended consequences, that a number of countries, including this one, over time, may take a look at advanced technology as it applies to nuclear power. I think there has been a dramatic change, both in generation of nuclear waste and size of—but it'll be a very interesting thing to observe.

Mr. Delbeke, I thank you for coming today. I appreciate the opportunity of getting your outlook and your plans and proposals for the European Union, and we look forward to working with you and hope someday we'll all be working together.

Thank you very much for being here.

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

The CHAIRMAN. Thank you.

Our next panel is Dr. Antonio Busalacchi, who is the Chair of the Climate Research Committee Board on Atmospheric Science and Climate on the National Research Council; Mr. Tom M.L. Wigley, who is a Senior Scientist, Climate and Global Dynamics Division and Climate Analysis Section, and Program Director of A Consortium for the Application of Climate Impact Assessments, the National Center for Atmospheric Research; Mr. Stephen H. Schneider, who is a Professor, Department of Biological Sciences, and Co-Director, Center for Environmental Science and Policy at Stanford University.

Mr. Schneider, I particularly want to thank you for traveling a long way on short notice. And, Mr. Wigley, I would like to congratulate you, you have the longest title of any witness who has appeared here.

[Laughter.]

The CHAIRMAN. Thank you.

Mr. Busalacchi, thank you, and we'll begin with you.

STATEMENT OF ANTONIO J. BUSALACCHI, JR., PH.D. CHAIRMAN, CLIMATE RESEARCH COMMITTEE, NATIONAL ACADEMY OF SCIENCES, AND DIRECTOR, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), UNIVERSITY OF MARYLAND

Dr. BUSALACCHI. Good morning, Senator.

The CHAIRMAN. Did I have the proper pronunciation, sir?

Dr. BUSALACCHI. Perfect.

The CHAIRMAN. Thank you.

Dr. BUSALACCHI. Very good. Thank you.

Good morning, Senators.

Senator LAUTENBERG. Good morning.

Dr. BUSALACCHI. Thank you very much for this opportunity to testify.

I'm Tony Busalacchi, Professor at the University of Maryland, and I serve as the Chair of the National Academy's Climate Research Committee.

I will use my time this morning to summarize what most scientists agree to be true about the change in the Earth's climate.

Understanding climate and whether it is changing and why is one of the most crucial questions facing humankind in the 21st century. This question is the subject of much scientific research and, of course, policy debate, since the economic and environmental implications could be large.

The National Academies have produced a number of reports focused on understanding climate in recent years, and my testimony draws heavily from two of these, a February 2003 report here, I show here, that gives input to the Administration's draft U.S. Climate Change Science Program's strategic plan, and a 2001 report called "Climate Change Science" that was done at the request of the White House. This report answered a series of specific questions designed to identify areas in climate-change science, where there are the greatest certainties and uncertainties. If you haven't read this report, there's an excellent summary, only about 25 pages long, written in very straightforward language.

As explained in that report, "Climate Change Science," there is wide scientific consensus that climate is, indeed, changing. Greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise.

Our confidence in this conclusion is higher today than it was ten or even 5 years ago. Yet uncertainties remain, because there is a level of natural variability inherent in the climate system. On timescales of decades and centuries, that can be difficult to interpret with precision, because we gather this evidence from sparse observations, numerical models, and proxy records such as ice cores and tree rings. Despite the uncertainties, however, there is widespread agreement that the observed warming is real and particularly strong within the past 20 years.

A diverse array of evidence supports the view that global air temperatures are warming. Instrumental records from land stations and ships indicate global mean surface temperatures have warmed by about .7 to 1.5 degrees Fahrenheit during the 20th century. The warming trend is spatially widespread and is inconsistent with the global retreat of mountain glaciers, reductions in snow cover extent, the earlier spring melting of ice on rivers and lakes, 20th century sea-level rise, to name a few.

The ocean, which represents the largest reservoir of heat in the climate system, has warmed since the 1950s by about a tenth of a degree, when averaged from the surface down two miles at depth into the ocean.

The role that human activities have played in causing these climate changes has been the subject of debate and research for more than a decade. There is no doubt that humans have modified the abundances of the key greenhouse gases in the atmosphere—in particular, carbon dioxide, methane, nitrous oxide, and tropospheric ozone. These gases are at their highest recorded levels. In fact, ice core records of carbon dioxide and methane show that today's amounts are significantly large than at any period over the last 400,000 years.

The increase in these greenhouse gases is primarily due to fossil fuel combustion, agriculture, and land-use changes. Recent research advances have led to widespread acceptance that the human-induced increase in greenhouse gas abundance is responsible for a significant portion of the observed climate. The precise size of that portion is difficult to quantify against the backdrop of natural variability and climate, forcing uncertainties.

Because the Earth's system responds so slowly to changes in greenhouse gas levels, and because altering established energy-use practices is difficult, changes in impacts attributable to these factors will continue during 21st century and beyond. Current models indicate the large potential range for future changes, with global mean surface temperature warming by anywhere from two-and-a-half to ten-and-a-half degrees Fahrenheit by 2100.

Given increasing evidence of how humans have modified the Earth's climate over the last century, it is imperative for the Nation to continue directing resources for better observing, modeling, and understanding the form future changes in climate and climate variability may take, the potential positive and negative impacts of these changes on humans and ecosystems, and how society can best mitigate or adapt to these changes.

Thank you for this opportunity to talk about climate change. This is a problem that affects us all and a problem the scientific communities does take seriously. It does not shy away from its responsibility to provide objective scientific assessment in support of sound policy decisions.

I'll be happy to take any questions at the appropriate time.

[The prepared statement of Dr. Busalacchi follows:]

PREPARED STATEMENT OF ANTONIO J. BUSALACCHI, JR., PH.D. CHAIRMAN, CLIMATE RESEARCH COMMITTEE, NATIONAL ACADEMY OF SCIENCES, AND DIRECTOR, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), UNIVERSITY OF MARYLAND

Good morning. Thank you very much for this opportunity to testify. I am Dr. Tony Busalacchi, a professor at the University of Maryland and I serve as the Chair of The National Academies' Climate Research Committee. I will use my time this morning to summarize what most scientists agree to be true about change in the Earth's climate.

Understanding climate and whether it is changing, and why, is one of the most crucial questions facing humankind in the twenty-first century. This question is the subject of much scientific research and, of course, policy debate, since the economic and environmental implications could be large. The National Academies have produced a number of reports focused on understanding climate in recent years and my testimony draws heavily from two of these: a February 2003 report that gives input to the Administration's draft U.S. Climate Change Science Program Strategic Plan (NRC 2003) and a 2001 report called "Climate Change Science" that was done at the request of the White House (NRC 2001). The latter report answered a series of specific questions designed to identify areas in climate change science where there are the greatest certainties and uncertainties. If you haven't read this report, it is an excellent summary (only 25 pages long) written in very accessible language.

As is explained in "Climate Change Science," there is wide scientific consensus that climate is indeed changing. Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Our confidence in this conclusion is higher today than it was ten, or even five years ago, but uncertainty remains because there is a level of natural variability inherent in the climate system on time scales of decades to centuries that can be difficult to interpret with precision because we gather this evidence from sparse observations, numerical models, and proxy records such as ice cores and tree rings. Despite the uncertainties, however, there is widespread agreement that the observed warming is real and particularly strong within the past twenty years.

As the report further explains, human-induced warming and associated sea level rises are expected to continue through the 21st century. Computer model simulations and basic physical reasoning show that there will be secondary effects from these changes. These include increases in rainfall rates and increased susceptibility of semi-arid regions to drought. The impacts of these changes will depend on the magnitude of the warming and the rate with which it occurs.

A diverse array of evidence supports the view that global air temperatures are warming. Instrumental records from land stations and ships indicate that global mean surface air temperature warmed about 0.4–0.8 degrees C (0.7–1.5 degrees F) during the 20th century. The warming trend is spatially widespread and is consistent with the global retreat of mountain glaciers, reductions in snow-cover extent, the earlier spring melting of ice on rivers and lakes, the accelerated rate of rise of sea level during the 20th century relative to the past few thousands years and the increase in upper-air water vapor and rainfall rates over many regions. A lengthening of the growing season also has been documented in many areas, along with an earlier plant flowering season and earlier arrival and breeding of migratory birds. Some species of plants, insects, birds and fish have shifted toward higher latitudes or higher elevations, often together with associated changes in disease vectors. The ocean, which represents the largest reservoir of heat in the climate system, has warmed by about 0.05 degrees C (0.09 degrees F) averaged over the layer extending from the surface down to 10,000 feet, since the 1950s.

It has been said that the Arctic will be the "canary in the coal mine" where the effects of global warming will be felt first and with the greatest magnitude. Analysis of recently declassified data from U.S. and Russian submarines indicates that sea ice in the central Arctic has thinned since the 1970s, and satellite data indicate a 10–15 percent decrease in summer sea ice concentration over the Arctic as a whole. Satellite measurements also indicate that the time between the onset of sea-ice melting and freeze-up has increased significantly from 1978 through 1996, and the number of ice-free days have increased over much of the Arctic Ocean. A decline of about 10 percent in spring and summer continental snow cover extent over the past few decades also has been observed. Looked at in total, the evidence paints a reasonably coherent picture of change, but the conclusion that the cause is greenhouse warning is still open to debate; many of the records are either short, of uncertain quality, or provide limited special coverage.

As you may have seen in the press, a large ice shelf recently broke up along the coast of northeast Canada's Ellesmere Island, followed by the drainage of an ice-dammed lake that had built up behind it (Disraeli Fiord). The Ward Hunt Ice Shelf was the largest remaining piece of an ice shelf that once, a century ago, rimmed the entire northern coast of Ellesmere Island. I have not studied this particular incident, nor has the Academy, but researchers working at the site had documented reductions in the freshwater volume of the lake accompanied by a rise in mean annual air temperature and have stated that they believe this change can be attributed to global warming. Other scientists have been more cautious, noting that many of the changes being seen in the Arctic could have more to do with long-term world climate patterns than with the release of carbon dioxide and other greenhouse gases. Still, atmospheric chemist and National Academy of Sciences member Ralph J. Cicerone of the University of California at Irvine was quoted in the *Washington Post* article on the ice-shelf breakup as saying:

> "But even though this ice melt and permafrost thawing [probably happened] too fast to be due to global warming, this is [a] prototype of what we should expect after the next few decades. . . . This is a good dress rehearsal for the kinds of things we could see later."

Some of the changes being experienced at high latitudes are believed to be reflections of changes in wintertime wind patterns rather than a direct consequence of global warming per se. It is important to note that the rate of warming has not been uniform over the 20th century. Much of the warming occurred prior to 1940 and during the past few decades. The Northern Hemisphere as a whole experienced a slight cooling from 1946–1975, and the cooling during that period was quite marked over the eastern United States. The cause of this hiatus in the warming is still under debate. One possible cause might be the buildup of sulfate aerosols due to the widespread burning of high sulfur coal during the middle of the century followed by a decline; it is also possible that at least part of the rapid warming of the Northern Hemisphere during the first part of the 20th century and the subsequent cooling were of natural origin—a remote response to changes in the oceanic circulation, or variations in the frequency of major volcanic emissions or in solar luminosity.

The role that human activities have played in causing these climate changes has been a subject of debate and research for more than a decade. There is no doubt that humans have modified the abundances of key greenhouse gases in the atmosphere, in particular carbon dioxide, methane, nitrous oxide, and tropospheric ozone. These gases are at their highest recorded levels. In fact, the ice-core records of carbon dioxide and methane show their twentieth century atmospheric abundances to be significantly larger than at any period over the past 400,000 years. The increase in these greenhouse gases is primarily due to fossil fuel combustion, agriculture, and land-use changes. Recent research advances have led to widespread acceptance that the human-induced increase in greenhouse gas abundances is responsible for a significant portion of the observed climate changes. The precise size of that portion is difficult to quantify against the backdrop of natural variability and climate forcing uncertainties.

Because the Earth system responds so slowly to changes in greenhouse gas levels, and because altering established energy-use practices is difficult, changes and impacts attributable to these factors will continue during the twenty-first century and beyond. Current models indicate a large potential range for future climates, with global mean surface temperature warming by 1.4 to 5.8 °C (2.5 to 10.4 °F) by 2100 (IPCC, 2001).

Given increasing evidence of how humans have modified the Earth's climate over the last century, it is imperative for the Nation to continue directing resources toward better observing, modeling, and understanding of what form future changes in climate and climate variability may take, the potential positive and negative impacts of these changes on humans and ecosystems, and how society can best mitigate or adapt to these changes.

Thank you for this opportunity to talk about climate change. This is a problem that affects us all, and a problem the scientific community does not shy away from in terms of its responsibility to provide objective scientific assessment in support of sound policy decisions. I'd be happy to take any questions.

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The CHAIRMAN. Thank you very much, Doctor.

Dr. Wigley?

STATEMENT OF TOM M.L. WIGLEY, SENIOR SCIENTIST, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Dr. WIGLEY. Thank you, Senator McCain, for giving me the opportunity to talk about this issue.

I've produced a written statement that I request be formally included in the record.

The CHAIRMAN. Without objection.

Dr. WIGLEY. My name is Tom Wigley. I'm a Senior Scientist at the National Center for Atmospheric Research, and I've been involved in climate change research for 20 or 30 years.

This is a brief statement that will flesh out some of the information that Dr. Busalacchi gave, in a quantitative sense. I'm going to address three issues. I want to say a little bit about the 20th century warming and our understanding of the causes for that warming. I'm going to say a little bit about the more recent record, over the last 25 years, of satellite temperatures of the free atmosphere, and then quantify the effects of human influences over the next hundred years.

This diagram shows——

The CHAIRMAN. Can you hold a minute, Dr. Wigley? In my declining years, I have trouble seeing, so I will come closer.

[Laughter.]

Dr. WIGLEY. Yes, I'm sympathetic to that. I don't know whether "declining" is really the right word to use, however.

OK. This diagram shows—the black, with little dots, is the observed global warming temperature record, and you can see that there's a warming here of roughly seven-tenths of a degree Centigrade over the last hundred years. In terms of Fahrenheit, that's a little over one degree.

And then there are two sets of curves. The lower two curves show model estimates of what the changes would have been if we accounted only for natural external forcing factors on the climate system. And the upper two curves correspond to the results that would attain if we included human influences. And you can see that including human influences is essentially the only way that we can explain the observed warming. And particularly, the dramatic warming over the last 30 to 50 years is largely the result of human factors. Natural variability alone cannot explain the past record.

This little diagram acts as a credibility test for climate models, and I'm going to give one other test for these climate models.

Now, this diagram looks at changes over the last 20 years, where we have very precise records from satellite observations using an instrument called the microwave sounding unit. And there are four results here. And on the lefthand side, labeled UAH, is one of the records that is based on satellite data from the University of Alabama at Huntsville. The RSS curve uses the same data, but is a different way of analyzing the changes from one satellite to another. And the ERA 40 curve is a composite of a variety of different types of evidence. The final curve, on the right-hand side model, shows the results that would be expected for tropospheric temperature trends using climate models and using our best estimates of what the forcing of the climate system has been over this time period.

You can see there are a lot of uncertainties. You can see that the RSS and ERA 40 curves, or trends, agree very well with the model expectation. There's some uncertainty associated with the satellite temperature records, and that's indicated by the difference between the two lefthand RSS and UAH panels there. So this is not a totally resolved issue, but there appears to be no inconsistency between model expectations and observed temperatures.

Given that credibility test for models, then we can use, with some confidence, these models for predicting what might happen in the future. And this diagram shows the past warming record, from minus-.7 Celsius up to that little triangle there in the year 2000, and then future projections. The two—the red and blue curves, these are just for one particular emission scenario or projection of what emissions of greenhouse gases might be in the future. The red and blue curves are an estimate of the uncertainty associated with the buildup of carbon dioxide and other gases and with the response of the climate system. You can see that the warming, even at the low end, the blue curve, is substantially than what has occurred over the last hundred years. The yellow bar, on the right-hand side, accounts for other uncertainties in emissions and other factors that affect the climate system, and that's the result given by the Intergovernmental Panel on Climate Change, IPCC. And just to summarize that bar, the warming at the low end is about double the warming over the last hundred years. At the high end, the warming rate is some seven times the warming rate over the last hundred years, clearly cause for concern.

And, in summary, we can't explain the 20th century warming unless we include human influences. Roughly 75 percent of the warming over the last hundred years appears to be due to these human influences. There's no problem with satellite data as far as the latest measurements go, in terms of their comparison with model results. And in the absence of climate mitigation policies, it seems that the future warming might be somewhere between two and seven times the rate of warming that occurred over the last century.

And I'd just like to conclude by thanking Senator McCain and other Senators involved for this balanced and responsible approach to the climate change problem.

Thank you.

[The prepared statement of Dr. Wigley follows:]

PREPARED STATEMENT OF TOM M.L. WIGLEY, SENIOR SCIENTIST, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

1. Introduction

Projections of future climate change made using state-of-the-art climate models suggest that changes over the coming century will be much larger than experienced over the past 100 years. The case for taking action to mitigate these human-induced (or 'anthropogenic') changes rests on the credibility of these models. There is a vast scientific literature on the development and testing of these models, summarized in the recent "*T*hird *A*ssessment *R*eport" (henceforth "TAR") produced under the auspices of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC, Houghton *et al.,* 2001). There are two main methods of model testing—comparing model simulations of the present state of the climate system (such as the geographical patterns of temperature, rain-and snowfall, sea-level pressure, etc.) against observations, and comparing model simulations of past changes in climate with observations.

The most recent climate models are able to simulate present-day climate remarkably well—with errors often less than the uncertainties in observational data sets. Here, however, I will not dwell on this aspect of model validation, but concentrate on the second method—comparison of observed and model-simulated changes. I will show that models simulate temperature changes over the past 100+ years with considerable fidelity provided they are driven (or "forced") by observed changes in both natural forcing agents (such as variations in the output of the Sun) *and* anthropogenic factors (such as changes in greenhouse gas concentrations and aerosol particle changes). Natural forcing factors alone cannot explain the past record.

Using the results from this model/observed data comparison, I will give projections of future changes in global-mean temperature for a central scenario for future emissions. These results, which are consistent with projections given in the IPCC TAR, imply, for this particular emissions scenario, a future warming rate of three to five times the warming that occurred over the 20th century. The uncertainty range expands to two to seven times the past warming rate when emissions and other uncertainties are accounted for. Even at the low end, these projections are cause for concern.

2. Temperature changes over the 20th century

The simplest indicator of climate change is the global-mean, near-surface temperature—the average over the Earth's surface area of temperature observations obtained primarily for the purposes of weather forecasting. After carefully correcting these data for instrumental and exposure changes, global-mean temperature shows a warming trend of about 0.7 °C over the past 100 years. This warming trend has, superimposed on it, substantial variability on monthly, annual and decadal timescales associated with natural climate processes such as El Niño and other interactions between the land, ocean and cryosphere (ice)—see Figure 1.

To understand the causes of the century timescale warming trend we make use of climate models. Such models are an efficient way to synthesize and integrate, in an internally-consistent way, the many complexities and interactions of the climate system. The basic procedure begins by defining, independently of the model, the changes in the external drivers of the climate system. We then use these drivers as input forcing factors for the model and run the model to see how well it agrees with observed changes. In doing so, we try to quantify any uncertainties in both the inputs and the model structure to see what affects these uncertainties might have on the model outputs.

The forcing factors are of two types: *natural* agents like the effects of large volcanic eruptions and changes in the energy output of the Sun; and a variety of *anthropogenic* factors. Volcanic eruptions have a strong short-term cooling effect (Robock, 1999), and only a minimal effect on decadal or longer timescales. Since the goal here is to understand the century timescale warming, I will not consider volcanic effects further in this analysis, beyond noting that climate models are able to simulate the short-term coolings well. For changes in solar output, I use the recent estimates of Foukal (2002) from 1915 onwards and Hoyt and Schatten (1993) prior to 1915. Other estimates of solar output changes yield similar results. I do not consider the hypothesized amplification of solar forcing through the effects of cosmic rays, partly because there is no credible physical basis for this amplification. I note, however, that any assumed amplification of solar forcing degrades the agreement between model and observed results.

The anthropogenic factors include changes in the concentrations of greenhouse gases (carbon dioxide, methane, nitrous oxide, ozone, and various man-made halocarbons, of which the CFCs—chlorofluorocarbons—are the most well known), and changes in the atmospheric loading of small particles (aerosols) associated primarily with fossil fuel burning. The greenhouse gases, of which carbon dioxide is the most important, have a warming effect. Aerosols, depending on type, may have either a warming or cooling effect. To date, the cooling effect dominates, but the magnitude of this cooling is still uncertain. In the results below I consider a range of possible values for the magnitude of aerosol cooling.

For the climate model I use the model employed by IPCC to produce their global-mean temperature projections (see Wigley and Raper, 2002, and references therein). This is a relatively simple model, but it has been rigorously tested against much more complex coupled Atmosphere/Ocean General Circulation Models (AOGCMs) and is able to simulate the results of these models with high accuracy over a wide range of conditions (Raper *et al.,* 2001).

The simpler model has the advantage that it can be used to examine the effects of uncertainties in the parameters that control the response of the climate system to external forcing. The primary source of uncertainty is the "climate sensitivity" parameter (designated by "S" below). This is usually characterized by the eventual (or "equilibrium") global-mean warming that would occur if we doubled the amount of carbon dioxide in the atmosphere. It has an uncertainty range of 1.5 °C to 4.5 °C with about 90 percent confidence. I will give results for sensitivity values of 2 °C and 4 °C to show the importance of this factor. For more information on sources of modeling uncertainty, see Wigley and Raper (2001).

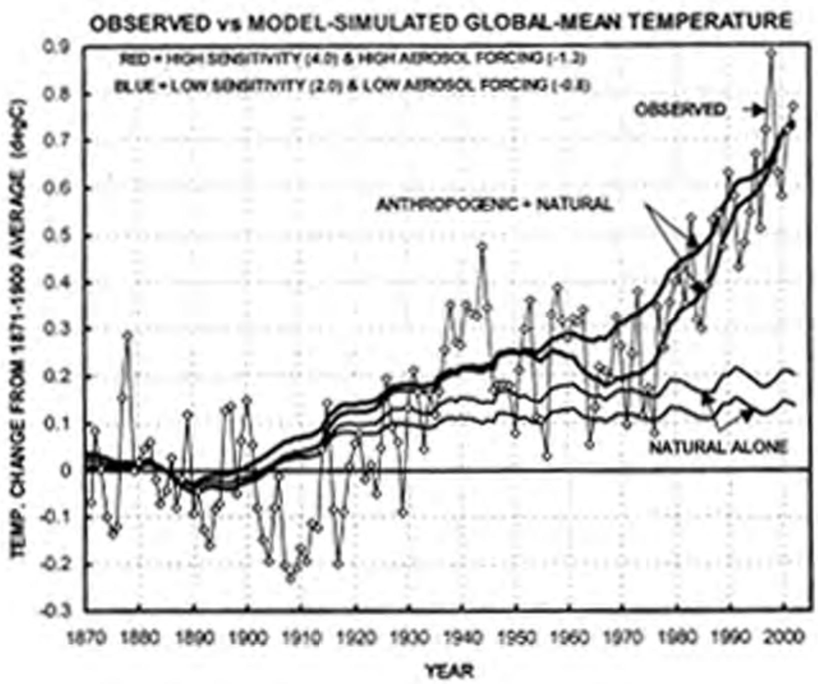

Figure 1: Observed versus model-simulated changes in global-mean, near-surface temperature. For observed data, see Jones *et al.,* (1999) and Jones and Moberg (2003).

Figure 1 compares observed near-surface temperature changes with model predictions. The four model-based curves consider two forcing cases; one in which the model is driven solely by the primary natural driving force, changes in the output of the Sun (lower two curves), and one where both natural and anthropogenic forcings are used to drive the model (upper two curves). The two curves for each case reflect the main sources of uncertainty in the modeling exercise, the magnitude of aerosol forcing, and the magnitude of the climate sensitivity.

The upper two curves show that it is possible to obtain a good match between the model and observations by using a low aerosol forcing (–0.8W/m^2 in 1990) combined with low climate sensitivity (S = 2.0 °C), or by using a relatively high aerosol forcing (–1.3W/m^2 in 1990) combined with low climate sensitivity (S = 4.0 °C). Since these values are within their accepted ranges of uncertainty, it is clear that there is no inconsistency between models and observations. The observations, however, do not narrow the ranges of uncertainty for these two parameters, so, in making projections of future change, we need to account for these uncertainties.

The lower two curves show the expected global-mean temperature changes in the absence of anthropogenic forcing. Up to around the mid 1970s both the natural-forcing-only and the natural-plus-anthropogenic forcing cases fit the observations reasonably well. After this, the natural-only case provides an increasingly bad fit, while the natural-plus-anthropogenic case fits the observed warming trend extremely well. It is clear from this that anthropogenic forcing effects *must* be considered in order to explain the observations.

3. Satellite-based temperature changes since 1979

One of the more puzzling aspects of recent climate change has been the apparent inconsistency between the linear trends in tropospheric temperatures (from satellite-based Microwave Sounding Units—MSU data), surface air temperatures, and model results (National Academy of Sciences (NAS), 2001). The original MSU data (see Christy *et al.,* 2003, and earlier references cited therein—this data set is referred to below as the UAH data, since its developers are associated with the *U*niversity of *A*labama at *H*untsville) showed little or no warming trend since the beginning of the satellite record in 1979, while both the surface data and model results for the surface and for the troposphere (as illustrated in Figure 1) showed a substantial warming trend. The NAS (2001) report concluded that there was no reason to suspect serious errors in any of the trends, but this rather down-played what is really an important inconsistency.

More recent work has moved towards resolving this inconsistency. First, an entirely independent analysis of the raw satellite data (the MSU2 data specifically) has recently been carried by Mears *et al.,* (2003—these authors are with *R*emote *S*ensing *S*ystems, Santa Rosa, CA, so their data set is referred to below as the RSS data). This new analysis has a warming trend that is both larger than the UAH trend and more consistent with both the surface and model data (Santer *et al.,* 2003a). Second, a new reanalysis product (the ERA–40 data produced by the European Centre for Medium-range Weather Forecasting), when used to construct equivalent MSU2 temperature trends, also shows a larger warming trend than the UAH data. (Reanalysis is a technique for synthesizing diverse observational data sets, including both satellite and radiosonde data, to produce an internally-consistent picture of changes in atmospheric meteorological conditions—the ERA exercise is described in Gibson *et al.,* 1997.) Third, analysis of changes in the height of the tropopause—the boundary between the lowest layer of the atmosphere, the troposphere, where temperatures decrease with height, and the layer above this, the stratosphere, where temperatures either change little or increase with height—show that these changes can only be explained if the troposphere is warming (Santer *et al.,* 2003b).

Trends in the three observed data sets, UAH, RSS and ERA–40 are shown in Figure 2, along with model results consistent with those shown in Figure 1. The observed trends have substantial statistical uncertainty because of the "noise" of interannual variations about the underlying trend. The statistical uncertainty ranges shown in the Figure are the 'two-sigma' ranges, corresponding to 95 percent confidence intervals. For the model results there are additional uncertainties associated primarily with radiative forcing and climate sensitivity uncertainties, as explained above.

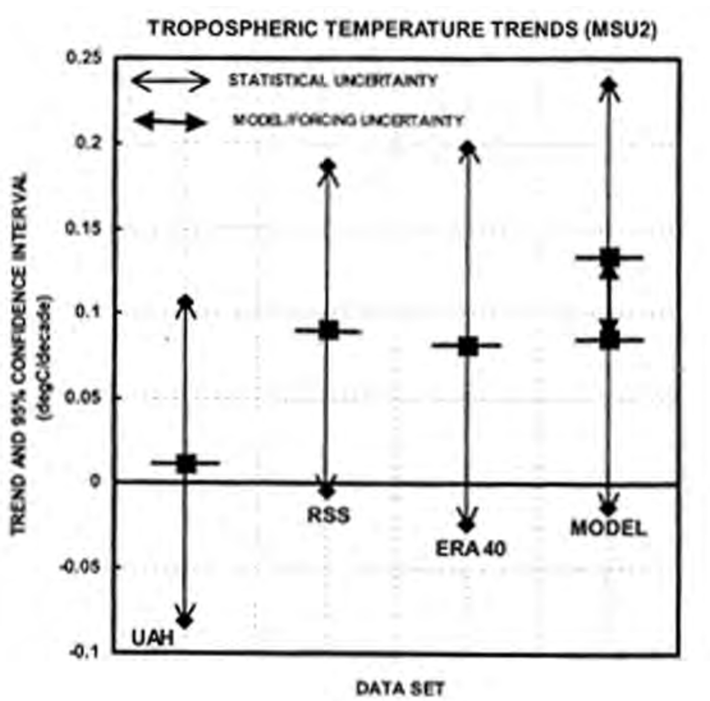

Figure 2: Trends over 1979–2001 and trend uncertainties for different tropospheric data sets.

In a statistical sense, Figure 2 shows that there is no significant difference between any of the trends. While it is clear that the UAH results are qualitatively different from the other results, because of the uncertainties involved it is too soon to pass judgment. As noted by Santer *et al.,* (2003a), model results cannot be used as a basis for selecting one observed data set over another. The key result of this comparison is that it exposes uncertainties that are larger than hitherto suspected. If, however, the UAH data are found to have underestimated the warming trend in the troposphere, then this will resolve an important climatological 'problem' and provide a strong endorsement for the validity of current climate models.

4. Supporting evidence for 20th century climate change

The temperature results above provide strong evidence for the reality of a strong warming trend over the 20th century. The warming is consistent with model expectations and can only be explained if one includes anthropogenic factors as part of the cause. From Figure 1, the natural warming trend over the 20th century accounts for only 23–32 percent of the total trend. The observations are also consistent with a climate sensitivity in the standard 1.5 °C to 4.5 °C range, and are not consistent with a lower value.

These results are consistent with many other lines of evidence that there are unusual changes occurring in the climate system. Not only are *global-mean* temperature changes consistent with models, but the horizontal and vertical patterns of change also agree with model predictions (TAR). In addition, a sharp cooling trend has been observed in the stratosphere that agrees well with model predictions (Santer *et al.,* 2003a). Sea level has been rising steadily (TAR), partly as a result of warming in the ocean that agrees with model expectations (Barnett *et al.,* 2001) and partly due to the melting of glaciers and small ice sheets (TAR). Sea ice area and thickness have also been decreasing in accord with the changes suggested by models (Vinnikov *et al.,* 1999). Sea-level pressure patterns have shown significant changes and, once again, these changes are similar to those predicted by models (Gillett *et al.,* 2003). The frequency of precipitation extremes has also been increasing (Karl and Knight, 1998; Groisman *et al.,* 1999), a result that agrees both with simple physical reasoning (Trenberth *et al.,* 2003) and with model predictions (Wilby and Wigley, 2002). Finally, based on paleoclimatological evidence, the warmth that characterizes the late 20th century is, at least for the Northern Hemisphere, unprecedented in at least 1000 years (Mann and Jones, 2003).

5. Climate change over the 21st century

Given the weight of evidence endorsing the credibility of climate models, at least at large spatial scales, we can safely use these models to estimate what changes might occur over the next 100 years. To do this we must first estimate how the emissions of all climatically-active gases will change in the future. As part of the IPCC Third Assessment Report process, a large set of future emissions scenarios was developed, all under the "no-climate-policy" assumption (referred to as the "SRES" scenarios for "*S*pecial *R*eport on *E*missions *S*cenarios"; Nakićenović and Swart, 2000). In total there are 35 complete scenarios spanning a range of assumptions about future population growth, economic growth, technological change, and so on—and each set of assumptions leads to a different set of emissions. In order to predict future climate one must take account of the attendant uncertainties in emissions, since it is these that drive changes in the composition of the atmosphere, which in turn drive changes in the climate system. At each step, in going from emissions to atmospheric composition changes, and from composition changes to climate, there are other uncertainties that must be taken into account. Most of these uncertainties were accounted for in the TAR, where the estimated changes in global-mean temperature over 1990 to 2100 were given as 1.4 °C to 5.8 °C. A more formal probabilistic analysis was given by Wigley and Raper (2001).

Here, to illustrate the procedure, I will use a single emissions scenario, the A1B scenario, which is roughly in the middle of the range covered by the SRES set. I will then account for uncertainties in aerosol forcing and climate sensitivity as in Figure 1 (recognizing that this does not span the full range of uncertainties in these parameters). The projected future changes in global-mean temperature, compared with past changes, are shown in Figure 3.

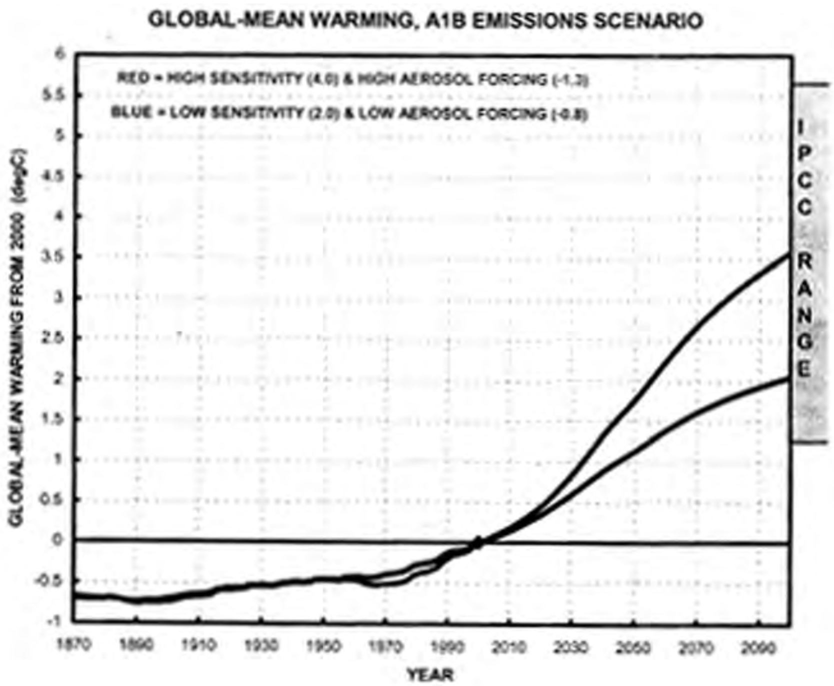

Figure 3: Projected global-mean warming.

Over 2000 to 2100 the warming range is 2.0 °C to 3.6 °C, which corresponds to warming rates of roughly three to five times the rate of warming over the 20th century—and temperatures are still increasing at the end of the century. A wider uncertainty range is obtained when other uncertainties are accounted for, as in the TAR analysis (shown by the bar on the right side of the Figure). Even at the low end of the range of possibilities, the warming rate over 2000 to 2100 is double the 20th century warming rate, while at the top end the future rate is seven times the past rate.

Major changes in all aspects of climate will occur in parallel with these unprecedented global-mean temperature increases. Many of these will be beyond our present adaptive capabilities (particularly in lesser developed countries), and will undoubtedly lead to damages to natural ecosystems and managed systems such as agriculture and water resources, and to possibly serious consequences for health and the spread of pests and disease. While the changes and their impacts cannot be predicted in detail, and while some of the consequences of future climate and atmospheric change may be positive, it would be prudent to insure against adverse changes either through improving our adaptive capabilities and/or, through emissions mitigation, reducing the magnitude of future climate change. In the absence of climate policies, as time goes by we will be moving further and further into unknown climate territory and committing ourselves to even larger future changes. Because of the inertia in both socioeconomic systems and the climate system, it is likely that quite aggressive actions may be required to avoid (quoting Article 2 of the Framework Convention on Climate Change) "dangerous interference with the climate system", and ensure that we are able to stabilize the composition of the atmosphere and the climate at acceptable levels.

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The CHAIRMAN. Thank you very much.

Dr. Schneider?

STATEMENT OF STEPHEN H. SCHNEIDER, PROFESSOR, DEPARTMENT OF BIOLOGICAL SCIENCES; CO-DIRECTOR, CENTER FOR ENVIRONMENTAL SCIENCE AND POLICY, STANFORD UNIVERSITY

Dr. SCHNEIDER. Thank you very much, Senator, and I appreciate your noticing my jet-lagged eyes.

[Laughter.]

Dr. SCHNEIDER. But let me begin with a personal point, which is how much I appreciate having testified before committees in which you sat since—maybe neither one of us wants to remember back to the mid-1980s, and the 1990s in the case of Senator Lieberman. And many of us in the outside community deeply appreciate your staying with this issue.

We also appreciate the opportunity to try to clarify very briefly, which is all I can do in the few minutes I have now, some of the items that may be confusing to people on the outside.

We hear claims that climate will lead to certain catastrophic outcomes. We hear claims that it'll be good for you from CO_2 fertilization. And I'll state my prejudice at the outset, sir, which is that "the end of the world" and "good for you" are the two lowest probability outcomes.

Almost everything else in between is more likely, and that includes a substantial number of events which could have serious consequences; and, therefore, I find that entirely justifiable that you and your colleagues are looking to find solutions which are both fair, cost effective, and able to handle the reduction in the growth rate of the gases that we think will create this problem.

I was asked, thinking back to a Committee that you were on in May 8, 1989, and, in fact, it was this very Committee, there was contention about the degree to which uncertainty would allow us to say anything. And I was pressed by Senators at the time to say, "Well, you don't know this based on looking at the temperature changes of the kind that Dr. Wigley just mentioned." And the point that I said—I just looked it up—I said, "Most of our confidence that the future will change is about the heat-trapping properties of gases, not so much based on the performance of the planet in this century. If we insist on waiting for the planet to catch up with what we expect it to do, it is another 10 to 20 years to prove that."

Well, so I put myself on the line. That was 14 years ago, and I would now argue that nature has caught up with theory. And precisely what Tom Wigley said has driven the vast bulk of climate scientists to assert that despite remaining uncertainties in many aspects of the problem, it's overwhelmingly clear that something unusual is going on in the last few decades. And recent studies are suggesting it isn't just the last few decades relative to the last hundred years, with the graphics we saw, but the last few decades are unusual over the timescale of 2,000 years.

Moreover, there are those who assert, "Well, maybe this is just an accident of nature. Maybe it's just the sun that did it." And, of course, it raises the question among most serious scientists, well, if the sun is acting so perverse, why did it choose the last two decades when we also happened to have increased greenhouse gases and land-use changes and other things?

So the best explanation we have for the complex set of issues is, as Dr. Wigley has said, and the IPCC, and the National Research Council, a combination of natural and human factors. And in the recent years, the human factors are probably becoming dominant.

Now, that's becoming dominant for the warming of up to the degree or so Fahrenheit we had, and what's really critical is predicting what might happen in the future. In order to do that, we depart with the climate science of arguing about feedbacks and oceans and so forth, and now move into the realm of human behavior, because we have to figure out how many people will there be in the world, what kind of standards of living will they demand, and what kind of technologies and organizations will they use to bring those about, because that's what determines the relative amount of emissions, land-use, and so forth. Not only do those behaviors of us—which, of course, we have a choice over, including supporting this bill, which, personally, I strongly do—we also have to say as countries evolve and as people develop, it changes our capacity to adapt to the very pressures that we will put on and that nature will put on.

So it all works interactively, and that what we have to do is recognize that our choices made in the next generation or so will then play themselves out, not just for the climate, but for our vulnerability to climate changes of all kinds over the century as a whole.

Therefore, rather than dwell more on climate, let me, instead, talk about the "so what." So what if the climate changes? And there's very good science that's recently emerged in that. In particular, two studies published this year, both using independent methods, showed that plants and animals in the world are not longer sitting passively, but actually beginning to respond to the six-tenths of a degree, seven-tenths of a degree warming that's already taken place.

Now, it shouldn't come as any surprise to somebody who's actually opened their eyes outside that if it gets warmer, the trees will flower early, or butterflies might move up mountains, or birds would lay eggs earlier. That wasn't the surprise. The surprise was that the warming we've had so far has been sufficient to lead to a clear statistically significant signal that's discernable in hundreds of species of plants and animals. No one has claimed harm from that yet, but if we can see the change already, at six-tenths of a degree-C, then if we end up with the numbers Dr. Wigley referred to, where warming would be, if we're lucky, another degree or so, and, unlucky, five, then we would expect dramatic reorganization of ecosystems. Not only would they be forced to move, and move rapidly, but they'd have to cross factories, farms, freeways, and urban settlements. And those combination of disturbances means that nature could very well be the prime reason for concern for dealing with the greenhouse effect and its future potential.

Let me wrap up by saying we have to take a long view. It's very difficult, as we all know—there's a famous expression that "politics is now, and politics is local"—and, indeed, there's a lot of truth in that. On the other hand, the tailpipe that I may have is going to do exactly the same thing to the climate as one from China or Russia. And as a result of that, we are all in this together. And as each nation fashions its own best solution, we have to recognize that that can only be partially effective without international agreements to try to coordinate cost-effective and fair actions.

You mentioned at the outset, for the first testimony, that there were critics who suggested that it was unimaginably expensive to try to deal with this problem. Last summer, a Swedish colleague, Christian Azar, and I had published a paper, in the Journal of Ecological Economics, where we examined that. And we looked and said, supposing we did the impossible thing, we had a draconian carbon tax of $300 or $400 a ton, something that would be considered politically outrageous today, and that led to a stabilization of carbon dioxide in the atmosphere of 300 or 400 parts per million, or 500, something well below any of the current IPCC scenarios. Well, if we costed those out using conventional economic models, the present value is on the order of something like $10 to $20 trillion. Well, that seems so outrageously unimaginable among the world economies, $30 trillion, that we can understand why people were criticizing it.

But then we took a step back and said, wait a minute, that's the present value of the entire event over a hundred years. All these same economic models project about a 2 percent per year growth rate in GDP, so the current economy, 30 trillion, would have to be multiplied times eight. It would be something like 250 trillion. So if you have a 2 percent per year growth rate in 2100, and you have a $250 trillion economy, a $20 trillion cost at that time is about 1 percent of GDP. In other words, we could essentially solve the global warming problem and do it by getting 500 percent richer in personal income, globally averaged, and have to have that wealth occur in 2101 instead of 2100. I would assert that's a very inexpensive insurance policy to deal with a potentially dangerous problem, such as climate change.

I have heard it similarly said about this very bill that we're discussing, that it could have very high costs. When one looks at numbers in absolute terms, like billions of dollars, that seems high. But when one looks at the very, very small percentages of change to GDP, you're literally talking about delaying 25 to 50 percent increases in personal income several months, at most, and that's with pessimistic assumptions.

So I think we need to have two kinds of perspectives in talking about this, and one is the absolute costs, and the other one is the relative costs to the growth rate in the economy. And if one looks at that, one will find that it is not remotely too expensive, in my personal view, to try to slow down the potential of dangerous climate change that the previous speakers have described.

Thank you, sir.

[The prepared statement of Dr. Schneider follows:]

PREPARED STATEMENT OF STEPHEN H. SCHNEIDER, PROFESSOR, DEPARTMENT OF BIOLOGICAL SCIENCES; CO-DIRECTOR, CENTER FOR ENVIRONMENTAL SCIENCE AND POLICY, STANFORD UNIVERSITY

Introduction and Personal Perspective. If I may indulge in a personal note at the outset: it is a pleasure to appear again in front of both Senators McCain and Lieberman on climate change issues, having had that honor on several occasions since the mid-1980s with Senator McCain and the mid-1990s with Senator Lieberman. As these hearings today are about the "case for action" on climate change based on sound science assessment, I will try to emphasize aspects of the science of climate change less exhaustively covered by other witnesses, such as Dr. Tom Wigley of the National Center for Atmospheric Research, whose testimony on climate change science I fully associate myself with. Instead, I will focus more on climate change impacts. The problem was well-stated by Senator Lieberman when I commented to the Senate Environment and Publics Works Committee, chaired by the late Senator Chaffee, in July 1997. At that time, Senator Lieberman said:

> Changes in climate have major implications for human health, water resources, food supplies, infectious diseases, forests, fisheries, wildlife populations, urban infrastructure, and flood plain and coastal developments in the United States. Although uncertainties remain about where, when, and how much climate might change as a result of human activities, the changes—when they happen—may have severe impacts on many sectors of the U.S. economy and on the environment. These are serious risks that we must start considering (p. 15).

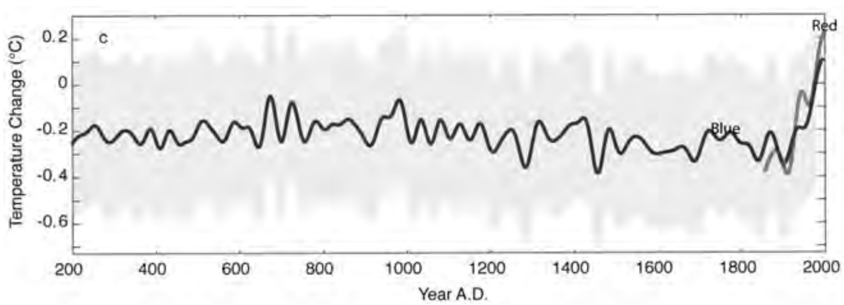
This statement is equally valid today and can be further supported by substantially more scientific studies pointing out potentially serious climate impacts. I will briefly review some of these and put them in the context of climate change cost-benefit analyses. But first, a brief statement about the climate change science itself.

While testifying to this Committee on May 8, 1989—when Senator McCain was a member of the Committee—I recall a discussion about the problem of uncertainties surrounding climate change and the question of how long we should wait before taking action. Some debaters had asserted that there wasn't enough direct evidence of human-induced climate change for strong policy actions. In response to Senators from this committee on that point, I agreed that "Most of our confidence that the future will change is based on literally millions and millions of observations which tell us about the heat trapping properties of gases, not based so much on the performance of the planet this century. If we insist on waiting for the planet to catch up to what we expect it to do, it is another 10 to 20 years to prove that beyond doubt" (p. 150).

Well, it is now 14 years since I said that. I believe the work of the Intergovernmental Panel on Climate Change (IPCC), the U.S. National Academy of Sciences (NAS), and others has amply demonstrated that, indeed, nature has "caught up" with our expectations of warming and in fact added a few surprises like rapid changes in polar regions and devastating heat-wave-induced deaths, even in modern, highly developed countries, with the more than 15,000 mortalities occurring in France this summer as a result of the extreme heat serving as a prime example.

Surface warming trends are solidly grounded in observational science and consistent with human-induced pressures. It is scientifically well established that the Earth's surface air temperature has warmed significantly, by about 0.6 ° Celsius (C) since 1860, and that an upward trend can be clearly discerned by plotting historical temperatures. Such a graph would show a rapid rise in temperature at the end of the twentieth century. This is supported by the fact that all but three of the ten warmest years on record occurred during the 1990s. But what has been learned only in the past five years is that this unusual warmth in recent years is not just an anomaly in temperature records of the last 140 years, but the past 2000, as Figure 1 displays.

Figure 1. 2,000-year reconstruction of global temperature changes in degrees Celsius



The blue line represents the temperature reconstruction, with 95 percent confidence band shown in yellow and the instrumental record in red. Notice that the last several decades of the 20th century exceed the range of temperatures over the past 2,000 years. (Source: Mann and Jones, 2003.)

The probability that the radical upward swing in temperature at the tail end of the 20th century is just a natural quirk of nature—as some "contrarians" and their political supporters contend—is exceedingly low. If, as some assert, "the sun did it", then what was the sun doing over the previous 2 millennia? It is rather perverse to expect such radical behavior from the sun just now, at the same time that we have clear evidence of human-induced pressures coincident with the warming. While the possibility (at some low probability) that natural factors are responsible for the unusual warmth of the Earth's surface at the end of the 20th century cannot be ruled out completely, a much more likely explanation is that the warming is the result of a mix of natural and human-induced (anthropogenic) factors. While this alone is cause for worry, more disquieting still are climate change projections for the 21st century, especially if we assume that greenhouse gas emissions follow a business-as-usual path.

It is for these reasons that I express my personal satisfaction for having, over the past two decades, had the opportunity to testify to the Senators currently leading this effort to establish a meaningful climate change policy for the United States that will actually result in emissions reductions. In my personal opinion, it is essential that we get on with the job of providing (mandatory) incentives to push the amazing industrial and intellectual capacity of our country to fashion cost-effective solutions. I thank the Senators for having pursued this issue over the long term.

As mentioned, nature has cooperated with theory in the past few decades, as evidenced by the record warming. In addition, it is well-established that human activities have caused increases in radiative forcing, with radiative forcing defined as a change in the balance between the radiation coming into and going out of the surface-atmosphere system. In the past few centuries, atmospheric carbon dioxide has increased by more than 30 percent, and virtually all climatologists agree that the cause is human activities, and the burning of fossil fuels in particular.

Despite the many well-established aspects of the science of climate change (*e.g.,* anthropogenic forcing of global warming), other aspects (*e.g.,* specific regional changes) are still being vigorously debated. In fact, the climate change debate is characterized by deep uncertainty, which results from factors such as lack of information, disagreement about what is known or even knowable, linguistic imprecision, statistical variation, measurement error, approximation, subjective judgment, and disagreement about structural models, among others (see Moss and Schneider, 2000). These problems are compounded by the global scale of climate change, which produces varying impacts at local scales, long time lags between forcing and its corresponding responses, very long-term climate variability that exceeds the length of most instrumental records, and the impossibility of before-the-fact experimental controls or empirical observations (*i.e.,* there is no experimental or empirical observation set for the climate of, say, 2050 AD, meaning all our future inferences cannot be wholly "objective," data-based assessments—at least not until 2050 rolls around). Moreover, climate change is not just a scientific topic but also a matter of public and political debate, and degrees of uncertainty may be played up or down (and further confused, whatever the case) by stakeholders in that debate.

Can We Define "Dangerous" Climate Change? Article 2 of the UN Framework Convention on Climate Change (UNFCCC) states that: "The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The Framework Convention on Climate Change further suggests that:

"Such a level should be achieved within a time frame sufficient

- to allow ecosystems to adapt naturally to climate change,
- to ensure that food production is not threatened and
- to enable economic development to proceed in a sustainable manner."

Thus, the term "dangerous anthropogenic interference" may be defined or characterized in terms of the consequences (or impacts) of climate change outcomes, which can be related to the levels and rates of change of climate parameters. These parameters will, in turn, be determined by the evolution of emissions and consequent atmospheric greenhouse gas concentrations. Evaluating the consequences of climate change outcomes to determine those that may be considered "dangerous" is a complex undertaking, involving substantial uncertainties as well as value judgments. In this context, the role of scientists is to assess the literature with a view to providing information that is policy-relevant, without being policy prescriptive.

Climate Sensitivity and Climate Scenarios to 2100 and Beyond. By how much will humans and natural changes in the Earth each contribute to future climate disturbance? The IPCC has attempted to tackle this controversial question in its Special Report on Emission Scenarios (SRES), which contains a range of possible future climate scenarios based on different assumptions regarding economic growth, technological developments, and population growth, arguably the three most critical determinants of future climate change. Together, the fan of possible climate scenarios and the probability distributions of possible climate sensitivities determine what policy makers often want to know—by how much will it warm in, say, 2100 (or any other time), depending on what policies we choose to change emissions scenarios (*e.g.,* Schneider, 2002).

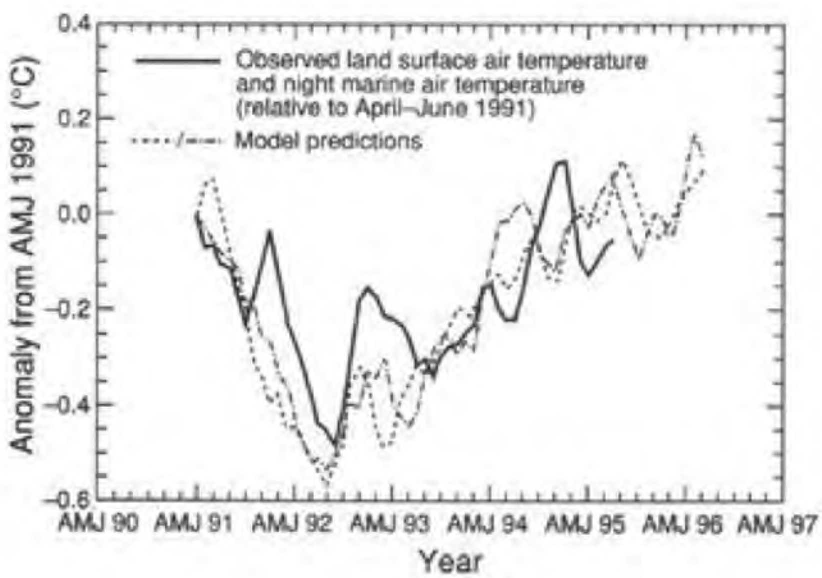
The SRES scenarios and other climate change projections depend on detailed modeling. The most typical way scientists codify knowledge is by constructing models made up of the many subcomponents of the climate system that reflect our best understanding of each subsystem. The most comprehensive models of atmospheric conditions are three-dimensional, time-dependent simulators known as general circulation models (GCMs). Because of the complexity and computational costs of GCMs, simpler models are often constructed to explore the sensitivity of outcomes to plausible alternative assumptions (*e.g.,* Wigley's, testimony to this session). The system model as a whole cannot be directly tested before the fact—that is, before the future arrives—but it can be verified against historical situations that resemble what we believe will be analogous to what will occur in the future (see “Model Validation” below).

While modeling has become both more complex and more accurate as computing abilities have advanced and more is understood about the climate problem, scientists still have to deal with an enormous amount of uncertainty, as mentioned above. In modeling, a major uncertainty is climate sensitivity, the amount by which the global mean surface air temperature will increase for a doubling of CO_2 concentrations from pre-industrial levels. Many scientists have done extensive modeling and observational research on this subject over the past 20 years, and most agree that climate sensitivity probably falls somewhere within the IPCC’s range of 1.5–4.5 °C. However, that old consensus is changing, as several recent studies (*e.g.,* Andronova and Schlesinger, 2001; Forrest *et al.,* 2001) have estimated that climate sensitivity could be an alarming 6 °C or higher. (To give a sense of the magnitude, a 5–7 °C *drop* in temperature is what separates Earth’s present climate from an ice age.)

Model Validation. In the presence of so much uncertainty, how can modelers be more confident in their model results? How do they know that they have taken into account all economically, ecologically, and/or climatologically significant processes, and that they have satisfactorily “parameterized” processes whose size scales are below that of their models’ grid cells? The answer lies in a variety of model validation techniques, most of which involve evaluating a model’s ability to reproduce—in the case of climate models—known climatic conditions in response to known forcings.

Volcanic eruptions are one good form of model validation. Major volcanic eruptions inject so much sulfuric acid haze and other dust into the stratosphere that they exert a global cooling influence that lasts several years. Such eruptions occur somewhat randomly, but there is typically one every decade or so, and they constitute natural “experiments” that can be used to test climate models. The last major volcanic eruption, of the Philippine volcano Mt. Pinatubo in 1991, was forecast by a number of climate modeling groups to cool the planet by several tenths of a degree Celsius. That is indeed what happened.

Figure 2. Predicted and observed changes in global temperature after the 1991 eruption of Mt. Pinatubo



Solid curve is derived from measured air temperatures over land and ocean surfaces. Broken curves represent climate model runs with slightly different initial conditions. In both cases the models included the effect of dust injected into the atmosphere by the volcanic eruptions. (Source: Hansen *et al.,* 1996.)

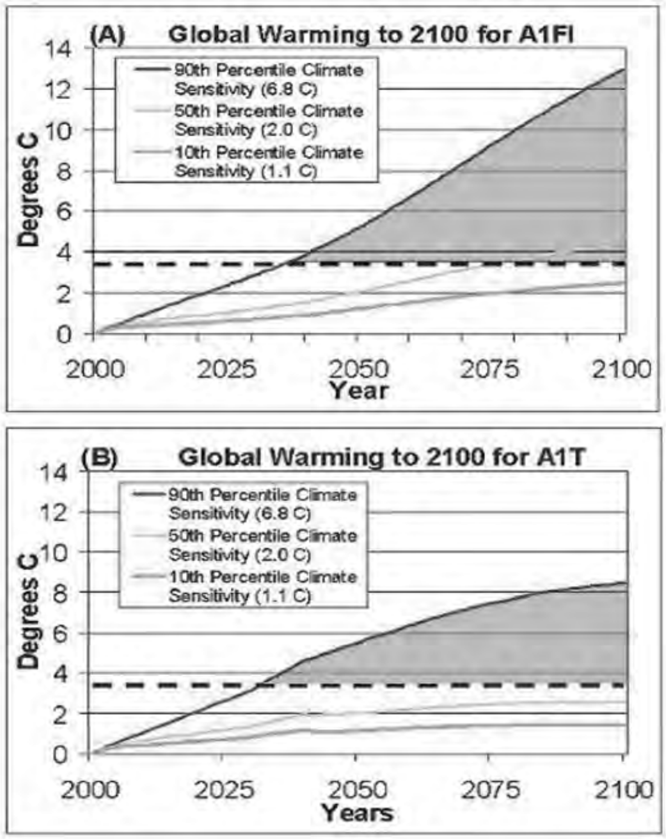
Figure 2 shows a comparison between actual global temperature variations and those predicted by a climate model for a period of five years following the Mt. Pinatubo eruption. Now, a drop in temperature of a few tenths of a degree Celsius is small enough that the observed variation just could be an unusual natural fluctuation. However, earlier eruptions, including El Chichón in 1983 and Mt. Agung in 1963, were also followed by a marked global cooling of several tenths of a degree Celsius. Studying the climatic effects from a number of volcanic eruptions shows a clear and obvious correlation between major eruptions and subsequent global cooling. Furthermore, a very simple calculation shows that the negative forcing produced by volcanic dusts of several watts per square meter is consistent with the magnitude of cooling following major volcanic eruptions. Viewed in light of these data, the graph above suggests that climate models do a reasonably good job of reproducing the large-scale climatic effects of volcanic eruptions over a time scale of a few years.

Seasonality provides another natural experiment for testing climate models. Winter weather typically averages some fifteen degrees Celsius colder than summer weather in the Northern Hemisphere and five degrees Celsius colder in the Southern Hemisphere. (The Southern Hemisphere variation is lower because a much larger portion of that hemisphere is water, whose high heat capacity moderates seasonal temperature variations.) Climate models do an excellent job reproducing the timing and magnitude of these seasonal temperature variations, although the absolute temperatures they predict may be off by several degrees in some regions of the world. However, the models are less good at reproducing other climatic variations, especially those involving precipitation and other aspects of the hydrological cycle. Of course, being able to reproduce the seasonal temperature cycle alone—since it comes full circle in only one year—does not guarantee that a model will accurately describe the climate variations resulting from other driving factors (such as increasing anthropogenic greenhouse gas concentrations) that will likely occur over decades or centuries. On the other hand, the fact that models do so well with seasonal variations is an assurance that the models' climate sensitivity is unlikely to be off by a factor of 5–10, as some contrarians assert.

Joint Probability Estimation. The combined effects of uncertainties in emissions and uncertainties in climate sensitivity are also known as a "joint probability" (*i.e.,* sensitivity and emissions varied jointly). How do we approach this question of the joint probability of temperature rise to 2100 *and* crossing some "dangerous" warming threshold, to use the language of the UNFCCC—which, by the way, was signed by President Bush in 1992 and ratified by the Senate. Instead of using two probability distributions, an analyst could pick a high, medium, and low range for each factor and plot the results, as I will demonstrate. For example, a glance at Andronova and Schlesinger's (2001) calculations shows that the 10 percentile value for climate sensitivity is 1.1 °C for a doubling of CO_2 (*i.e.,* 4 W/m^2 of radiative forcing). 1.1 °C is, of course, below the IPCC's lower limit climate sensitivity value of 1.5 °C. However, this merely means that there is a 10 percent chance climate sensitivity will be 1.1 °C or less—that is, a 90 percent chance climate sensitivity will be 1.1 °C or *higher.* The 50th percentile result—that is, the value that climate sensitivity is as likely to be above as below—is 2.0 °C. The 90th percentile value for climate sensitivity from Andronova and Schlesinger (2001) is 6.8 °C, meaning there is a 90 percent chance climate sensitivity is 6.8 °C or less, but there is still a very uncomfortable 10 percent chance it is even higher than 6.8 °C—a value well above the 4.5 °C figure that marks the top of the IPCC's range. Using these three values to represent a high, medium, and low climate sensitivity, we can produce three alternate projections of temperature over time, once an emissions scenario is decided on.

In Schneider (2003), the three climate sensitivities just explained were combined with two SRES storylines: A1FI, the very high emissions, fossil fuel-intensive scenario; and A1T, the high technological innovation scenario, in which development and deployment of advanced technologies dramatically reduces the long-term emissions. This comparison pair almost brackets the high and low ends of the 6 SRES representative scenarios' range of cumulative emissions to 2100, and since both are for the "A1 world," the only major difference between them is the technology component. This component should be viewed as a "policy lever" that could be activated through the implementation of policies to encourage decarbonization, for example—like the bill before this committee. Therefore, studying how different the evolution of projected climate is to 2100 for the two different scenarios is a very instructive exercise and can help in exploring the different likelihoods of crossing "dangerous" warming thresholds.

Figure 3. Three climate sensitivities and two scenarios (source: Schneider, 2003)



As noted in Figure 3 above, the three climate sensitivities—10th, 50th and 90th percentiles—designated by Andronova and Schlesinger (2001) are combined with the radiative forcings for the A1FI and A1T scenarios laid out in the SRES. The dashed horizontal lines in both graphs represent the 3.5 °C cut-off—a very conservative number picked by me as the threshold value for "dangerous" climate change—and the blue shaded area marks the extent to which each temperature change scenario exceeds that 3.5 °C threshold. As shown, these scenarios produce similar projections of warming for the first several decades of the 21st century, but diverge considerably—especially in the high-sensitivity 90th percentile case—after mid-century. The 50th and 90th percentile A1FI cases both exceed the threshold of 3.5 °C warming before 2100, and the area shaded in blue is much more dramatic in the fossil-intensive scenario than the technological innovation scenario. In fact, at 2100, when the A1T curves are stabilizing, the A1FI curves are still upwardly sloped—implying even greater warming in the 22nd century. In order to fully assess "dangerous" climate change potential, simulations that cover well over 100 years will be necessary, since it is widely considered that warming above a few degrees Celsius is likely to be much more harmful than changes below a few degrees (see Figure 4 below).

How Long is a "Long View"? The most striking features of both scenarios in Figure 3 are the top (red) lines, which rise very steeply above the two lines below them. That is because of the peculiar shape of the probability density function for climate sensitivity in Andronova and Schlesinger (2001). [For those concerned with the technical details, that is because the probability density function has a long tail on the right-hand side, representing the possibility that aerosols have been holding back not-yet-realized warming and the rise in temperature could be much higher than currently expected.] Also striking is that both the 10th and 50th percentile results for both the A1FI and A1T scenarios don't differ much in 2050, but then diverge considerably by 2100. This has led some to declare (erroneously, in my view) that there is very little difference in climate change across scenarios or even among different climate models with different sensitivities. This is clearly wrong, for although both A1FI and A1T have emissions, and thus CO_2 concentration, projections that are not very different for the first several decades of the 21st century, they diverge after 2050, as does the temperature response. For the 90th percentile results, both the A1FI and the A1T temperature projections exceed the "dangerous" threshold of 3.5 °C at roughly the same time (around 2040), but the A1FI warming not only goes on to outstrip the A1T warming, but is still steeply sloped at 2100, implying warming beyond 13 °C in the 22nd century, which would undoubtedly leave a dramatic legacy of environmental damage for distant posterity and great ecological stress for nature.

Figure 3 shows, via a small number of curves (6 in all), the probability of temperature changes over time for three climate sensitivity probabilities, but it does not give probabilities for the emissions scenarios themselves; only two are used to "bracket uncertainty," and thus no joint probability can be gleaned from this exercise. This is the next step that needs to be taken by the research community. An MIT integrated assessment group (Webster *et al.,* 2003) has already attempted to fashion a probability distribution for future climate using a series of different models and expert judgments. Like other assessments, their work also suggests a wide range of possibilities, with some representing quite "dangerous" potential outcomes. That approach, I predict, will be the wave of the future in such analyses, but given the heavy model-dependence of any such results, individual "answers" will remain controversial and assumption-bound for a considerable time to come.

The likelihood of threshold-crossing is quite sensitive to the particular selection of scenarios and climate sensitivities used. However, in these bracketing studies, the probability of crossing "dangerous" thresholds of climate change is typically around ten percent—a risk society will have to weigh against the costs of climate mitigation activities. As will be discussed shortly, that is a high risk indeed.

If conventional economic discounting were applied, some present-day "rationalists" might argue that the present value of damages postponed for a century or so is virtually nil. But what if our behavior were to trigger irreversible changes in sea levels and ocean currents or the extinction of species (on generational time scales)? Is it fair to future generations for us to leave them the simultaneous legacy of more wealth and severe ecosystem damage? That is the dilemma thoughtful analysts of the climate policy debate have to ponder, since the next few generations' behaviors will precondition to a considerable extent the long-term evolution of the climate and the planetary ecosystems.

Climate Impacts. Let us consider some of the effects that might occur in the next century if the SRES emissions *do* occur. We can use models to calculate the climatic consequences of those scenarios unfolding, which then allow us to estimate potential impacts of climate changes, and in turn, the benefits of avoiding some of those potential damages through mitigation and/or other measures.

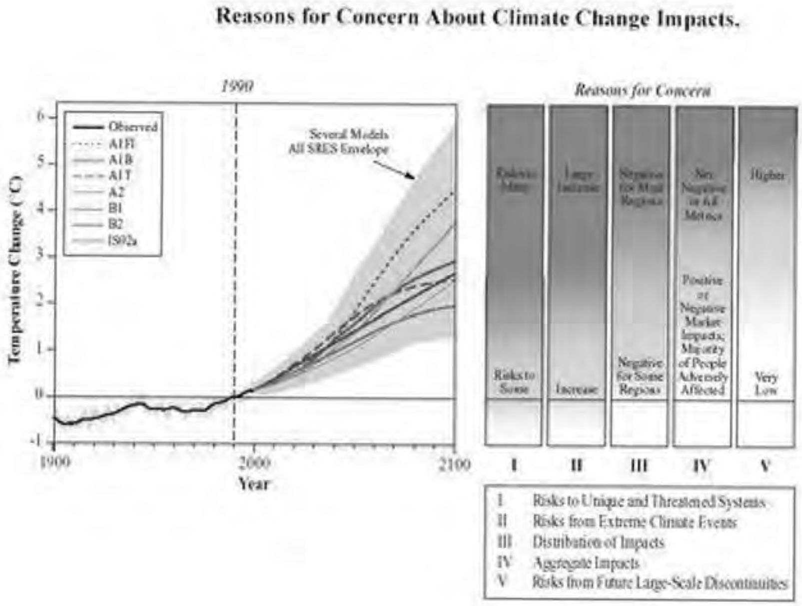
Table 1 shows the IPCC's summary of a number of such projected impacts. These effects have been consolidated into five major reasons for concern and represented graphically, as shown in Figure 4.

Table 1.—Projected effects of global warming during the 21st Century

(adapted from IPCC 2001b, table SPM–1)

Projected Effect	Probability estimate	Examples of Projected Impacts with high confidence of occurrence (67—95 percent probability) in at least some areas
Higher maximum temperatures, more hot days and heat waves over nearly all land areas	Very likely (90–99%)	Increased deaths and serious illness in older age groups and urban poor Increased heat stress in livestock and wildlife Shift in tourist destinations Increased risk of damage to a number of crops Increased electric cooling demand and reduced energy supply reliability
Higher minimum temperatures, fewer cold days, frost days and cold waves over nearly all land areas	Very likely (90–99%)	Decreased cold-related human morbidity and mortality Decreased risk of damage to a number of crops, and increased risk to others Extended range and activity of some pest and disease vectors Reduced heating energy demand
More intense precipitation events	Very likely (90–99%) over many areas	Increased flood, landslide, avalanche, and mudslide damage Increased soil erosion Increased flood runoff increasing recharge of some floodplain aquifers Increased pressure on government and private flood insurance systems and disaster relief
Increased summer drying over most mid-latitude continental interiors and associated risk of drought	Likely (67–90%)	Decreased crop yields Increased damage to building foundations caused by ground shrinkage Decreased water resource quantity and quality Increased risk of forest fire
Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities	Likely (67–90%) over some areas	Increased risks to human life, risk of infectious disease epidemics and many other risks Increased coastal erosion and damage to coastal buildings and infrastructure Increased damage to coastal ecosystems such as coral reefs and mangroves
Intensified droughts and floods associated with El Niño events in many different regions	Likely (67–90%)	Decreased agricultural and rangeland productivity in drought- and flood-prone regions Decreased hydro-power potential in drought-prone regions
Increased Asian summer monsoon precipitation variability	Likely (67–90%)	Increase in flood and drought magnitude and damages in temperate and tropical Asia
Increased intensity of mid-latitude storms	Uncertain (current models disagree)	Increased risks to human life and health Increased property and infrastructure losses Increased damage to coastal ecosystems

Figure 4—Reasons for concern about climate change impacts (source: IPCC Working Group 2 Third Assessment Report, figure SPM–2)



In Figure 4 above, the left part of the figure displays the observed temperature increase up to 1990 and the range of projected increases after 1990, as estimated by IPCC Working Group I (IPCC, 2001a). The right panel displays conceptualizations of five reasons for concern regarding climate change risks evolving through 2100. White indicates neutral or small negative or positive impacts or risks, yellow indicates negative impacts for some systems, and red means negative impacts or risks that are more widespread and/or greater in magnitude. This figure shows that the most potentially dangerous impacts (the red colors on the figure) typically occur after a few degrees Celsius of warming—thus, my use of 3.5 °C as a tentative "threshold" for serious climate damages in Figure 3 is very conservative. (The European Union has suggested the "dangerous" threshold is about 2 °C.) The risks of adverse impacts from climate change increase with the magnitude of climate change.

Despite uncertainties surrounding emissions scenarios and climate sensitivity, the IPCC has projected that, if its latest estimate that the Earth's atmosphere will warm somewhere between 1.4 and 5.8 °C by 2100 is correct, likely effects will include: more frequent heat waves (and less frequent cold spells); more intense storms (hurricanes, tropical cyclones, etc.) and a surge in weather-related damage; increased intensity of floods and droughts; warmer surface temperatures, especially at higher latitudes; more rapid spread of disease; loss of farming productivity and/or movement of farming to other regions, most at higher latitudes; species extinction and loss of biodiversity; and rising sea levels, which could inundate coastal areas and small island nations (see Table 1).

The threat of rising sea levels has been studied in great detail. It is thought that warmer atmospheric temperatures would lead to warming of ocean water (and corresponding volumetric expansion) until the heat was well-distributed throughout the oceans—a mixing time known to be on the order of 1,000 years. Instead of only up to a meter of sea level rise over the next century or two from thermal expansion of warmed ocean waters—and perhaps a meter or two more over the five or so centuries after that—significant global warming would likely trigger nonlinear events like a deglaciation of major ice sheets near the poles. That would cause many additional meters of rising seas for many millennia, and once started, might not be reversible on the time scale of thousands of years.

It is important that scientists continue to develop stronger models and probe the issue of climate sensitivity, as improvements in the science will lead to improvements in our understanding of the potential impacts of various levels of temperature change.

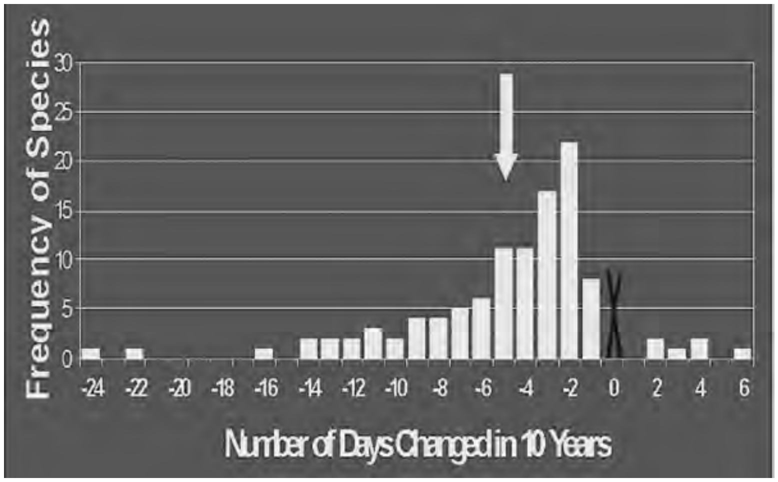
In What Units Can We Measure Climate Damage? Schneider, Kuntz-Duriseti, and Azar (2000) have argued that the best way to estimate the full extent of the climate change-induced damages described above is by examining not just monetarily-quantifiable ("market") damage, but the "five numeraires": monetary loss (market category), loss of life, quality of life (including coercion to migrate, conflict over resources, cultural diversity, loss of cultural heritage sites, etc.), species and/or biodiversity loss, and distribution/equity. Assessing climate impacts in all these categories should ensure a fairer, more accurate assessment of the actual costs of global warming.

The last numeraire, the issue of equity in climate change, is, and will likely continue to be, contentious. Climate change inequality will likely come in two forms. First, it will produce inequity in effects. Some countries or sectors within countries will benefit from a certain degree of warming, whereas others will be harmed by it. The developed countries, who are responsible for most of the greenhouse gases emitted into the atmosphere thus far may not be affected as much as the developing countries for two reasons: first, there is usually higher adaptive capacity in richer, cooler countries than in poorer, warmer ones. Second, developing countries that have not yet experienced the economic fruits of an industrial revolution and want their chance to emit and industrialize fear that policies to restrict emissions will deny them their "fair share" of the atmospheric commons to use—quite literally—as a waste dump. One strategy to solve this problem is "technology leapfrogging," the transfer or development of cleaner technologies to developing countries on a much-accelerated time schedule (relative to the developments that have emerged over a century in now-rich countries).

Moreover, as there are disparities in countries' abilities to pay for global warming-related problems, once again, the developing countries will be affected more yet have less of an ability to pay than the rich nations. While I agree it is essential to deal with climate policy at home—and thus personally applaud this bill before the committee today—we will have to join with other countries to fashion joint solutions in the near future if we are to make progress on the climate change problem.

Nature Is Already Responding. Another numeraire mentioned above was the loss of biodiversity. Very recent studies (*e.g.,* Root *et al.,* 2003; Parmesan and Yohe, 2003) have shown that nature is already responding to climate trends of the past several decades. Figure 5 (below), for example, shows the activities of many plants and animals—such as the flowering of trees and the migrating of birds in the spring—have been occurring earlier due to observed climate trends. That warmer weather would make flowers bloom earlier is hardly surprising, but that "only" 0.6 °C of warming to date has already caused a statistically significant "discernible impact" on plants and animals is surprising. Moreover, it is sobering to consider what major movements—and extinctions—would likely take place in plant and animal communities if the climate changes by several degrees or more.

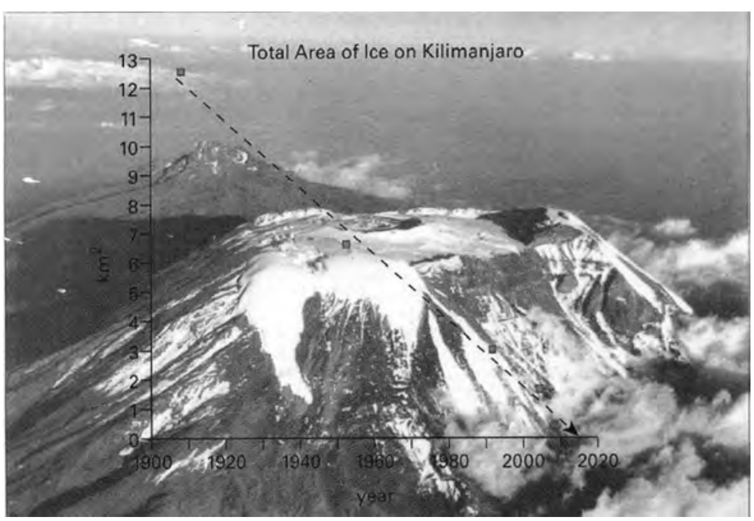
Figure 5. Frequency of species and groups of species with a temperature-related trait changing by number of days in 10 years for data gathered primarily since 1960



The arrow indicates the mean and the "x" indicates no data were tabulated for species showing no clear trait changes. This is a highly statistically significant result demonstrating that there has been a discernible impact of recent climate trends on plants and animals. Their vital activities that are linked to temperature are occurring earlier, in concert with global warming trends. (Source: Root *et al.,* 2003.)

Another clear climate impact is the retreat of mountain glaciers. This problem goes beyond just the disruption of scenic beauty as glaciers in places like Glacier National Park continue to disappear; it can be damaging to societies that are flooded during the glacier-melting stage and will later suffer from lack of water as their current supplies disappear with the glaciers. Figure 6 shows the dramatic disappearance of Mt. Kilimanjaro's glaciers, which have decreased in size by 80–90 percent relative to 100 years ago.

Figure 6. What will happen to the snows of Kilimanjaro?



The extent of ice cover on Mt. Kilimanjaro decreased by 81 percent between 1912 and 2000. Disappearing paleoclimate archives such as this are a priority target of the Global Paleoclimate Observing System currently being proposed by the Past Global Changes (PAGES) scientists.

Climate Surprises? The IPCC and others have stated that “dangerous” climate change, including surprises, is more likely to occur with more than a few degrees Celsius of additional warming. Surprises, better defined as “imaginable abrupt events”, could include deglaciation and/or the alteration of ocean currents, the most widely-used example of the latter being a slowdown of the Thermohaline Circulation, or THC, system in the North Atlantic Ocean. Ecosystems, especially those already stressed by land use pressures, are particularly vulnerable to rapid climate changes.

Estimating climate damages that are expected to occur gradually and their effects is simple relative to forecasting “surprise” events and their consequences. But rather than being ignored as unlikely, surprises and other irreversibilities like plant and animal extinctions should be treated like other climate change consequences by scientists performing risk assessments, where *risk* is defined as *probability x consequence.* While the possible consequences of climate change have been discussed thoroughly, they are often not accompanied by probabilities. The probability component of the risk equation will entail subjective judgment on the part of scientists, but this is far preferable to overlooking the risk equation entirely.

Policymakers will be better able to determine what is “dangerous” and formulate effective legislation to avoid such dangers if probabilities appear alongside scientists' projected consequences. These probabilities and consequences will vary regionally. In general, temperature rises are projected to be greatest in the subpolar regions, and to affect the polar winter more dramatically than the summer. Hotter, poorer nations (*i.e.,* developing nations near the equator) are expected to suffer more dramatic effects from climate change than their developed neighbors in the North. This is partly due to the lower expected adaptive capacities of future societies in developing nations (when compared with their developed country counterparts), which depend on their resource bases, infrastructures, and technological capabilities. This implies that damages may be asymmetrically felt across the developed/developing country divide. The scenario in which climate change brings longer growing seasons to the rich northern countries and more intense droughts and floods to the poor tropical nations is clearly a situation ripe for increasing international tensions and could cause developing nations to feel increasing resentment towards the most-polluting nations in the twenty-first century. That scenario has clear security implications for the United States.

Regardless of the different levels of vulnerability and adaptive capacity that future societies are expected to have and the need for regional-level assessments that that implies, all people, governments, and countries should realize that “we're in this together.” In all regions, people's actions today will have long-term consequences. Even if humanity completely abandons fossil fuel emissions in the 22nd century, elevated CO_2 concentrations are projected to remain for a millennium or more. The surface climate will continue to warm from this greenhouse gas elevation, with a transient response of centuries before an equilibrium warmer climate is established. How large that equilibrium temperature increase is depends on both the final stabilization level of the CO_2 and the climate sensitivity.

Implications for Climate Policy Choices. In the face of such uncertainty, potential danger, and long-term effects of present actions, how should climate change policy be confronted? As discussed previously, climate change, like many other complex socio-technical issues, is riddled with “deep uncertainties” in both probabilities and consequences. They are not resolved today and may not be resolved to a high degree of confidence before we have to make decisions regarding how to deal with their implications. With imperfect, sometimes ambiguous, information on both the full range of climate change consequences and their associated probabilities, decision-makers must decide whether to adopt a “wait and see” policy approach or follow the “precautionary principle” and hedge against potentially dangerous changes in the global climate system. Since policymakers operate on limited budgets, they must determine how much to invest in climate protection versus other worthy improvement projects—like new nature reserves, clean water infrastructure and other health improvement, and better education.

Ultimately, the decision on whether or not to take action on climate change entails a value judgment on the part of the policymaker regarding what constitutes “dangerous” climate change, ideally aided by complete risk assessments provided by scientists. Cost-benefit analyses (CBAs) are also useful in deciding the ifs and whats of climate change policy, but uncertainties and the need for multiple metrics (*e.g.,* the “five numeraires”) make this exercise difficult as well, especially when attempting to estimate the costs of surprise and other catastrophic events.

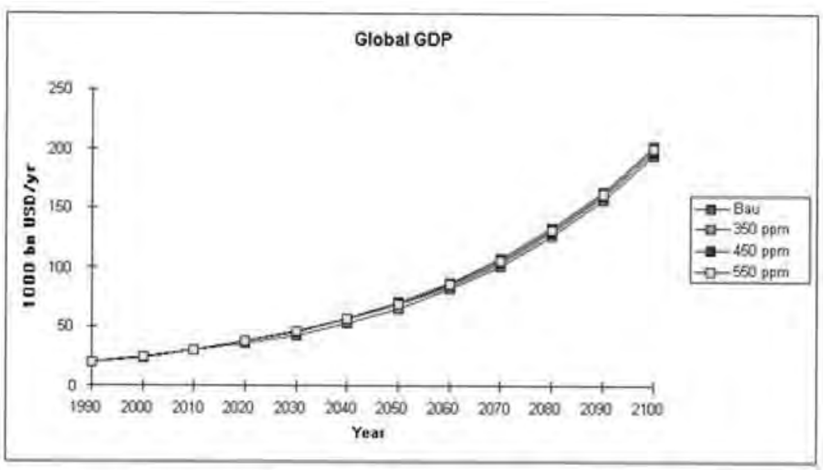
Any policies that are implemented should encourage, and possibly even go so far as to subsidize, technological change. Encouraging technological change through energy policies, in particular, is of critical importance when addressing climate change.

As Figure 3 shows, alternate energy-technology scenarios could dramatically lower the risk of "dangerous" climate change.

Is It Really Too Expensive To Mitigate Global Warming? Christian Azar and I (Azar and Schneider, 2002) developed a simple economy model and estimated the present value (discounted to 1990, expressed in 1990 USD, and assuming a discount rate of five percent per year) of the costs to stabilize atmospheric CO_2 at 350 parts per million (ppm), 450 ppm, and 550 ppm to be 18 trillion USD, 5 trillion USD, and 2 trillion USD, respectively. Obviously, 18 trillion USD is a huge cost; the output of the entire global economy in 1990 amounted to about 20 trillion USD. Seen from this perspective, these estimates of the costs of abatement tend to create the impression that we would, as critics suggest, have to make draconian cuts in our material standards of living in order to reduce emissions and achieve the desired levels of CO_2 concentration. These same critics view the cost estimates as unaffordable and politically impossible.

However, viewed from another perspective, an entirely different analysis emerges. In the absence of emission abatement and without factoring in any damages from climate change, GDP is assumed to grow by a factor of ten or so over the next 100 years, which is a typical convention used in long-run modeling efforts. (The plausibility of these growth expectations is not debated here, but the following analysis will show how GDP is expected to grow with and without climate stabilization policies.) If the 350 ppm target were pursued, the costs associated with it would only amount to a delay of two to three years in achieving this aforementioned tenfold increase in global GDP. Thus, meeting a stringent 350 ppm CO_2 stabilization target would imply that global incomes would be ten times larger than today by April 2102 rather than 2100 (the date the tenfold increase would occur for the no-abatement-policies scenario). This trivial delay in achieving phenomenal GDP growth is replicated even in more pessimistic economic models. These models may be very conservative, given that most do not consider the ancillary environmental benefits of emission abatement (see Figure 7 below).

Figure 7. Global income trajectories under business-as-usual (BAU) and in the case of stabilizing the atmosphere at 350 ppm, 450 ppm, and 550 ppm



Observe that we have assumed rather pessimistic estimates of the cost of atmospheric stabilization (average costs to the economy assumed here are $200/ton Carbon (tC) for 550 ppm target, $300/tC for 450 ppm, and $400/tC for 350 ppm) and that the environmental benefits in terms of climate change and reduction of local air pollution of meeting various stabilization targets have not been included. (Source: Azar & Schneider, 2002.)

Representing the costs of stringent climate stabilization as a few short years of delay in achieving monumental increases in wealth should have a strong impact on how policymakers, industry leaders, and the general public perceive the climate policy debate. Similar results can be presented for the Kyoto Protocol: the drop in GDP below "baseline" levels that would occur if the Kyoto Protocol were implemented ranges between 0.05 percent and 1 percent, depending on the region considered and the model used (see IPCC Working Group III, chapter 8, IPCC 2001c, p. 537–538).

The drops in the growth rates for OECD countries over the next ten years would likely fall in the range of 0.005–0.1 percent per year below baseline scenario projections under the Kyoto Protocol. (It should be kept in mind that the uncertainties about baseline GDP growth projections are typically much larger than the presented cost-related deviations.) Returning to the analysis Azar and I did, assuming a growth rate of two percent per year in the absence of carbon abatement policies, implementation of the Kyoto Protocol would imply that the OECD countries would get 20 percent richer (on an annual basis) by June 2010 rather than January 2010, assuming the high-cost abatement estimate.

Similar statements could well be made about the costs associated with this bill that is before the Committee. Although I have not analyzed it myself, I strongly suspect that the loss of GDP from the costs incurred as a result of implementing this measure would be such a small fraction of typically-projected U.S. GDP growth rates that only months of delay in growth would occur, nowhere enough to prevent large increases in personal income from occurring. Thus, this bill is likely to be an inexpensive "insurance premium" to slow down global warming and lower the likelihood of "dangerous" climate impacts.

Whether the costs mentioned are big or small is, of course, a value judgment, but in any case, it is difficult to reconcile the long-term climate benefits of a short-term delay in GDP growth with the strident rhetoric of contrarians like Lindsey (2001) who states in a speech to a colloquim on Science and Technology Policy (organized by the American Association for the Advancement of Science, or AAAS) that "the Kyoto Protocol could damage our collective prosperity and, in so doing, actually put our long-term environmental health at risk" (p.5). Others have made similar statements about this bill, and they have been refuted by careful economic analyses (Pizer and Kopp, 2003; Paltsev *et al.,* 2003). Clearly, such balanced quantitative economic assessments, rather than pessimistic and often politically-motivated exaggerations should guide the evaluations of making bills like this one the laws of the land.

I thank the Committee for asking for my views on this important piece of legislation.

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

Dr. Busalacchi, could I refer back to your statement? I think it's a very strong and compelling one. "Despite uncertainty, there's widespread agreement that the observed warming is real and particularly strong within the last 20 years." Your statement if full of very strong assertions that we have a serious problem, and yet your answer is, well, all we need to do is keep monitoring and observing. "It's imperative that the Nation continue directing resources toward better observing, modeling, and understanding of what form future changes in climate and climate variability may take, potential positive and negative impacts of these changes on the human ecosystem, and how society can best mitigate"——

Doctor, your recipe belies the problem. Don't you think we should at least take some modest steps toward reducing these impacts that you so graphically and dramatically describe, rather than continue monitoring and observing?

Dr. BUSALACCHI. I'm trying to draw a distinction between myself, as a physical scientist—trying to give you the assessment of the system. And you ask me now, as a parent, as a citizen, then I give you a different answer. All right? So I am trying to—I'm not trying to play games. OK?

The CHAIRMAN. Well, as a parent and as citizen, perhaps we deserve the benefit of your view.

Dr. BUSALACCHI. I want an environment, I want quality of life for my grandchildren to be better than it is for me right now. We——

The CHAIRMAN. And better than it's projected to be under the present circumstances.

Dr. BUSALACCHI. That's correct. And we are not—right now, we, collectively, are not on a path to give my grandchildren and your grandchildren improved quality of life.

So now when we're talking about policy actions, yes, I mean, the time has come to take action. The burden of proof there within the scientific community is there. Outside this room, quite oftentimes, the pulse of the scientific community is oftentimes described as—you have a collection of scientists over here that are pro-global-warming, and a collection of scientists over here that are skeptical. That's not the way the situation is, in reality. It's actually like—the burden of proof is way over on this side that we have a problem, this planet has a fever, and it is time to be taking action.

The CHAIRMAN. And could I re-emphasize your point, going back to what Dr. Schneider was mentioning. If this hearing, 15 years ago, in the 1980s, we would have had basically that balance you're talking about. Right?

Dr. BUSALACCHI. Yes.

The CHAIRMAN. I've been around long enough to know that. And the preponderance keeps shifting in the direction of the conclusions that you reach in your statement.

Dr. BUSALACCHI. The evidence is there. The time is now to take action.

The CHAIRMAN. Well, I thank you for that statement.

Also, thank you for all your good works by the way. Dr. Wigley, we've had witnesses and writings and other things, "Look, back 40,000 years ago, or whatever it was, we had an ice age, and Earth almost froze. Look, you guys are not looking at the long-term problem here." Now, that's one reason why I was very interested in your chart, just going back to 1870. But there are many people who are opposed to us taking any actions, who will claim that this is just one of those accidents of history, using the ice age as an example.

Dr. WIGLEY. Yes, I don't deny that there are natural changes, but the changes that are projected over the next hundred years are far, far greater than anything that's occurred over the last 10,000 years, at least. And, as Stephen Schneider pointed out, there's very strong evidence that the present warming of the last 20 to 50 years is totally unprecedented in the last 2,000 years.

So, you know, we're talking about moving into totally unknown territory. Forty-thousand years ago, you know, if you were a mammoth, then maybe you were happy. But I don't think there were any industrialized nations or human beings, you know, coping with water resources and agriculture at that time. You know, we're in a different situation nowadays, and these changes really are unprecedented. And they're in a direction where immediate action of some form is absolutely required.

The CHAIRMAN. You know, this proposal of Senator Lieberman's and mine has been described as the end of Western civilization as we know it.

[Laughter.]

The CHAIRMAN. Would you perhaps comment, perhaps all three of you, very briefly, as to—I'm sorry to say, it's a very modest measure that it, indeed, is. I don't know if you want to comment, Dr. Busalacchi, but perhaps you would.

Dr. BUSALACCHI. Just following with what I said last time, it's time to be moving forward. Even if it is modest steps, they're steps forward rather than no steps at all. And so we need to be advancing on this issue, plain and simple.

The CHAIRMAN. Thank you, sir.

Dr. Wigley?

Dr. WIGLEY. Yes, or course. I agree.

The CHAIRMAN. And if you had a magic wand, you would want us to do the following.

Dr. WIGLEY. The proposals you've made, I think, are both beneficial to the environment and potentially beneficial to the economy. As with the Kyoto Protocol, they are only first steps in what is a century timescale problem, but they seem to be very positive first steps. And as the European Union is doing, I mean, the only way to approach this problem is learning by doing. And, you know, the only way to learn by doing is to do first, and then benefit from that experience, and then decide what to do on a longer timescale.

The CHAIRMAN. Thank you.

Dr. Schneider, would you respond? And also, would you care to comment—because you were highlighted by Senator Inhofe as being a critic of the Intergovernmental Panel on Climate Change Results, maybe you'd like to clarify your comments there.

Dr. SCHNEIDER. Yes, thank you.

You began your question to us by noting that rhetorical excess is not absent from the climate debate either, and we're all used to it.

The unfortunate problem is that when you have a complex issue of this type, what happens is you get one scientist who says "good for you" and one "the end of the world," and they get equal time in the op-ed pages, it's very easy for people to be confused about this complexity.

But as my colleagues have said earlier, there is very little debate among the mainstream scientific community over the substantial likelihood that humans are already in the game and will, in fact, become increasingly strong over time.

Looking backward 40,000 years, in fact, is very important. It's the backdrop against which we calibrate our understanding to go forward. There are no analogies from the past about what will happen in the future, because there weren't six billion people tightly locked in national boundaries, they didn't have a billion of them at nutritional margins, they didn't have the land-use pressures they've put on, nor the dependencies on expected climate to feed that many people, for example. So as a result of that, the situation is different, and we go backward to try to explain how the thing works. Then we look at what humans might do and what policies such as those that you're discussing now might do in reducing the pressure we put on. And we ask those questions differentially. And I think that's the appropriate mode to go in.

And the rhetorical excesses will go on, because those are often by people who are—let's be very blunt—who are special interests in protecting certain groups who are afraid that the kinds of actions we do remind us that the atmosphere is not a free sewer, and if our tailpipes are going to be reducing what we dump in it, it will probably have to have a charge associated with it; otherwise, it won't work. It's very difficult to expect people to stop at red lights or at stop signs if they were voluntary. And as a result of that, one has to look toward rules that are fair and effective. And I applaud the Committee for doing that.

You asked one other thing at the end, and I'm not certain I remember. If you could again—my jet lag—I will try and answer that, because I was answering the first part of your questions.

The CHAIRMAN. Senator Inhofe——

Dr. SCHNEIDER. Oh, yes. Quoting me as saying that there's uncertainty is fine. That's, you know, a correct quote. In fact, for the last IPCC, Richard Moss and I were somewhat unaffectionately dubbed "the uncertainty cops," because we wrote the guidance paper that was rather aggressive in insisting that for policymakers to find statements from scientists useful, they wanted to have probabilities attached so you'd know how to make resource decisions in the face of scarcity by knowing the relative likelihood of various outcomes. And I clearly believe that uncertainty is necessary.

I'm also, like any scientist, skeptical of any result, new and old, and we're always continuously refining, which is precisely how the community works. On the other hand, the more we try to prove something wrong and the less we can do it, the more we begin to believe that there's a substantial likelihood that it's true, and that's precisely where the mainstream scientific community is sitting on this.

What he quoted, unfortunately, was not accurate. He quoted me as saying that the IPCC was not peer-reviewed. In fact, the IPCC is mega-peer-reviewed. I edit a peer-reviewed journal, "Climatic Change," and I am very envious of the degree of peer-review IPCC or the National Research Council is able to obtain.

I get two or three scientists to comment on a paper, and then usually the comments are sufficiently critical that we have to have it rewritten, and then maybe I'll bring in a fourth person to try to give advice on whether it's a balanced response. And I, like a judge, have to make a decision as to what's enough.

In the case of the IPCC, it was almost odious for those of us who were lead authors, because not only did we have peer-review comments from hundreds and hundreds of people and from many, many different nations and from all stakeholder groups, but we had to prepare, in our revisions, responses to review editors saying how we dealt with each comment. We couldn't just dismiss it, because, you know, in the coffee klatch around the room, we said, "Well, we don't like this guy, so we don't trust him. We're going to ignore it." There had to be real reasons written down to justify to the review editors any peer comment that was ignored, and we had to explain how we dealt them and why and that we didn't overreact. And this didn't just happen once, it happened three times.

So for a *pro bono* operation, it was absolutely amazing that the scientific community responded by putting in so many personal hours working on this project with this kind of peer review and the requirement that it be justified how you respond. And I'm personally very proud of my colleagues for having done that, and appreciate your noticing the credibility of the IPCC and the National Academy. And those people who impune it either don't know about it or have other convenient personal reasons for making charges that are, frankly, false.

The CHAIRMAN. Senator Lautenberg?

Thank you, Dr. Schneider.

Senator LAUTENBERG. Thanks, Mr. Chairman.

Mr. Wigley, you were included in Senator Inhofe's commentary on the floor of the U.S. Senate. He repeatedly quoted from your writings, stating that you believe that science in support of climate change is unsubstantiated. Is that a correct appraisal of what you said?

Dr. WIGLEY. No, that's certainly not a correct appraisal at all. I believe he implied that some work that I published with a co-author of mine a year or so ago suggested that the science behind climate change was unstable and, therefore, could not be trusted. And the reason for making that statement was because they're projections made by Intergovernmental Panel on Climate Change. In their most recent report, it was different fairly substantially from the projections made in the previous report of 1995/96.

In the paper that we published, we tried to break down the reasons for those changes into a number of different factors, and the primary reason was not related to our understanding of the climate system, not related to the development or lack of development of climate models. It was related to our understanding of how people globally would respond to the emissions of sulphur dioxide. Now, sulphur dioxide produces more particles, called aerosols, in the atmosphere, which have a cooling effect. And in the earlier second assessment report and projections of the emissions of sulphur dioxide, the pollution effect of those emissions was not accounted for, and so their emissions rose very substantially and caused a substantial global cooling, offsetting the warming due to greenhouse gases.

Senator LAUTENBERG. Dr. Wigley, I assume that your answer was no.

Dr. WIGLEY. Yes, absolutely.

[Laughter.]

Senator LAUTENBERG. Thank you very much.

The science is befuddling to those of us who only think about war and peace and budgets and things of that nature. I have so much respect for all three of you for the presentation that you've made and for the work that you've done.

Let me ask you a question. If the United States was to join in the Kyoto principles, could you see an impact from that coming in fairly short-term, if we were to sign on and join in the pact on Kyoto? Anyone?

Dr. WIGLEY. Well, I'm sure that there would be an impact if we were to sign on. I mean, certainly it would allow multilateral trading, particularly with the European Community, and that would be a positive benefit, because the trading scheme is a way of making the economics much more efficient.

There is a small avenue for some sort of trading through what's called the "clean development mechanism," but that's not really directed toward countries like the United States.

So there would be an advantage. It would broaden the playing field and make the global situation economically more efficient.

Senator LAUTENBERG. Dr. Schneider?

Dr. SCHNEIDER. Yes. That's another area where there has been a lot of distortion. People suggest that the only thing we do in the next hundred years is Kyoto, that in 2100 the world will only be two-tenths of a degree cooler than it otherwise would have been, so why have we spent all this money to get the same amount of warming 4 years later?

No one in the scientific community that has been involved in these credible assessments, like IPCC or the National Research Council, has ever said that Kyoto was the final and only step. In fact, it has been clear, again and again and again, in report after report after report, science, over the past 25 years, and, in testimony before this Committee and others, that in order to keep the atmospheric concentrations of carbon dioxide, for example, below doubling above pre-industrial level, that would have to cut something on the order—and Tom has done many calculations on this, himself—of about 50 percent by mid-century for typical businesses, and we'd have to go down to nearer to zero in the next century.

The good news is, we have a century to do that. The bad news is, the longer and longer we delay the process of beginning to develop the relative carbon-free energy at reasonable prices, the more expensive it becomes to do it when you have to do it decades from now.

So the answer I would give you to Kyoto, or, as well, to this bill, is while there will be skeptics and critics who will say that its overall impact on global warming reduction is relatively modest, that's true in the short-run. But, you know, all journeys begin with small steps. And if one does not begin the process of sending positive incentives to the incredible industrial and technological machinery in the United States and other countries, it'll be that much longer before we invent the low-cost technologies that are necessary to deal with the problem over time, when the really big cuts start to occur decades from now.

So getting started in a cost-effective manner, and sending the right incentive signals, is very important. And that's why I personally wish that we would be involved with other nations through the Kyoto process. In fact, because of the presence of the United States during the negotiations in the 1990s and early 2000s, Kyoto added a number of mechanisms, so-called "flexibility mechanisms," that allow us to have much lower-cost trading and other actions than otherwise would happen. So I think we've already taken long, good steps in that direction.

This bill reflects those very components.

Senator LAUTENBERG. Mr. Chairman, one other question.

I mentioned before that I had been to Antarctica and saw this incredible reservoir of fresh water with 70 percent of all the fresh water in the world stored there. It was being dissipated as the cracks and fissures and float-offs, if I can call them that, occurred because it just melts into the sea. The consequence down the road would be higher water levels and just loss of that precious resource.

In that visit, I went to Australia also, and there was conversation about how children going to the beach had to wear hats and full bathing suits and everything else, because Australia has the highest rate of melanoma skin cancers of any country, developed country, in the world.

More recently, I read something about the hole in the ozone layer, and that it was seen to be closing. Is that an observation that any of you have heard about? I read it in the paper, and I just wanted to know if—well, what might be causing that? Is there some improvement that we're making that would permit that to happen?

Dr. BUSALACCHI. There have been the comments in the press about it closing, but I think what it showed is this is—that was another example of natural variability going on in the region, experiencing some extremes, but you can't point to any, sort of, human influence on that.

Let's go back to your last question, though. I think we really can have an impact in the short-term, especially with respect to short-lived species, be it black carbon, the aerosols, even methane. And I think the Montreal Protocol taught us that we can work in the international context and have a positive impact on the environment.

Senator LAUTENBERG. Thank you.

The CHAIRMAN. Thank you very much, all of you.

Thanks.

Senator Nelson?

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

Senator NELSON. Thank you, Mr. Chairman. And thank you for your devotion to this issue and the fact that you won't let it go. I appreciate your leadership.

I tried to offer some leadership on this issue in the mid-1990s as the elected insurance commissioner of Florida. I tried to point out that, of all places, that Florida was going to be one of the ones that was going to be affected the most by the rising of the sea levels, by the increased temperatures, and, therefore, the increased ferociousness of storms, as well as pestilence. And I, particularly in the mid-1990s, reached out to the insurance companies to try to get them to understand that it was in their interest to start planning, and I would hit a solid brick wall.

I am heartened to see that one of your people testifying is from Swiss Re today, and it's fairly strong testimony. And there was some indication, even back in the late 1990s, that some of the European insurance companies were starting to come around, but the American insurance companies didn't want to talk about it.

I'd like your comments about this.

Dr. BUSALACCHI. Well, Senator, as a graduate of Florida State, I remember your efforts at that time. I think the Southeast is a particularly vulnerable part of the country. I can't say anything about the recent passage of Isabel being due to global warming, but it's a very good sort of harbinger or lessons learned of potential things to come because of the extreme damage due to storm surge and floods as a result that we could expect from global warming.

Basically, as we pump more energy into the system, the way our system, our planet, expresses itself is as a result of the severe events, storms, and floods. So we expect an intensification of the hydrological cycles. So we have precipitation, more intense precipitation. And where that drier air descends, we expect semi-arid regions to become more arid.

So, I, again, can't say that a hurricane, that hurricane, was due to global warming, but, sort of, the storm-surge examples, a lot of what we went through in this area, is something that may be signs of things to come.

Senator NELSON. Well, do you think the insurance companies are waking up to reality?

Dr. BUSALACCHI. I think we'll defer to our speaker—but definitely even in—with respect to the hurricanes in Florida, yes, most definitely, the insurance industry is very much in tune to how, let's say, climate variability and whether or not we have an El Niño event affects landfall hurricanes or whether or not they go out to sea. So the insurance community is much more in tune to where we are with climate science, more than many of us realize.

Senator NELSON. Most of our development is along the coast. And, of course, with the rising of the sea, that then threatens property. And you would think that the insurance companies would be first in line, but they didn't want to talk about it.

Dr. BUSALACCHI. No, I think things have changed drastically in the last——

Senator NELSON. And what has caused that change in the CEO's minds of insurance companies?

Dr. BUSALACCHI. I wouldn't dare speak for the mind of a CEO. [Laughter.]

Senator NELSON. In your opinion. In your opinion.

Dr. BUSALACCHI. Some of the very points you mentioned to. They are extremely vulnerable, and we now know that the state of the climate system is not constant and stationary. It is changing, and we actually now have an understanding of how it's changing, and so we can take our knowledge of this change and put it to good use, and prevent those losses, both for the people in those houses and the monetary losses for the companies.

Senator NELSON. Would you say that the scientific community is virtually 95 percent now in a consensus that global warming is real?

Dr. BUSALACCHI. Yes. Maybe it was before you came in——

Senator NELSON. Yes.

Dr. BUSALACCHI.—I made the remark that the press portrays our problem has having the community over here in favor of global warming, a community over here as skeptics.

Senator NELSON. And that's not the way it is.

Dr. BUSALACCHI. No, it's like this.

Senator NELSON. It's 95 to 5.

Dr. BUSALACCHI. Way over here, that global warming is real, and it's time now to take action.

Senator NELSON. Do the 5 percent really believe it, or are they paid to say that?

Dr. BUSALACCHI. Yes.

[Laughter.]

Senator NELSON. That's a good answer. I ought to learn from that one.

[Laughter.]

Senator NELSON. Well, I'll tell you, you know, this is just as simple as anything to me, and maybe it's because I've always lived on the coast. But, I'll tell you, if I were President—and, by the way, I'm one of the few Senate Democrats who is not running for President——

[Laughter.]

Senator NELSON.—but, I mean, it's pretty simple. I'd work the international community on this issue like crazy, and what I'd do on things like the energy bill is that—I mean, we get beat around here just when we try to raise the miles-per-gallon on SUVs. But I'd take it further. I mean, I'd put an Apollo kind of project going to build a hydrogen engine that was cheap enough so it was economical so that we could wean ourselves from the dependence on foreign oil, and so that we could start the process of cleaning up the environment.

Thank you.

The CHAIRMAN. Well, thank you very much, Senator Nelson.

Senator NELSON. Maybe that's my announcement speech.

[Laughter.]

The CHAIRMAN. Well, we're not short of those.

[Laughter.]

The CHAIRMAN. I thank you. I do thank you, Senator Nelson, for you long advocacy and support on this issue. And I really do believe that states like Florida are in some significant danger here. But I think the reality is that about 80—70 percent, something like that, of the American people live on both coasts, and there's a real challenge.

I would like to thank the witnesses for being here. I would like to thank them for their candor, and I would like to thank them for their honesty and integrity. And one thing I am fairly confident of, we will be seeing each other again, because this issue is not going away for a long time, and, unfortunately, we are a long way from coming up with a coherent international set of priorities and policies to address this issue, in my opinion.

I thank you very much, thank the witnesses.

Our third panel is Mr. Paul Gorman, who is the Executive Director of the National Religious Partnership for the Environment; Mr. Ethan J. Podell, who is the President of Orbis Energy; Mr. John B. Stephenson, the Director of the Natural Resources and Environment at the U.S. General Accounting Office; and Mr. Christopher Walker, who is the Managing Director of the Greenhouse Gas Risk Solutions, Swiss Re Financial Services Corporation.

As the witnesses are seating themselves, I received a letter from the Executive Office of the President, Control on Environmental Quality, and he would like to take this opportunity to share with us in the Committee a summary of the actions the Bush Administration has taken thus far to implement the President's 10-year strategy to reduce the greenhouse gas intensity of the American economy by 18 percent. As demonstrated by the enclosed summary, the Administration is actively addressing the complex long-term issue of global climate change and will work toward meeting the commitments outlined in the President's strategy.

This will be included in the record. Remarkable.

[Laughter.]

[The information referred to follows:]

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
Washington, DC, September 30, 2003

Hon. JOHN MCCAIN,
United States Senate,
Washington, DC.

Dear Chairman McCain:

I understand the Senate Commerce Committee is scheduled to conduct a hearing Wednesday, October 1, on "The Case for Climate Change Action." As you explore this important issue, I would like to take the opportunity to share with you and the Committee a summary of the actions the Bush Administration has taken thus far to implement the President's 10-year strategy to reduce the greenhouse gas intensity of the American economy by 18 percent. As demonstrated by the enclosed summary, the Administration is actively addressing the complex, long-term issue of global climate change, and will work toward meeting the commitments outlined in the President's strategy. I respectfully request that this summary be entered into the record.

Sincerely,

JAMES L. CONNAUGHTON

Enclosure

cc: Members of the Senate Commerce, Science, and Transportation Committee

The Bush Administration's Actions on Global Climate Change

"I've asked my advisors to consider approaches to reduce greenhouse gas emissions, including those that tap the power of markets, help realize the promise of technology and ensure the widest-possible global participation….Our actions should be measured as we learn more from science and build on it. Our approach must be flexible to adjust to new information and take advantage of new technology. We must always act to ensure continued economic growth and prosperity for our citizens and for citizens throughout the world." — President Bush (6/11/01)

The Bush Administration has delivered on the President's commitment with a comprehensive, innovative program of domestic and international initiatives:

National Goal to Reduce Emissions Growth: In February 2002, President Bush committed the United States to a comprehensive strategy to reduce the greenhouse gas intensity of the American economy (how much we emit per unit of economic activity) by 18 percent over the next 10 years. Meeting this commitment will prevent more than 500 million metric tons of carbon-equivalent emissions through 2012.

Large Budget Increases for Global Climate Change: President Bush's FY '04 budget sought a 15 percent increase in funding for climate change-related programs, bringing total U.S. Government spending this year to $4.3 billion. If enacted, it will be the highest level ever. In addition, substantial funding for conservation programs under the 2002 Farm Bill will significantly increase the amount of carbon storage from agriculture.

Tax Incentives for Renewable Energy and Hybrid and Fuel-Cell Vehicles: The President's FY '04 budget proposes tax incentives totaling $4.2 billion through FY '08 to spur the use of clean, renewable energy and energy efficient technologies. Consistent with the President's National Energy Policy, the tax incentives include credits for the purchase of hybrid and fuel-cell vehicles, residential solar heating systems, energy produced from landfill gas, electricity produced from alternative energy sources such as wind and biomass, and combined heat and power systems.

Cabinet Committee on Climate Change Science and Technology Integration: President Bush has created an interagency, cabinet-level committee, co-chaired by the Secretaries of Commerce and Energy, to coordinate and prioritize Federal research on global climate science and advanced energy technologies. This Committee develops policy recommendations for the President and oversees the sub-cabinet interagency programs on climate science and energy technologies.

Federal Energy and Carbon Sequestration Programs: FY '04 budget request includes $1.7 billion to fund Federal technology research, development, and deployment activities. Major new initiatives for FY '04 and beyond include:

Hydrogen Energy. President Bush launched his Hydrogen Fuel Initiative in this year's State of the Union address. The goal is to work closely with the private sector to accelerate our transition to a hydrogen economy, both on the technology of hydrogen fuel cells and a fueling infrastructure. The President's Hydrogen Fuel Initiative and the FreedomCAR Partnership launched last year will provide $1.7 billion over the next 5 years to develop hydrogen-powered fuel cells, a hydrogen infrastructure, and advanced automobile technologies, allowing for commercialization by 2020. The United States will pursue international cooperation to affect a more rapid, coordinated advance for this technology that could lead to the reduction of air pollutants and a significant reduction of greenhouse gas emissions in the transportation sector worldwide. For more information on this initiative, please visit http://www.whitehouse.gov/ceq/hydrogen-fuels.html.

"FutureGen" Coal-Fired, Zero-Emissions Electricity Generation. In February 2003, President Bush announced that the United States would sponsor, with international and private-sector partners, a $1 billion, 10-year demonstration project to create the world's first coal-based, zero-emissions electricity and hydrogen power plant. This project is designed to dramatically reduce air pollution and capture and store greenhouse gas emissions. This initiative is part of an international Carbon Sequestration Leadership Forum, chaired by the Secretary of Energy, to work cooperatively with our global partners–including developing countries–on research, development and deployment of carbon sequestration technologies in the next decade. In June 2003, the inaugural Forum meeting was held in Virginia, and attended by representatives of Australia, Brazil, Canada, China, Colombia, India, Italy, Japan, Mexico, Norway, Russian Federation, the United Kingdom, and the European Commission. These global partners signed the first international charter setting the framework for international cooperation in research and development. For more information,

please visit
http://www.fe.doe.gov/programs/powersystems/futuregen/.

Fusion Energy. In January 2003, President Bush committed the United States to participate in the largest and most technologically sophisticated research project in the world to harness the promise of fusion energy, the same form of energy that powers the sun. If successful, this $5 billion, internationally supported research project will advance progress toward producing clean, renewable, commercially available fusion energy by the middle of the century. Participating countries include the United Kingdom, Russia, Japan, China, and Canada. To read the President's statement, please visit http://www.whitehouse.gov/news/releases/2003/01/20030130-18.html.

Federal Climate Change Science Program (CCSP): Includes $1.7 billion in FY '04 budget request to fund Federal, multi-agency research program, with $185 million requested for the Climate Change Research Initiative in FY '04.

10-year Federal Strategic Research Plan Released. The Interagency U. S. Climate Change Science Program proposed a 10-Year Strategic Plan in November 2002, accompanied by a 1300-person workshop, with representatives from over 35 countries. The final, comprehensive plan was released in July 2003 by Secretary Abraham and Secretary Evans, as well as White House Office of Science and Technology Policy Director Marburger. The document describes a strategy for developing knowledge of variability and change in climate and related environmental and human systems, and for encouraging the application of this knowledge. Secretary Evans also announced a $103 million, two-year Federal initiative to accelerate the deployment of new global observation technologies, focused on oceans, atmospheric aerosols, and the natural carbon cycle. To read the plan, please visit http://www.climatescience.gov/Library/stratplan2003/default.htm.

U.S. Hosts Inaugural Earth Observation Summit. The first-ever Earth Observation Summit was held July 31, 2003 to generate strong, international support to link thousands of individual technological assets into a coordinated, sustained, and comprehensive global Earth observation system. The purpose of the system is to provide the tools needed to substantially improve our ability to identify and address critical environmental, economic, and societal concerns.

More than 30 countries and 20 international organizations participated in the Summit. Participants adopted a Summit Declaration recognizing the need to support development of a comprehensive, coordinated Earth observation system. For more information, please visit http://www.climatescience.gov/Library/observation-summit2003.htm.

Fuel Economy Increase for Light Trucks: On April 1, 2003, the Bush Administration finalized regulations requiring an increase in the fuel economy of light trucks for Model Years 2005 - 2007, the first such increase since 1996. The increase from 20.7 miles per gallon to 22.2 miles per gallon by 2007 more than doubles the increase in the standard that occurred between Model Years 1986 and 1996, when it increased from 20.0 miles per gallon to 20.7 miles per gallon. The new standards are projected to result in savings of approximately 3.6 billion gallons of gasoline over the lifetime of these trucks with the corresponding avoidance of 31 million metric tons of carbon dioxide emissions.

Voluntary Greenhouse Gas Reduction Initiatives with Business and Industry: The Federal government administers nearly 60 different voluntary programs on energy efficiency, agricultural practices, and greenhouse gas reductions. Major initiatives announced by the Bush Administration include:

"Climate VISION" Partnership. In February 2003, President Bush announced that twelve major industrial sectors and the membership of the Business Roundtable have committed to work with four of his cabinet agencies (DOE, EPA, DOT, and USDA) to reduce greenhouse gas emissions in the next decade. Participating industries included America's electric utilities; petroleum refiners and natural gas producers; automobile, iron and steel, chemical and magnesium manufacturers; forest and paper producers; railroads; and the cement, mining, aluminum and semiconductor industries. To read the President's statement, please visit http://www.whitehouse.gov/news/releases/2003/02/20030212.html.

Climate Leaders. Announced by EPA Administrator Whitman in February 2002, Climate Leaders is an EPA partnership encouraging individual companies to develop long-term, comprehensive climate change strategies. Under this program, partners set corporate-wide GHG reduction goals and inventory their emissions to measure progress. Over 35 major companies are now participating, including General Motors, Alcoa, BP, Pfizer, Staples, International Paper, IBM, Miller Brewing, Eastman Kodak, and Target. For more information, please visit http://www.epa.gov/climateleaders/.

Voluntary Registry for Reporting GHG Reductions. Responding to President Bush's February 2002 charge, the Secretaries of Energy, Commerce, and Agriculture, and the EPA Administrator provided the President with their initial recommendations for enhancing and improving the DOE's greenhouse gas emissions reduction registry. The improvements are intended to enhance the accuracy, reliability, and verifiability of greenhouse gas reductions measurements. As part of the 2002 public comment process, DOE hosted workshops in Houston, Washington, San Francisco, and Chicago. Final guidelines are anticipated in early 2004.

Targeted Incentives for Greenhouse Gas Sequestration. On June 6, 2003, Agriculture Secretary Veneman announced that, for the first time, consideration will be given to management practices that store carbon and reduce emissions of greenhouse gases in setting priorities and implementing USDA's forest and agriculture conservation programs, such as the Environmental Quality Incentives Program and Conservation Reserve Program. USDA would provide financial incentives, technical assistance, demonstrations, pilot programs, education, and capacity building, along with measurements to assess the success of these efforts. For more information, please visit http://www.usda.gov/news/releases/2003/06/0194.htm

International Outreach:

International Cooperation. The U.S. is engaged in extensive international efforts on climate, both through multilateral and bilateral activities. Multilaterally, the U.S. is by far the largest funder of the activities of the UN Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change, and leads R & D projects through the Generation IV International Forum, which is developing the next-generation nuclear systems to produce electricity and hydrogen for transportation use without emitting greenhouse gas emissions. Bilaterally, the U.S. has developed a number of agreements with major international partners to pursue research on global climate change and deploy climate observation systems, collaborate on energy and sequestration technologies, and explore methodologies for monitoring and measuring GHG emissions. To date, new bilateral agreements have been established with countries representing over 70 percent of global greenhouse gas emissions: Australia, Japan, China, India, Italy, Canada, Russia, the Republic of Korea, New Zealand, Mexico, the European Union, and CONCAUSA, an organization of seven Central American countries.

Global Environmental Facility (GEF). As part of a $2.2 billion international replenishment agreement, the Bush Administration has pledged $500 million to the GEF over the next 4 years to help developing countries address environmental problems, including global climate change. The GEF is the financial mechanism under the United Nations Framework Convention on Climate Change and the United States' contribution is the largest of any country. This commitment, which will fund technology transfer and capacity building in developing countries, represents a 16 percent increase over the U.S. contribution in the previous replenishment.

United States Agency for International Development. The Administration intends to spend at least $175 million in FY '04 for all USAID climate change programs including those that fund the transfer of advanced technologies to developing countries, including cleaner, more efficient energy technologies, technologies to make manufacturing and agriculture more productive and efficient, and programs to foster responsible forestry practices.

President's Initiative Against Illegal Logging. On July 28, 2003, Secretary of State Powell launched the President's Initiative Against Illegal Logging, developed with the objective of assisting developing countries in their efforts to combat illegal logging, including the sale and export of illegally harvested timber, and in fighting corruption in the forest sector. The initiative represents the most comprehensive strategy undertaken by any nation to address this critical sustainable development challenge, and reinforces the U.S. leadership role in taking action to counter t he problem and preserve forest resources that store carbon. For more information, please visit http://www.state.gov/r/pa/prs/ps/2003/22843.htm.

Tropical Forest Conservation. In FY '04, the Bush Administration will direct $50 million for tropical forest conservation. These funds will provide the resources needed to pursue additional "debt-for-nature" projects under the Tropical Forest Conservation Act and contribute to the Congo Basin Forest Partnership launched by Secretary of State Powell and then-EPA Administrator Whitman in September 2002 to preserve eleven key landscapes in Cameroon, the Central African Republic, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, and the Republic of the Congo. To view the fact sheet , please visit http://www.state.gov/g/oes/rls/fs/2003/22973.htm.

The CHAIRMAN. Mr. Gorman, welcome.

STATEMENT OF PAUL GORMAN, EXECUTIVE DIRECTOR, NATIONAL RELIGIOUS PARTNERSHIP FOR THE ENVIRONMENT

Mr. GORMAN. Thank you, Senator and Members of the Committee. Thank you for your own perseverance on these questions, Senator McCain, and your openness today to hearing religious and moral and ethical principles related to this issue.

I represent the National Religious Partnership for the Environment, which is an alliance of faith groups across a very broad spectrum, the U.S. Conference of Catholic Bishops, the National Council of Churches of Christ, a federation of 36 mainline protestant and orthodox denominations, the Coalition on the Environment in Jewish Life, which represents 29 national Jewish organizations, and the Evangelical Environmental Network, which is an alliance of evangelical Christian organizations.

Each has its own distinctive perspectives, but we share precepts for God's creation, for caring for it, albeit with different, often imaginative, forms of expression. For example, facilitating renewable and solar energy programs, the Interfaith Power and Light Campaign, led by the Episcopal Church, has helped over 300 congregations in California alone conserve energy, preventing four million tons of carbon dioxide form entering the atmosphere. The Catholic Bishops of the Pacific Northwest issued a pastoral letter on protecting the Columbia River. The Redwood Rabbis, so-called, have fought to preserve all-growth forests. In addition to asking, "What would Jesus drive," the evangelical Christians have worked for extension of the Endangered Species Act.

So with the bishops in rivers, and rabbis in redwoods, and evangelicals in wetlands, and Episcopalians cleaning the sky, we're at least trying to get out of the house and open our eyes and perhaps add a new voice and a source of activity.

About global climate change, we have fundamental agreements, all of which have been stated in formal declarations at the highest levels of governance, which we would like to be able to submit for the record, Mr. Chairman.

The CHAIRMAN. Without objection.

[The information referred to follows:]

Interfaith Climate & Energy Campaign

A Call for Power Plant Clean-Up

As the U.S. Senate begins debate on legislation that addresses the clean-up of America's dirty power plants, religious leaders call on policy makers to adopt legislation that includes carbon dioxide as a regulated pollutant from power plants. Carbon dioxide is a byproduct of burning fossil fuels such as coal and oil. In a balanced system, carbon dioxide helps regulate the Earth's climate. However, too much carbon dioxide causes excess heat to be trapped in the atmosphere, forcing global temperatures upward, the process known as global warming.

The largest source of carbon dioxide in the U.S. is the electric power industry, accounting for about 40 percent of all U.S. emissions. More than 88 percent of emissions come from older, dirtier coal-fired facilities. In addition, these power plants are a source of nitrogen oxide and sulfur dioxides which cause smog, asthma and other breathing-related illnesses and mercury exposure which causes birth defects.

There is broad agreement among scientists and experts that global warming is occurring and that it will likely result in changes that will harm people in the U.S.

and around the world. As described in the recent climate report of the Bush Administration to the United Nations, climate change is linked to devastating environmental impacts: including an increase in the severity of hurricanes, floods and droughts. Though there may be some positive results to climate change, such as increased agricultural productivity in some places, the majority of effects are likely to cause harm. These events are likely to exact a terrible toll in terms of both human suffering and economic loses.

Protecting God's children and God's creation from harmful air pollution is a fundamental moral obligation. Cleaning up dirty power plants that cause harmful pollution must therefore be a policy priority. The following moral principles ought to apply to policies on power plants:

(1) *Justice for all God's children* by addressing the reality that carbon dioxide emissions are causing global warming and that we must protect all God's children from the harmful affects of mercury emissions.

(2) *Justice for future generations* who will be adversely affected by the harmful air pollution that is produced today.

(3) *Solidarity with people who live in poverty* around the world who are more dangerously affected by air pollution and who do not have the resources to adapt to the realities of global warming.

(4) *Stewardship of the balance of creation* which sustains all life on Earth.

In response to such global environmental concerns, senior religious leaders from America's leading denominations have said, *"At stake are: the future of God's creation on earth; the nature and durability of our economy our public health and public lands; the environment and quality of life we bequeath our children and grandchildren. We are being called to consider national purpose not just policy."* With respect to the current debate in the U.S. Senate, the Interfaith Climate & Energy Campaign calls for:

- *A "4P" Approach—The Dramatic Reduction of Pollutants Which Cause Smog, Acid Rain, Respiratory Disease, Mercury Contamination AND Global Warming.* Legislation should be adopted that dramatically cuts power plant emission of the four major power plant pollutants (4P). One such proposal before the Senate would dramatically cut power plant emission of the four major power plant pollutants by 2007: nitrogen emissions would be cut by 75 percent from 1997 levels, sulfur emissions would be cut by 75 percent below Phase II Acid Rain levels, mercury emissions would be cut by 90 percent from 1999 levels, and carbon dioxide emissions would be cut to 1990 levels. This level of carbon dioxide reduction is contained in the Framework Convention on Climate Change, which was signed by former President Bush and unanimously ratified by the U.S. Senate.
- *Close the Grandfather Loophole that Exempts Dirty Old Coal Plants.* Legislation should require all power plants to meet the most recent pollution control standards for new pollution sources within a reasonable timeframe.
- *Corporate voluntary measures have proven insufficient in addressing carbon dioxide pollution.* Since the early 1990s when the Federal Government began calling for voluntary action in reducing carbon emissions, the reality has been that greenhouse gas emissions have significantly increased.

The Interfaith Climate & Energy Campaign is a coalition of religious American leaders, institutions and individuals who for nearly two years have been working in 21 states to educate congregants about the causes and effects of global climate change and to speak out about the religious and moral imperatives to protect God's creation and all of God's children. Over 1,200 leading religious leaders have joined in calling for Federal policies for energy conservation and climate justice.

Mr. GORMAN. We are not scientists, but we are convinced of the problem's urgency, as documented by eminent scientists worldwide. And to amplify this scientific consensus, we would affirm a religious and moral consensus.

It seems best, in this brief time, to outline four principles in this consensus, moral precepts which provide a case, we hope, for guiding policy, and scripture guides us here.

First, in Genesis, God declares creation as very good and commands us to till and to tend the garden. Humankind is called to stewardship. That's why we're here.

Second, we read, in Psalms, the Earth is the Lord's and the fullness thereof, the gifts of creation are intended for the well-being of all.

Third, we have a paramount obligation to defend the poor and the orphan, to do justice to the afflicted, and to care first for the least of these. Care for God's creation requires justice and equity for God's children, and not putting innocent lives at risk.

And we call upon the Senate, in your forthcoming deliberations, to address the impact of global climate change on the poor, vulnerable peoples and nations of the planet.

Finally, we have an obligation to the future well-being of all life on Earth. God's covenant, which I make between me and you and every living creature for perpetual generations, in Genesis.

Protecting our planet's climate is a religious duty, because it embraces everything and everyone on Earth.

Stewardship, covenant, justice, intergenerational equity. These perennial principles have never seemed to many of us more meaningful and mandatory. We are all part of God's creation. Environmental isolationism is neither morally acceptable nor faithful to God's law.

These are high standards, easy to proclaim in rooms like this, but they are in the hearts and consciences of an increasing number of people of faith in this country, worldwide. We recognize challenges still before us, the need for further scientific research and energy policy which reduces greenhouse gas emissions and steadily and forcibly moves us beyond reliance on fossil fuels, assurance of economic security, and protection of workers.

Human habits of materialism and over-consumption, we believe, in the faith community, are also root causes of environmental degradation. And while we understand the drive of deeply held convictions—we have some issues here ourselves—partisanship and shortsightedness seem to be leading to dead-ends.

We have to lift our vision. This is an enterprise for the entire human species. So we share these convictions not simply as articles of our own faith, but toward a universal moral resolve, a conversion of hearts and conscience, without which it would seem very difficult to me to challenge at this scale.

We're grateful for your invitation to share these beliefs. We look forward to discussing them further and will be communicating them to individual Senators during the October recess.

But we are here to say that the religious community is committed to help provide new momentum, as you do here, Mr. Chairman to what must be a universal enterprise for the common good.

[The prepared statement of Mr. Gorman follows:]

PREPARED STATEMENT OF PAUL GORMAN, EXECUTIVE DIRECTOR, NATIONAL RELIGIOUS PARTNERSHIP FOR THE ENVIRONMENT

Thank you, Mr. Chairman and members of the Committee:

I represent members of the National Religious Partnership for the Environment, an alliance of faith groups across a broad spectrum: the United States Conference of Catholic Bishops, the National Council of Churches of Christ (a federation of 36 mainline Protestant and Orthodox communions), the Coalition on the Environment and Jewish Life (representing 29 national bodies), and the Evangelical Environmental Network (an alliance of evangelical Christian organizations). Each has its own distinctive perspectives. But we share biblical precepts for care of God's creation, albeit with different, often imaginative forms of expression.

For example, supporting renewable and solar energy programs, The Interfaith Power and Light campaign, led by the Episcopal Church, has helped over 300 congregations in California alone conserve energy, preventing 40 million pounds of carbon dioxide from entering the atmosphere. The Catholic Bishops of the Pacific Northwest issued a pastoral letter on protecting the Columbia River. "The Redwood Rabbis" have fought to preserve old growth forests. In addition to asking "What Would Jesus Drive?", evangelical Christians have worked for extension of the Endangered Species Act. So with bishops in rivers, rabbis in forests, evangelicals in wetlands, and Episcopalians looking to the sun, we're at least getting out of the house and perhaps making a fresh contribution.

About global climate, change we have fundamental agreements, all of which have. been stated in formal declarations at the highest levels of governance, which we would like to submit for the record.

We are convinced of the problem's urgency as documented by eminent scientists worldwide.

To amplify a *scientific* consensus, we affirm a *religious and moral* consensus.

It seems best, in this brief time—perhaps as an introduction to those outside the faith community—to outline four principles of this religious consensus. These are moral precepts that should guide policy.

First, in Genesis, God beholds creation as "very good" (Gen 1:31) and commands us to "till and tend the garden" (Gen 2:15). Humankind is called to stewardship. Second, we read in Psalms, "The Earth is the Lord's and the fulness thereof' (Ps 24:1). Creation's gifts are intended for the well-being of all. Third, we have a paramount obligation to "defend the poor and the orphan; do justice to the afflicted" (Ps 82:3) and to care first for "the least of these" (Math 25:35). Care for God's creation requires justice for God's children and not putting innocent lives at risk. And we call upon the Senate, in your forthcoming deliberations, to address the impact of global climate change on the poor and vulnerable peoples and nations of our planet.

Finally, we have an obligation to the *future* well-being of all life on Earth, God's "covenant which I make between me and you and every living creature for perpetual generations" (Gen 9:12). Protecting our planet's climate is a religious duty because it embraces everything and everyone on Earth.

Stewardship, covenant, justice, intergenerational equity: these perennial principles have never seemed more meaningful and mandatory. We are all part of God's creation. Environmental isolationism is neither morally acceptable nor faithful to God's Law.

These are high standards, easier to proclaim than to practice. We recognize challenges still before us all: the need for further scientific research; an energy policy which reduces greenhouse gas emissions and steadily moves us beyond reliance on fossil fuels; assurance of economic security and protection of workers. Human habits of materialism and over-consumption lie deeply at the root of environmental degradation. And while we understand the drive of deeply held convictions—we have some issues here ourselves—partisanship and short-sightedness seem to be leading to dead ends.

We have to lift our vision. This is an enterprise for the entire human species. So we share these convictions not simply as articles of our own faith but toward a universal moral resolve—a conversion of hearts and habits . . . without which it would seem difficult to meet a challenge of this scale.

We are grateful for your invitation to share these core beliefs. We look forward to discussing them further, and will be communicating them to individual Senators particularly during the October recess. Perhaps you will pass them on as well. But we are here to say this: the religious community is committed to help provide new momentum, as you do here, Mr. Chairman, for what must be a universal enterprise to reduce global warming for the common good.

The CHAIRMAN. Thank you very much, Mr. Gorman, for a very powerful statement.

Mr. Podell?

STATEMENT OF ETHAN J. PODELL, PRESIDENT, ORBIS ENERGY ADVISORS INC.

Mr. PODELL. Mr. Chairman and distinguished Members of the Senate, I'm grateful for the invitation to address the Committee and to share my perspective, as a businessman who has tried to get corporate America to take voluntary action on climate change.

I'm the President of Orbis Energy Advisors, a financing consulting firm focused on the business of climate change and renewable energy, and I'm also here today as a representative of E2, Environmental Entrepreneurs, a national group of professional businesspeople who believe in protecting the environment while building economic prosperity.

E2 has over 400 members in 16 states who have been in financing and founding more than 800 companies, which have created over 400,000 jobs. E2 members currently represent more than $20 billion in private equity capital available for investment into new companies.

After a 20 year career as a media entrepreneur, I've spent the better part of the past 2 years trying to get corporate America to understand and, more importantly, to take some meaningful action to address this enormous looming problem before us, global warming. My conclusion from this experience is that it is essential to enact mandatory limits on greenhouse gas emissions, as provided for in S. 139.

I have consulted on strategy and business development for Canter Fitzgerald's greenhouse gas trading business in the United States. And from March through August of this year, I was the Senior Vice President for Sales and Marketing for the Chicago Climate Exchange. As you may know, the Chicago Climate Exchange is the first voluntary greenhouse gas cap-and-trade program in the United States. My principal role at the Exchange was to recruit corporate clients willing to commit to a modest pilot program requiring minimal reductions in their greenhouse gas emissions.

I'm here to tell you today that there is very little evidence that corporate America has any real interest in participating in a voluntary greenhouse gas reduction trading program.

The Chicago Climate Exchange is a terrific idea and an innovative institution of the first order. Its founder, Richard Sandor, is one of the most dynamic and visionary leaders of the business community I've ever met. It seeks to prove the concept that a voluntary greenhouse gas emissions reduction program, using a cap-and-trade, can be effective within the American business community. It's designed as a 4 year pilot program running from now through 2006, so the companies which join the program are really making a very limited time commitment. And Exchange members are also making a very limited commitment to reduce their greenhouse emissions, as the targets, the reduction targets, set by the Exchange are really rather modest. Those reductions are 1 percent below baseline this year, rising to 4 percent below baseline in 2006.

The Chicago Climate Exchange was designed over a number of years with the active participation of leading companies from many sectors of American business. Notwithstanding the modest reduction targets and other incentives embedded in the rules of the Exchange, which are designed to make for a very slow and non-threatening game of softball, there are, so far, at least, very few takers in the corporate world.

The Chicago Climate Exchange has about 20 members responsible for about 3 or 4 percent of the total United States greenhouse gas emissions. If you do the math, and apply the 1 percent per year emissions reductions required of members of the Exchange against the 4 percent of total U.S. emissions which these companies represent, what we end up with is a very small drop removed from a very large bucket. This bucket has 10,000 drops. The current members of the Chicago Climate Exchange will remove four of those 10,000 drops this year, and 16 in the year 2006.

As we have seen with the Acid Rain Program, cap-and-trade can accomplish real environmental goals at modest cost when coupled with a mandatory set of targets. However, without regulation and governmentally imposed sanctions, the early evidence, at least, is that the American business community is not very interested.

Over the past 6 months, I have spoken or met with more than 250 companies, mostly in the Fortune 500, but smaller private businesses, as well, about why they should join the Chicago Climate Exchange. I've also marketed the Exchange to municipalities, universities, and state governments.

For cap-and-trade to work, you really need only three things: a target, or cap, representing some reduced level of emissions when measured against the past; two, a group of participants that will reduce their emissions below the target and have excess reduction credits to sell; and, three, a group who will miss the target and need to buy credits to be in compliance with the rules of the game.

In marketing the Chicago Climate Exchange, we have very few companies in this country willing to buy emissions credits to be in compliance with the voluntary greenhouse gas reduction program.

The companies which are willing to participate in a voluntary cap-and-trade are those that see carbon trading as a way to make some money by selling excess credits, and a way to make a statement, really a gesture, about their environmental awareness. For these companies, the ones which will be sellers of emissions reduction credits, participating in a program such as the Chicago Climate Exchange is largely a risk-free, money-making opportunity. The companies we really need to join a carbon cap-and-trade program, the large emitters of greenhouse gases, those who will end up as buyers of emissions reduction credits—the utilities, the oil, gas, and petrochemical companies, the cement-makers, the truckers and railroads, those companies are not yet prepared to join a voluntary cap-and-trade.

The large carbon emitters listen attentively to all the arguments: regulation will happen sooner or later, so they should get in early and learn ahead of their competitors; Wall Street and other stakeholders are increasingly concerned about the link between the companies' carbon liabilities and its balance sheets; that the companies' overseas operations are, as a practical matter, soon going to be subject to international greenhouse gas reductions under Kyoto or other emerging regulations, whether or not the U.S. Government participates along with the international community. Yes, they listen. Some even agree to gather data on their historic levels of emissions. But very few companies are prepared to reduce these emissions if it will cost them any money.

Yes, it's true, there is nothing from preventing a voluntary system from working here, other than the absence of volunteers. And that is precisely what we have, the absence of volunteers. And why, after all, should any one American company agree to take the lead on voluntary greenhouse gas emissions reductions? Were are their competitors on this issue? Why be a pioneer when it will just cost them money, threaten their market share? And, worst of all, even if they agree to join a voluntary reduction program, where's the assurance that Washington will recognize their early participation in the voluntary program and not eventually pass legislation which raises the bar and penalizes the early movers?

The image here is that pioneers were the ones who ended up with arrows in their backs. Long-term thinking about the environment being in short supply in corporate America, our business leaders generally ignore or forget the fact that many pioneers ended up not with arrows in their backs, but as the owners of very valuable real estate.

In the absence of rules and clear guidelines, the field evidence I have is that most American businesses would prefer to sit this one out from the sidelines. Washington needs to provide firm rules and regulations if you expect corporate America to respond. When it comes to climate change, voluntary action from the American business community means hardly any action at all.

As S. 139 recognizes, a cap-and-trade system is likely be cost-effective in reducing greenhouse gas emissions, provided it's a mandatory system.

S. 139, or other mandatory cap-and-trade programs, will cause some disruption, some adjustments in everyone's business-as-usual behavior, and it is not, at least not in the short-term, without some costs. However, the costs are regularly exaggerated, and the benefits often ignored.

A recent MIT study of S. 139 showed that its enactment would affect household purchasing power by less than one-tenth of 1 percent. The gains in energy efficiency and in technological innovation which will follow once we start to constrain carbon emission in this country will far outweigh any of the temporary short-term burdens which will arise. And over time, the cost of compliance will turn into real and large levels of cost savings.

A recent analysis of S. 139 by the Tellus Institute shows that as this legislation is implemented over time, it will ultimately yield net cost savings to American consumers of some $50 billion per year.

[The information referred to follows:]

NATURAL RESOURCES DEFENSE COUNCIL
Washington, DC, October 1, 2003

ANALYSIS OF THE MCCAIN LIEBERMAN CLIMATE STEWARDSHIP ACT (S. 139)

The Tellus Institute conducted an analysis for NRDC of the McCain-Lieberman Climate Stewardship Act (S.l39) using a modified version of the Energy Information Administration's (EIA) NEMS model. The analysis finds that S. 139 in conjunction with targeted complementary policies significantly reduces U.S. emissions of heat-trapping gases while saving consumers billions of dollars.

The bipartisan Climate Stewardship Act is a comprehensive market-based solution to cut heat-trapping emissions from U.S. sources to 2000 levels in 2010 and 1990 levels in 2016. In late September or early October, the Senate is expected to vote on the modified version of S. 139, originally introduced in January 2003. This bill would create a comprehensive market-based program to cut heat-trapping pollution from U.S. sources. The modified McCain-Lieberman bill contains only the first phase of their original bill limiting emissions to 2000 levels in 2010. The second phase (1990 levels in 2016) contained in the original bill is not included in the modified version. The modified bill will be even cheaper to implement than the original bill analyzed in this report. An MIT economic analysis finds that meeting the phase-one emission limits will affect household purchasing power by less than one-tenth of one percent.

Key findings of the Tellus study include:

- Net savings to consumers accrue from 2013, reaching $48 billion annually in 2020.
- Household electricity bills decrease because of reduced demand, even though electricity prices rise slightly.
- There is no spike in natural gas prices because demand decreases relative to the base case, the result of efficiency policies and the emissions cap.
- Allowance prices increase from $8/tonne CO_2-equivalent in 2010 to $22/tonne in 2020.
- Results of the new Tellus study are consistent with a recent study by the Massachusetts Institute of Technology (MIT), with the Tellus study forecasting even lower compliance costs. Both analyses predict sharply lower costs than forecast by the Energy Information Administration, which does not adequately predict energy savings.

The modeling encompasses a set of complementary policies for cost-effective implementation of the Act, including energy efficiency investments funded by sales of pollution allowances, oil savings of 1 million barrels per day by 2013, renewable energy standards, promotion of combined heat and power systems, caps on other power plant pollutants, and smart growth measures. A scenario analyzing a more aggressive (Advanced) policy to improve vehicle fuel efficiency showed lower allowance prices and higher net economic benefits. These policies are relatively modest in comparison to bipartisan proposals already offered in congress, and backed by NRDC and others.

Table 1.—Key Results for the Policy and Advanced Policy Cases

	2000	2010			2015			2020		
		Base	Pol.	Adv.	Base	Pol.	Adv.	Base	Pol.	Adv.
Allowance Price ($/tonne$CO_2$-eq)	---	---	8	7	---	18	9	---	22	15
Emissions (MMtCO2-eq)	5617	6486	5884	5884	7088	5677	5633	7703	5692	5656
Net Benefits (Billion 2001$)	--	--	-6	7	--	15	55	--	48	98
Avg. Electricity Bill (2001$/Household)	943	939	1064	1051	962	1014	957	989	932	877
Avg. Electricity Price (2001cents/kWh)	6.9	6.4	7.4	7.3	6.5	7.6	7.1	6.6	7.5	7.0
Natural Gas Price (2001$/Mcf)	3.8	3.3	3.2	3.1	3.6	3.5	3.2	3.6	3.3	3.2
Gas Consumption (Quadrillion BTU)	24	28	27	27	30	29	28	33	32	30

Comparison to Other Studies

The MIT Joint Program on the Science and Policy of Global Change recently published *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain Lieberman Proposal.* Scenario 7 of that analysis resembles the scenario analyzed in this analysis, although the MIT analysis does not include complementary policies. The MIT results have allowance prices increasing from \$21/tonne CO_2 in 2010 to \$36/tonne CO_2 in 2020 (2001\$), higher than the values that we have calculated. Even with the higher

allowance prices, MIT calculates that welfare costs (the cost to the economy as measured by the impact on household purchasing power) would be only 0.09 percent to 0.13 percent of the business-as-usual consumption levels. MIT also analyzed a Phase 1 only of the above scenario (Scenario12). They find the costs of the Act to be significantly lowered. If only Phase 1 reductions are implemented the MIT results have allowance prices increasing from only \$9/tonne CO_2 in 2010 to \$14/tonne CO_2 in 2020 (2001\$), more than half the value found for full implementation of the Act. The corresponding welfare costs are also substantially reduced to only 0.02 percent of the business-as-usual consumption levels from 2010 onward. This translates to a cost per household of only \$15–\$19 per year from 2010–2020.

The MIT results suggest that if the complementary policies adopted in our analysis were included also in the MIT analysis, the effect would be to further reduce both MIT's estimate of allowance prices and welfare costs. As in this study, MIT finds that natural gas consumption would be lower under S. 139 than under its business-as-usual case.

The Energy Information Administration analyzed S. 139 at the request of Senator Inhofe (and a subsequent request by Senator Lieberman). EIA used its energy forecasting NEMS model to conduct the analysis without the modifications and complementary policies considered in this analysis. In this form the NEMS model is well known to respond weakly to policy signals, implying that higher allowance prices are needed to achieve the emission limits of S. 139.

The allowance prices forecast by EIA average more than twice as high as those forecast by Tellus and are also significantly above MIT's prices. Welfare costs projected by EIA are also much higher than those found in the MIT study by a factor that greatly exceeds the difference in allowance prices. This translates into cost to households that are vastly higher than found in MIT's study, where the costs are quite modest, to the Tellus study were households in the later years actually begin to save considerable amounts of money because electricity prices increase only modestly compared to the reference case while energy efficiency measures help reduce electricity demand. Another major difference is that EIA projects an increase, rather than a decrease, in natural gas consumption under S. 139 relative to its Base case. This is due to the very weak demand response in the end-use sectors projected by EIA. As a result a much greater proportion of the total emission reductions must be achieved by fuel switching from coal to natural gas in the electric sector, driving up gas demand and prices.

Table 2.—Comparison of S. 139 Analyses

	2010				2015				2020			
	Tel	MIT *Phase 1&2*	MIT *Phase 1 only*	EIA	Tel	MIT *Phase 1&2*	MIT *Phase 1 only*	EIA	Tel	MIT *Phase 1&2*	MIT *Phase 1 only*	EIA
Allowance Price (2001$/tonne CO_2-eq)	8	21	9	22	18	28	11	32	22	36	14	49
Cost per Household per year (2001$)	53	67	15	344	-124	91	17	630	-379	121	19	534
Gas Consumption (Quadrillion BTU)	27	21	23	28	29	23	24	31	32	23	25	37

EIA's energy forecasting model reflects and reinforces the status quo. It, thus, limits the potential impact of new and innovative policies that differ from business as usual behavior. Analyses reviewing the historical record of energy-economic model results, including NEMS, have shown a strong tendency to over project energy consumption and underestimate the impacts that technological change can have on reducing consumption. This results in a systematic overestimation of both future allowance and energy prices. Furthermore, the NEMS model assumes a reference case where all resources are fully employed and efficiently allocated. Therefore, by definition any changes in the mix to protect the environment will automatically lead to a less efficient and more costly outcome. Yet, to assume that there must be a trade-off between environmental and economic benefits has been shown to be false. For example, it has been shown over and over again in the economic literature and through practical experience that energy efficiency measures can and do result in a net benefit to businesses and consumers.

Our results for the policy cases analyzed demonstrate that the Climate Stewardship Act is a cost-effective approach to managing U.S. emissions of global warming pollution, especially when partnered with sound energy policies that help increase energy efficiency and clean, renewable, sources of energy. Furthermore, implementation of just Phase 1 of the Act is shown to further decrease costs.

The executive summary and full report can be found at:

http://www.tellus.org/energy/publications/McCainLieberman2003.pdf

If you have any questions or need additional information, please do not hesitate to contact the following NRDC Climate Center staff:

Dan Lashof, Director of Science dlashof@nrdc.org

Antonia Herzog, Staff Scientist aherzog@nrdc.org

Mr. PODELL. Real meaningful action on climate change is not an academic or theoretical issue anymore. A March 2003 Gallup Poll survey found that 75 percent of Americans support mandatory controls on carbon dioxide and other greenhouse gas emissions.

In a recent University of Oregon poll, some 80 percent of Americans said that climate change is a real problem and one for which the business community should take direct responsibility.

Many in the business community understand the magnitude of global warming. Some are waiting for our political leadership to devise the necessary rules and policies, others are hoping that regulation will never occur. But in either case, without regulation, the business community will stay in its comfort zone and continue to wait and delay action on this critical world issue.

Scientific understanding today of climate change is clear and certain enough to point public policy in one direction, and one direction only. We do not really need more research on the relationship between clouds and climate change before we take action. We do not need to wait a decade for energy research to magically deliver a silver bullet, which will never arrive unless the private sector has a clear incentive to invest in innovative solutions.

No, what we need is to take action now to reduce our greenhouse gas emissions. We are kidding ourselves if we think that a plea for voluntary action to reduce greenhouse gas emissions in the United States will accomplish anything.

Finally, climate change is, as the World Business Council said not too long ago, the single biggest issue facing the world business community. The American business community has a special responsibility here to participate fully and actively in finding the right solution. We emit 25 percent of the world's greenhouse gases.

S. 139 is a path-breaking, innovative step, a bold effort to take America in the right direction on a critical issue for the future of the world. Only with a mandatory set of greenhouse gas emissions targets will we make any meaningful progress in winning this crucial war with carbon.

Thank you.

[The prepared statement of Mr. Podell follows:]

PREPARED STATEMENT OF ETHAN J. PODELL, PRESIDENT,
ORBIS ENERGY ADVISORS INC.

Summary

The evidence so far is that voluntary greenhouse gas (GHG) cap-and-trade programs are not attracting many volunteers from the American business community.

For instance, the Chicago Climate Exchange ("CCX")—the nation's first attempt to create a voluntary, multi-sector greenhouse gas cap-and-trade program—has only attracted 20 or so members. It is not because the CCX imposes large GHG reduction obligations on its members; the reductions are only 1 percent below baseline in 2003, rising to 4 percent below baseline in 2006. Furthermore, CCX members are only making a limited, 4-year commitment to a pilot program running from now through 2006.

The companies which are so far participating in a voluntary GHG reduction program such as the Chicago Climate Exchange are those that see carbon trading as a way to make some money by selling excess reduction credits, and a way to make a statement—really a gesture—about their environmental awareness. For these companies participating in a program such as the Chicago Climate Exchange is largely a risk-free, money-making opportunity.

The companies we really need to join a GHG cap-and-trade program, the large emitters of greenhouse gases, those who will end up as buyers of emission reduction credits—the utilities, the oil/gas/petrochemical companies, the cement makers, the truckers and railroads—these companies are not prepared to join a voluntary cap-and-trade program. They view voluntary compliance as a short term expense which will create competitive disadvantages. Long term benefits and cost savings are ignored.

Washington needs to provide firm rules and regulations if you expect corporate America to respond. When it comes to climate change, voluntary action from the corporate community means hardly any action at all. As S. 139 recognizes, a cap-and-trade system is likely to be effective in reducing greenhouse gas emissions, *provided it is mandatory.*

Mr. Chairman and distinguished Members of the Senate,

I am grateful for the invitation to address the Committee and to share my perspective as a businessman who has tried to get corporate America to take voluntary action on climate change.

My name is Ethan Podell. I'm the President of Orbis Energy Advisors, a finance and consulting firm focused on the business of climate change and renewable energy. I am also here today as a representative of E2—Environmental Entrepreneurs—a national group of professionals and business people who believe in protecting the environment while building economic prosperity. E2 has over 400 members in 16 states who have been involved in financing and founding more than 800 companies, which created over 400,000 jobs. E2 members currently represent more than $20 billion in private equity capital available for investment into new companies.

After a 20 year career as a media entrepreneur, I've spent the better part of the past two years trying to get corporate America to understand—and more importantly to take some meaningful action to address—this enormous problem looming before us . . . global climate change. *My conclusion from this experience is that it is essential to enact mandatory limits on greenhouse gas emissions as provided for by S. 139.*

I consulted on strategy and business development for Cantor Fitzgerald's greenhouse gas trading unit. From March through August of this year, I was the senior vice president for sales and marketing for the Chicago Climate Exchange. As you may know, the Chicago Climate Exchange is the first *voluntary,* greenhouse gas cap-and-trade program in the U.S. My principal role at the Exchange was to recruit corporate clients willing to commit to a modest, pilot program requiring minimal reductions in their greenhouse gas emissions.

I'm here to tell you today that there is very little evidence that corporate America has any real interest in participating in a voluntary greenhouse gas reduction trading program.

The Chicago Climate Exchange is a terrific idea and an innovative institution of the first order. It seeks to prove the concept that a *voluntary,* greenhouse gas emissions reduction program using a cap-and-trade system can be effective with the American business community. The Exchange is designed as a 4-year pilot program, running from now through 2006, so that companies which join the program are making a limited time commitment. And Exchange members are also making a very limited commitment to reduce their greenhouse gas emissions, as the reduction targets set by the Exchange are extremely modest. Those reductions are 1 percent below baseline in 2003, rising to 4 percent below baseline in 2006.

The Chicago Climate Exchange was designed over a number of years with the active participation of leading companies from many sectors of American business. Notwithstanding the modest reduction targets and other incentives embedded in the rules of the Exchange, which are designed to make for a very slow and non-threatening game of softball, there are—so far at least—very few takers in the corporate world. As of last week, only about 20 companies in the U.S. had agreed to participate in the Chicago Climate Exchange. These companies are responsible for about 3 or 4 percent of the total U.S. greenhouse gas emissions. If you do the math and apply the 1 percent per year emissions reduction required of members of the Chicago Climate Exchange against the 4 percent of total U.S. emissions which these companies represent, what we end up with is a very small drop removed from a very large bucket. This bucket has 10,000 drops; the current members of the Chicago Climate Exchange will remove 4 of these 10,000 drops this year and 16 in the year 2006.

As we have seen with the acid rain program, cap-and-trade can accomplish real environmental goals at modest cost *when coupled with a mandatory* set of targets. However, without regulation and governmentally-imposed sanctions, the early evidence, at least, is that the American business community is not very interested in a voluntary, greenhouse gas cap and trade program.

Over the past six months, I've spoken or met with more than 250 companies, mostly in the Fortune 500, but smaller private businesses as well, about why they should join the Chicago Climate Exchange. I've also marketed the Exchange to municipalities, universities and state governments.

For a cap and trade system to work, you really need only three things: (1). a target or cap representing some reduced level of emissions when measured against the past; (2). a group of participants that will reduce their emissions below the target and have excess reduction credits to sell; and (3). a group who will miss the target and need to buy credits to be in compliance with the rules of the game.

What I've seen in marketing the Chicago Climate Exchange is that there are very few companies in this country willing to commit to buy emission credits to be in compliance with a voluntary greenhouse gas reduction program.

The companies which are willing to participate in a voluntary can-and-trade program are those that see carbon trading as a way to make some money by selling excess credits, and a way to make a statement—really a gesture—about their environmental awareness. For these companies, the ones which will be sellers of emission reduction credits, participating in a program such as the Chicago Climate Exchange is largely a risk-free, money-making opportunity.

The companies we really need to join a carbon cap-and-trade program, the large emitters of greenhouse gases, those who will end up as buyers of emission reduction credits—the utilities, the oil/gas/petrochemical companies, the cement makers, the truckers and railroads—these companies are not yet prepared to join a voluntary cap-and-trade program.

The large carbon emitters listen attentively to all the arguments: that regulation will happen sooner or later so they should get in early and learn ahead of their competitors; that Wall Street and other stakeholders are increasingly concerned about the link between the company's carbon liabilities and its balance sheet; that the company's overseas operations are as a practical matter subject to greenhouse gas reductions under the Kyoto Protocol or other emerging international regulations whether or not the U.S. Government participates along with the international community. . . . Yes, they listen, some even agree to gather data on their historic levels of emission, but very few companies are prepared to reduce these emissions if it will cost them any money.

Yes, it's true that there is nothing to prevent a voluntary system from working here . . . other than the absence of volunteers. And that is precisely what we have—the absence of volunteers.

And, why after all, should any one American company agree to take the lead on voluntary greenhouse gas reductions? Where are their competitors on this issue? Why be a pioneer when it will just cost them money, threaten their market share, and worst of all, even if they agree to join a voluntary reduction program, where's the assurance that Washington will recognize their early participation in a voluntary program, and not later create legislation which raises the bar and penalizes the early movers? The image here is that pioneers were the ones who ended up with arrows in their backs. Long-term thinking about the environment being in short supply in corporate America, our business leaders generally ignore, or forget, the fact that many pioneers ended up, not with arrows in their backs, but as the owners of very valuable real estate.

In the absence of rules and clear guidelines, the field evidence I have is that most American businesses would prefer to sit this one out from the sidelines. Washington needs to provide firm rules and regulations if you expect corporate America to respond. When it comes to climate change, voluntary action in the real world means hardly any action at all. As S. 139 recognizes, a cap-and-trade system is likely to be cost-effective in reducing greenhouse gas emissions, *provided it is a mandatory system.*

A mandatory carbon cap-and-trade program, such as S. 139, will cause some disruption, some adjustments in everyone's business-as-usual behavior, and it is not—at least not in the short term—without some costs. However, the costs are regularly exaggerated, and the benefits often ignored by the business community. A recent MIT study on S. 139 showed that its enactment would affect household purchasing power by less than 1/10th of 1 percent. The gains in energy efficiency and in technological innovation which will follow once we start to constrain carbon emissions in this country will far outweigh any of the short term burdens which will be imposed upon the business community. And over time, the cost of compliance will turn into real and large levels of cost savings. A recent analysis of S. 139 by the Tellus Institute shows that as this legislation is implemented over time, it will ultimately yield net cost savings to American consumers of some $50 billion per year.

Real, meaningful action on climate change is not an academic or theoretical issue anymore. A March, 2003 Gallup Poll found that 75 percent of Americans support "mandatory controls on carbon dioxide and other greenhouse gas emissions." In a recent University of Oregon poll, some 80 percent of Americans said that climate change is a real problem and one for which the business community should take direct responsibility.

Many in the business community understand the magnitude of global warming. They are waiting for our political leadership to devise the necessary rules and policies. Without regulation, the business community will stay in its comfort zone, and continue to wait and delay action on this critical world issue.

Scientific understanding today of climate change is clear and certain enough to point public policy in one direction and one direction only. We do not really need more research on the relationship between clouds and climate change before we take action. We do not need to wait a decade for energy research to magically deliver a silver bullet, which will never arrive unless the private sector has a clear incentive to invest in innovative solutions. No, what we need is to take action now to reduce our greenhouse gas emissions. We are kidding ourselves if we think that a plea for voluntary action to reduce greenhouse gas emissions in the U.S. will accomplish anything.

Climate change is, as the World Business Council said not too long ago, the single biggest issue facing the world business community. The American business community has a special responsibility here to participate fully and actively in finding the right solution. We emit 25 percent of the world's greenhouse gases. S. 139 is a pathbreaking, innovative step, a bold effort to take America in the right direction on a critical issue for the future of our world. Only with a mandatory set of greenhouse gas emission targets will we make any meaningful progress in winning this crucial war with carbon.

Thank you.

ETHAN J. PODELL

Trained as a lawyer, Ethan Podell spent over twenty years as an entrepreneur in television programming and distribution. He co-founded and built two private media enterprises, active in both the U.S. and European markets. Both companies—Orbis Communications and Orbis Entertainment—were eventually sold to publicly-traded entertainment companies. Podell has served as chief financial officer (Orbis Communications Inc.) and chief executive officer of Orbis Entertainment Company (later All American Orbis), where he was responsible for client relationships, program creation and sales. Podell began his career in 1978 as a lawyer for O'Melveny & Myers in Los Angeles, and then worked in legal and business affairs for CBS and HBO, before starting his first company.

Several years ago Ethan Podell began an entirely new career focused on environmental issues, in particular business opportunities connected with climate change and greenhouse gas trading. As a consultant, Podell developed a marketing strategy for greenhouse gas trading in the U.S. (for a unit of Cantor Fitzgerald), and recruited clients for the first voluntary greenhouse gas trading program in the U.S. (Chicago Climate Exchange), where he was senior vice president for sales and marketing. Podell recently founded Orbis Energy Advisors Inc., a finance and consulting company focused on the business of climate change and renewable energy.

Podell is active in E2, a national community of professionals and business people promoting environmental protection while building economic prosperity. He has also done pro bono work as a lawyer and business adviser for the Rainforest Alliance and The Nature Conservancy.

Ethan Podell earned his undergraduate degree at Brown University (B.A. 1974) where he was elected to Phi Beta Kappa. He holds a Masters from the University of Chicago (Committee on Social Thought, 1975) and a law degree from Northwestern University (1978), where he was on the editorial board of the Law Review.

Podell is a member of the State Bar of California, and currently resides in New York.

ETHAN J. PODELL,
President,
Orbis Energy Advisors Inc.

The CHAIRMAN. Thank you, sir.

Mr. Stephenson, welcome back.

STATEMENT OF JOHN B. STEPHENSON, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, UNITED STATES GENERAL ACCOUNTING OFFICE

Mr. STEPHENSON. Thank you.

Mr. Chairman, Senator Lautenberg, and Senator Nelson, my only purpose in being here today is to make some preliminary and, I might add, independent observation about the Administration's

Global Climate Change Initiative that it announced back in February 2002.

This initiative included, among other things, a goal concerning domestic emissions of carbon dioxide and other greenhouse gases. Specifically, the initiative established the goal of reducing U.S. emissions intensity by 18 percent by 2012. This is 4 percentage points more than the—or, I should say, less than the 14 percent reduction that would otherwise have been expected to occur without the initiative. It's important to note that the Administration's goal is based on emission intensity, not total emissions.

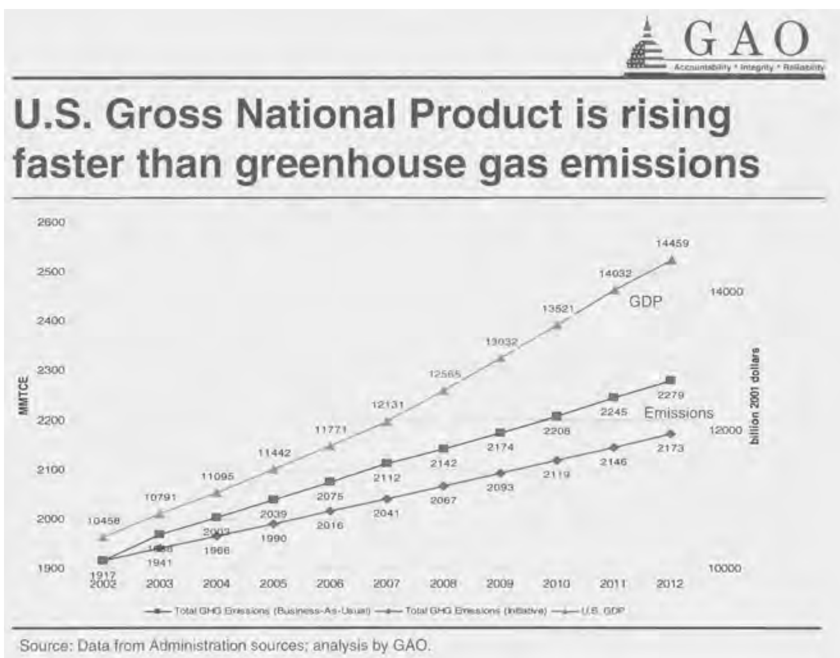
I had a graphic to show, that hopefully was handed out.

The CHAIRMAN. We have it.

Mr. STEPHENSON. Good.

Now, emissions intensity is the ratio between that top line, the green line, and the bottom two lines. So, for example, in 1990, which you don't have on your chart, U.S. emissions totaled about 1,909 million metric tons of carbon equivalents, and the economic output at that time was about $9.2 trillion. Dividing these two numbers yields the emission intensity ratio of 200 million metric tons. If emissions and economic output increase by the same proportion, the ratio doesn't change.

[The chart referred to follows:]



What the Administration is saying is that emissions will increase more slowly than output increases, and, therefore, the emission intensity ratio will decrease by 18 percent.

So it's important to note that we're playing with the slope of the line. The blue line on your chart is the business-as-usual case that's projected through 2012. The red line represents the Administration's slowed growth rate. And, therefore, the ratio of those, between that top line, which is the gross domestic product, would decline. So it's a little bit misleading when you talk about, you know, a declining intensity ratio. It's really still increasing the emissions, just at a slower rate.

My testimony is based on ongoing work for this Committee to, in part, determine, one, the basis for the Administration's 18 percent emissions intensity reduction goal; two, the extent to which the 30 projects comprising the initiative contribute to the goal; and, three, the extent to which the Administration plans to track progress in meeting its goal.

First, in analyzing the 18 percent goal, let me reiterate that it's four additional percentage points beyond the 14 percent otherwise expected, so it's very, very modest. We could not, however, find a specific rationale for the reduction, as opposed to any other level that they might have proposed. The 4 percent represents about 100 million metric tons less than otherwise occur in 2012 if you did nothing in that 1 year. For the overall 11-year period, it's only 2 percent, or 500 million metric tons, less than would otherwise occur.

Second, the Administration's climate change initiative identifies 30 projects, albeit notional projects, it expects to help reduce greenhouse gas emissions and achieve the 18 percent goal. However, we found no current or comprehensive source of information about all of the projects or specifically how the contributions of these individuals projects will add up to the 500 million metric tons that it estimates the initiative will save over the 11-year period.

Our analysis show that no emission estimates were provided for 19 of those 30 projects. Of the 11 projects that did contain emission estimates, eight were based upon past reduction levels or related to measures that were already underway before the initiative was announced. That leaves only three of the 30 projects representing future emission estimates specifically attributable to the initiative.

And, finally, the Administration states that it plans to determine, in 2012, whether the goal of reduced emission intensity was met. This means that it will not be in a position to determine, until a decade after announcing the initiative, whether its efforts are on track or whether additional efforts may be warranted.

We believe that the Congress and the public would be better served if the Administration would, one, make regularly available more current and complete information regarding the basis for establishing its goal; two, better describe the specific projects and their expected contribution to the goal; and, three, develop a plan for monitoring interim progress. Providing such information would constitute a small, but important, step toward addressing broader issues in the policy debate now before the Congress about challenges posed by global climate change.

Mr. Chairman, that concludes my statement. I'll be happy to answer questions.

[The prepared statement of Mr. Stephenson follows:]

PREPARED STATEMENT OF JOHN B. STEPHENSON, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, UNITED STATES GENERAL ACCOUNTING OFFICE

Preliminary Observations on the Administration's February 2002 Climate Initiative

Mr. Chairman and Members of the Committee:

We are pleased to be here today to discuss our preliminary observations on certain aspects of the Administration's February 2002 Global Climate Change Initiative. This Initiative included, among other things, a goal related to domestic emissions of carbon dioxide and other greenhouse gases.

Specifically, the Initiative established the goal of reducing U.S. emissions intensity 18-percent by 2012, which is 4 percentage points more than the 14-percent reduction that was otherwise expected to occur. In 2012, this4-percent reduction in emissions intensity is expected to translate into a 100 million ton reduction in carbon emissions below levels that would be expected in the absence of the Initiative. The Initiative is comprised of 30 elements, including partnerships with industry and tax credits, designed to achieve the reduction in emissions intensity.

It is important to note that the Administration's goal is to reduce emissions intensity, not total emissions. Emissions intensity measures the amount of greenhouse gases emitted per unit of economic output. For example, in 1990, U.S. emissions totaled 1,909 million metric tons of carbon equivalent and economic output (or Gross Domestic Product) totaled $9,216 billion.[1] Dividing these numbers yields an emission intensity ratio of 207 tons of emissions per million dollars of economic output. Emissions intensity changes in response to variations in either emissions or economic output. For example, if emissions increase more slowly than economic output increases, the ratio decreases. If emissions increase more quickly than economic output increases, the ratio increases. If emissions and economic output increase by the same proportion, emissions intensity does not change.

Our testimony, which is based on ongoing work, discusses the extent to which the Administration's public documents (1) explain the basis for its general goal of reducing emissions and its specific goal of reducing emissions intensity 18 percent by 2012, (2) explain how the elements included in the Administration's Initiative are expected to reduce emissions and contribute to the goal of reducing emissions intensity 18 percent, and (3) discuss the Administration's plans to track progress toward meeting the goal. We expect to issue a final report on the results of our work later this year.

Our testimony is based on our analysis of the Administration's February 2002 Global Climate Change Policy Book and subsequent White House fact sheets, as well as congressional testimony by administration officials, an August 2003 report on Federal climate change spending,[2] and related documents. Because of time constraints, we limited our work to reviewing these documents.

We performed our work between July and September 2003 in accordance with generally accepted government auditing standards.

Summary

In summary, in our review of the Administration's documents, we found that the Administration provided a general basis for its climate goal, but did not provide a detailed rationale for the emissions intensity target that it established. That is, we did not find a specific justification for the additional 4-percentage-point reduction—as opposed to any other target that could have been established—or what achieving a 4-percent reduction is specifically intended to accomplish.

The Administration's documents identified 30 elements that it expects to help reduce greenhouse gas emissions, but did not consistently provide information on how each element would contribute to the approximately 100 million metric tons that it estimates the Initiative will save in 2012. In 11 cases, the Administration provided an estimate of the element's contributions, but in 19 other cases it did not provide such an estimate. Moreover, while 3 of the 11 estimates represented future savings levels related to activities that occurred after the Initiative was announced, the other 8 estimates were based upon past or current savings levels or were related to elements that were underway before the Initiative was announced. Furthermore, we found no current and comprehensive source for information about all 30 of the

[1] To allow for comparisons among greenhouse gases, which differ in terms of their effects on the atmosphere and their expected lifetimes, emissions are sometimes measured in million metric tons of carbon equivalent (which we refer to as million metric tons). The economic output number is expressed in 1996 dollars.

[2] *Federal Climate Change Expenditures: Report to Congress,* Aug. 2003.

Initiative's elements and their expected contributions toward achieving the goal of the Initiative.

Finally, the Administration states that it plans to determine, in 2012, whether the goal of reducing emissions intensity was met. However, the documents we reviewed did not indicate whether it plans to assess its progress in the interim. Unless the Administration conducts one or more interim assessments, it will not be in a position to determine, until a decade after announcing the Initiative, whether its efforts to meet the goal are having the intended effect or whether additional efforts may be warranted.

To help the Congress credibly assess the likelihood that the Initiative will achieve its stated goal, we believe that it would be helpful if the Administration would make readily available more current and complete information regarding the basis for establishing its emissions intensity goal, the elements intended to help achieve it as well as their expected contributions, and plans for monitoring interim progress toward the goal. Providing such information would constitute a small, but important step toward addressing broader issues in the policy debate now before the Congress about the challenges posed by global climate change.

Background

Carbon dioxide and certain other gases trap some of the sun's heat in the earth's atmosphere and prevent it from returning to space. The trapped energy warms the earth's climate, much as glass in a greenhouse. Hence, the gases that cause this effect are often referred to as greenhouse gases. In the United States, the most prevalent greenhouse gas is carbon dioxide, which results from the combustion of coal and other fossil fuels in power plants, the burning of gasoline in vehicles, and other sources. The other gases are methane, nitrous oxide, and three synthetic gases. In recent decades, concentrations of these gases have built up in the atmosphere, raising concerns that continuing increases might interfere with the earth's climate, for example, by increasing temperatures or changing precipitation patterns.

In 1997, the United States participated in drafting the Kyoto Protocol, an international agreement to limit greenhouse gas emissions, and in 1998 it signed the Protocol. However, the previous administration did not submit it to the Senate for advice and consent, which are required for ratification. In March 2001, President Bush announced that he opposed the Protocol.

In addition to the emissions intensity goal and domestic elements intended to help achieve it, the President's February 2002 climate initiative includes: (1) new and expanded international policies, such as increasing funding for tropical forests, which sequester carbon dioxide, (2) enhanced science and technology, such as developing and deploying advanced energy and sequestration technologies, and (3) an improved registry of reductions in greenhouse gas emissions. According to testimony by the Chairman of the White House Council on Environmental Quality, the President's climate change strategy was produced by a combined working group of the Domestic Policy Council, National Economic Council, and National Security Council.

While U.S. greenhouse gas emissions have increased significantly, the Energy Information Administration reports that U.S. emissions intensity has generally been falling steadily for 50 years. This decline occurred, in part, because the U.S. energy supply became less carbon-intensive in the last half-century, as nuclear, hydropower, and natural gas were increasingly substituted for more carbon-intensive coal and oil to generate electricity.

Administration's Public Documents Provide a Context But Not a Specific Basis for the 18-percent Goal

The Administration explained that the Initiative's general goal is to slow the growth of U.S. greenhouse gas emissions, but it did not explain the basis for its specific goal of reducing emissions intensity 18 percent by 2012 or what a 4-percent reduction is specifically designed to accomplish. Reducing emissions growth by 4 percentage points more than is currently expected would achieve the general goal, but—on the basis of our review of the fact sheets and other documents—we found no specific basis for establishing a 4-percentage-point change, as opposed to a 2- or 6-percentage-point change, for example, relative to the already anticipated reductions.

According to the Administration's analysis, emissions under its Initiative will increase between 2002 and 2012, but at a slower rate than otherwise expected. Specifically, according to Energy Information Administration (EIA) projections cited by the Administration, without the Initiative emissions will increase from 1,917 million metric tons in 2002 to 2,279 million metric tons in 2012. Under the Initiative, emissions will increase to 2,173 million metric tons in 2012, which is 106 million metric tons less than otherwise expected. We calculated that under the Initiative, emissions would be reduced from 23,162 million metric tons to 22,662 million metric tons cumulatively for the period 2002–12. This difference of 500 million metric tons represents a 2-percent decrease for the 11-year period.

Because economic output will increase faster than emissions between 2002 and 2012, according to EIA's projections, emissions intensity is estimated to decline from 183 tons per million dollars of output in 2002 to 158 tons per million dollars in 2012 (a 14-percent decline) without the Initiative, and to 150 tons per million dollars under the Initiative (an 18-percent decline).

Administration's Public Documents Estimated Contributions for Some, but Not All, of the Initiative's Elements

The Administration identified 30 elements (26 in February 2002 and another 4 later) that it expected would help reduce U.S. emissions by 2012 and, thus, contribute to meeting its 18-percent goal. These 30 elements include regulations, research and development, tax incentives, and other activities. (The elements are listed in Appendix I.) The Administration groups them into four broad categories, as described below.

Providing incentives and programs for renewable energy and certain industrial power systems. Six tax credits and seven other elements are expected to increase the use of wind and other renewable resources, combined heat-and-power systems, and other activities. The tax credits cover electricity from wind and new hybrid or fuel-cell vehicles, among other things. Other elements would provide funding for geothermal energy, primarily in the western United States, and advancing the use of hydropower, wind, and other resources on public lands. Still other elements involve research and development on fusion energy and other sources.

Improving fuel economy. Three efforts relating to automotive technology and two other elements are expected to improve fuel economy. The technology efforts include advances in hydrogen-based fuel cells and low-cost fuel cells. Two of the five elements are mandatory. First, a regulation requiring the installation of tire pressure monitoring systems in cars and certain other vehicles was finalized in June 2002 and will be phased in between 2003 and 2006.[3] Properly inflated tires improve fuel efficiency. Second, a regulation requiring an increase in the fuel economy of light trucks, from the current 20.7 miles per gallon to 22.2 miles per gallon in 2007, was finalized in April 2003.[4]

Promoting domestic carbon sequestration. Four U.S. Department of Agriculture programs were identified as promoting carbon sequestration on farms, forests, and wetlands. Among other things, these programs are intended to accelerate tree planting and converting cropland to grassland or forests.

Challenging business to reduce emissions. Voluntary initiatives to reduce greenhouse gases were proposed for U.S. businesses. For major companies that agreed to establish individual goals for reducing their emissions, the Environmental Protection Agency (EPA) launched a new Climate Leaders Program. In addition, certain companies in the aluminum, natural gas, semiconductor, and underground coal mining sectors have joined voluntary partnerships with EPA to reduce their emissions. Finally, certain agricultural companies have joined two voluntary partnerships with EPA and the Department of Agriculture to reduce their emissions.

The Administration provided some information for all 30 of the Initiative's elements, including, in some cases, estimates of previous or anticipated emission reductions. However, inconsistencies in the nature of this information make it difficult to determine how contributions from the individual elements would achieve the total reduction of about 100 million metric tons in 2012. First, estimates were not provided for 19 the Initiative's elements. Second, for the 11 elements for which estimates were provided, we found that 8 were not clearly attributable to the Initiative because the reductions (1) were related to an activity already included in ongoing programs or (2) were not above previous or current levels. We did find, however, that the estimated reductions for the remaining 3 elements appear attributable to the Initiative.

We have concerns about some of the 19 emission reduction elements for which the Administration did not provide savings estimates. At least two of these elements

[3] Federal Motor Vehicle Safety Standards; Tire Pressure Monitoring Systems; Controls and Displays, 67 Fed. Reg. 38704 (2002)(to be codified at 49 C.F.R. pts. 571 and 596).

[4] Light Truck Average Fuel Economy Standards, Model Years 2005–2007, Final Rule, 68 Fed. Reg. 16868 (2003)(to be codified at 49 C.F.R. pt. 533).

seem unlikely to yield emissions savings by 2012. For example, the April 2003 fact sheet listed hydrogen energy as an additional measure, even though it also stated a goal of commercializing hydrogen vehicles by 2020, beyond the scope of the Initiative. Similarly, the same fact sheet listed a coal-fired, zero-emissions power plant as an additional measure, but described the project as a 10-year demonstration; this means that the power plant would not finish its demonstration phase until the last year of the Initiative, much less be commercialized by then.

Of the 11 elements for which estimates were provided, we found that the estimated reductions for 8 were not clearly attributable to the Initiative. In five cases, an estimate is provided for a current or recent savings level, but no information is provided about the expected additional savings to be achieved by 2012. For example, the Administration states that aluminum producers reduced their emissions by 1.8 million metric tons to meet a goal in 2000, but it does not identify future savings, if any. Similarly, it states that Agriculture's Environmental Quality Incentives Program, which provides assistance to farmers for planning and implementing soil and water conservation practices, reduced emissions by 12 million metric tons in 2002. However, while the Administration sought more funding for the program in Fiscal Year 2003, it did not project any additional emissions reductions from the program.

In two cases, it is not clear how much of the claimed savings will occur by the end of the Initiative in 2012. The requirement that cars and certain other vehicles have tire pressure monitoring systems is expected to yield savings of between 0.3 and 1.3 million metric tons a year when applied to the entire vehicle fleet. However, it will take years for such systems to be incorporated in the entire fleet and it is not clear how much of these savings will be achieved by 2012. Similarly, the required increase in light truck fuel economy is expected to result in savings of 9.4 million metric tons over the lifetime of the vehicles covered. Again, because these vehicles have an estimated lifetime of 25 years, it is not clear how much savings will be achieved by 2012.

In one case, savings are counted for an activity that does not appear to be directly attributable to the Initiative. Specifically, in March 2001 (nearly a year before the Initiative was announced), EPA and the Semiconductor Industry Association signed a voluntary agreement to reduce emissions by an estimated 13.7 million metric tons by 2010. Because this agreement was signed before the Initiative was announced, it is not clear that the estimated reductions should be considered as additions to the already anticipated amount.

Estimates for the remaining 3 of the 11 elements appear to be attributable to the Initiative in that they represent reductions beyond previous or current levels and are associated with expanded program activities. These are:

- Agriculture's Conservation Reserve Program was credited with additional savings of 4 million metric tons a year. This program assists farm owners and operators to conserve and improve soil, water, air, and wildlife resources and results in carbon sequestration.
- Agriculture's Wetland Reserve Program was credited with additional savings of 2 million metric tons a year. This program helps convert cropland on wetland soils to grassland or forest and also sequesters carbon emissions.
- The Environmental Protection Agency's Natural Gas STAR Program was credited with additional savings of 2 million metric tons a year. This program works with companies in the natural gas industry to reduce losses of methane during production, transmission, distribution, and processing.

More current information about certain of these elements and their expected contributions has been made public, but has not been consolidated with earlier information about the Initiative. For example, the Department of Agriculture's website includes a June 2003 fact sheet on that agency's programs that contribute to carbon sequestration. Among other things, the fact sheet estimated that the Environmental Quality Incentives Program, cited above, will reduce emissions 7.1 million metric tons in 2012. However, we did not find that such information had been consolidated with the earlier information, and there appears to be no comprehensive source for information about all of the elements intended to help achieve the Initiative's goal and their expected contributions. The lack of consistent and comprehensive information makes it difficult for relevant stakeholders and members of the general public to assess the merits of the Initiative.

Administration's Public Documents Do Not Discuss Plans for Monitoring Interim Progress

According to the February 2002 fact sheet, progress in meeting the 18-percent goal will be assessed in 2012, the final year of the Initiative. At that point, the fact sheet states that if progress is not sufficient and if science justifies additional action, the United States will respond with further policies; these policies may include additional incentives and voluntary programs. The fact sheets did not indicate whether the Administration plans to check its progress before 2012. Such an interim assessment, for example, after 5 years, would help the Administration determine whether it is on course to meet the goal in 2012 and, if not, whether it should consider additional elements to help meet the goal.

Mr. Chairman, this concludes our prepared statement. We would be happy to respond to any questions that you or Members of the Committee may have.

Contacts and Acknowledgments

For further information about this testimony, please contact me. John Delicath, Anne K. Johnson, Karen Keegan, David Marwick, and Kevin Tarmann made key contributions to this statement.

Appendix I

Table 1.—Summary of Initiative's Elements Expected to Reduce Greenhouse Gas Emissions

Number	Measure
Providing tax incentives and programs for renewable energy and certain industrial power systems	
1	Tax credit for combined heat and power systems
2	EPA Combined Heat and Power Partnership
3	Department of Energy challenge to heat and power industry
4	Tax credit for residential solar energy systems
5	Tax credit for electricity from wind and certain biomass sources
6	Tax credit for electricity from additional biomass sources
7	Tax credit for new methane landfill projects
8	Tax credit for new hybrid or fuel-cell vehicles [a]
9	Funding for geothermal energy
10	Renewable energy on public lands
11	Hydrogen energy
12	Coal-fired, zero-emissions electricity generation
13	Fusion energy
Improving fuel economy	
14	Advancing hydrogen-based fuel cells
15	Department of Energy public-private projects for low-cost fuel cell technology
16	Fuel economy standards for light trucks
17	Tire pressure monitoring systems
18	High-efficiency automobile technology
Promoting domestic carbon sequestration	
19	Conservation Reserve Program
20	Environmental Quality Incentives Program
21	Wetland Reserve Program
22	Forest Stewardship Program
Challenging business to decrease emissions	
23	EPA Climate Leaders Program
24	Semiconductor industry
25	Aluminum producers
26	EPA Natural Gas STAR Program
27	EPA Coal Bed Methane Outreach Program
28	AgSTAR Program
29	Ruminant Livestock Efficiency Program
30	Climate VISION Partnership

Source: Data from Global Climate Change Policy Book, Feb. 2002; White House Fact Sheets, July 2002 and April 2003; analysis by GAO.

[a] Also listed in improving fuel economy category.

The CHAIRMAN. Thank you very much, Mr. Stephenson.

Mr. Walker, welcome.

STATEMENT OF CHRISTOPHER T. WALKER, MANAGING DIRECTOR, GREENHOUSE GAS RISK SOLUTIONS, ON BEHALF OF SWISS RE

Mr. WALKER. Good morning.

Good morning, Mr. Chairman and Members of the Committee. We have submitted a written statement for the record.

My name is Chris Walker. I am the Managing Director of the Greenhouse Gas Risk Solutions Team for Swiss Re in North America. Thank you for giving me this opportunity to discuss greenhouse gas emissions and its effect on climate change.

Founded in 1963, Swiss Re is North America's largest reinsurer, and the world's second-largest reinsurer, and largest life and health reinsurer. The company is global, operating in 70 offices in 30 countries. We have 2,300 employees in the U.S., and 9,000 worldwide.

Natural catastrophes have always been a critical concern to the reinsurance industry. Swiss Re has paid claims on every major U.S. catastrophe since the 1906 California earthquake. No other single factor affects the bottom line of our industry or livelihood of our clients more than natural catastrophes. We believe that climate change has the potential to affect the number and severity of these natural catastrophes and have a significant impact on our business.

Swiss Re supports strategies that protect the global climate system. The need to contain potential consequences of climate change calls for a precautionary global climate protection policy.

Swiss Re congratulates Chairman McCain and his entire Committee for dedicating a significant portion of your busy agenda to this critical issue. In particular, we also thank Senator Nelson for his leadership in the past capacity as Florida insurance commissioner on this issue.

Climate change natural disasters are forecasted to cost the world's financial centers as much 150 billion per year within the next 10 years, according to the U.N. Environmental Program's Finance Initiative Report of last year. Our analysis indicates that climate change will impact various insurance lines, such as property and casualty, due to potential increases in severity and frequency of storms, floods, droughts, et cetera. Also, though, on the life and health side, we may experience changes in mortality rates and disease factors.

To enhance our understanding of this potential problem, Swiss Re is funding a study of the health impacts of climate change with Harvard Medical School's Center for Health and Global Environment, and the U.N.—United Nations Development Program.

Swiss Re also supports measures to reduce greenhouse gas emissions by offering financial solutions to facilitate the market mechanisms that would be employed.

At present, we see business at a crossroads for how to conduct operations in a carbon-constrained future. Responsible businesses are taking action, but do so blindly without governmental leadership on this issue.

As a global reinsurer, we work to understand global trends. Because we operate throughout the world, we are in a unique position to witness what may not be seen, the consequences of change in climate on property, life, and health in the developing world.

As an industry, we can raise awareness and change attitudes. We saw this firsthand last year when we participated in the carbon disclosure project with 35 other financial institutions constituting 4 trillion in investments. The project wrote to the world's 500 largest companies by market capitalization, asked them for the disclosure of investment-related information concerning their greenhouse gas emissions. The CDP study found that 80 percent of respondents acknowledged the importance of climate change as a financial risk, but only 35 to 40 percent were actually taking action to address the risks and opportunities. To us, this is not acceptable as management.

Swiss Re has focused on risk from GHG emissions reductions to our own current customers. For example, we are focusing on the exposure potentially for directors and officers coverage. D&O insurance is professional liability insurance for directors and officers and members of senior management. Companies that are not complying with climate-change-related regulations could create personal liabilities for directors and officers. Noncompliance with these GHG reduction requirements potentially represents a significant risk. We consider GHG-related shareholder actions to be a distinct possibility in creating this risk; and, therefore, it is of concern to us.

Worldwide policy measures to stimulate reductions in GHG emission are inevitable. From the emerging GHG regulations in the EU, Japan, and Canada, to the multitude of proposed U.S. Federal and state policies, as well as global NGO initiatives, the public and other stakeholders are exerting increasing pressure for concrete action. Some companies have taken up the challenge and are voluntarily reducing their emissions footprint, but a long and demanding learning curve awaits many companies who have not made the GHG reductions a part of their daily business practice.

The issue of climate change is real, and we believe a domestic regulatory response is both necessary and inevitable. With this perspective in mind, we believe that we are better off as a company and industry if we develop an implement an effective moderate response now. If we wait five to 10 years, we may discover the need for a much more drastic and difficult response.

Thank you for the opportunity to testify before the Committee. I am happy to answer any questions.

[The prepared statement of Mr. Walker follows:]

PREPARED STATEMENT OF CHRISTOPHER T. WALKER, MANAGING DIRECTOR, GREENHOUSE GAS RISK SOLUTIONS ON BEHALF OF SWISS RE

Introduction

Good morning. My name is Chris Walker and I am the Managing Director of the Greenhouse Gas Risk Solutions team for Swiss Re in North America. Thank you for giving us this opportunity to discuss greenhouse gas emissions (GHG) and its effect on climate change.

Founded in 1863, Swiss Re is North America's leading reinsurer and the world's second largest reinsurer and largest life and health reinsurer. The company is global, operating from 70 offices in 30 countries. Swiss Re has three business groups: Property & Casualty reinsurance, Life & Health reinsurance and Financial Services. We have 2,300 employees in the U.S. and 9,000 worldwide.

Natural catastrophes have always been of critical concern to the reinsurance industry. Swiss Re has paid claims on every major U.S. catastrophe since the 1906 California earthquake. No other single factor affects the bottom line of our industry or the livelihood of our clients more than natural catastrophes. We believe that climate change has the potential to affect the number and severity of these natural catastrophes and result in very significant impact on our business.

In 1994, Swiss Re published its first publication on climate change, "Global Warming, Element of Risk". At the time, there was still uncertainly as to whether global climate change could be influenced by human intervention. Today, we recognize that global warming is a fact. The climate has changed, visibly, tangibly and measurably. One only has to look at the extreme summer heat in Europe or severe draughts in the Western United States to understand that something has changed.

The question is no longer whether the climate is changing, but how the occurring climate change will affect our existence, what conclusions can be drawn from it and what can be done to mitigate the impact.

Swiss Re supports strategies that serve to protect the global climate system. The need to contain potential consequences of climate change calls for a precautionary global climate protection policy. Swiss Re congratulates Chairman McCain and his entire committee for dedicating a significant portion of your busy agenda to this critical issue.

Assessing the risks

Climate change-driven natural disasters are forecasted to cost the world's financial centers as much as $150 billion per year within the next 10 years, according the UN Environment Program's (UNEP) finance initiative report.

Our analysis indicates that climate change will impact various insurance lines of such as:

- Property and casualty insurance due to potential increases in severity and frequency of storms, floods, droughts, etc., and
- Life and health insurance may experience changes in mortality rates and disease vectors. To enhance our understanding of this potential problem, Swiss Re is funding a study of the health impact of climate change, undertaken by the Harvard Medical School's Center for Health and the Global Environment [1] and the United Nations Development Program.

Offering financial solutions

Swiss Re supports measures to reduce GHG emissions. At present, we see business at a crossroads for how to conduct operations in a carbon-constrained future. Responsible businesses are taking action, but do so blindly without government leadership on this issue.

As a global reinsurer, we work to understand global trends. This may give us an advantage in considering the impact of long-term issues such as climate change and sustainability. Because we operate throughout the world, we are in a unique position to witness what many may not see—the consequences of changing climate on property, life and health in the developing world.

The financial services industry, of which Swiss Re is a leading player, has an opportunity and an obligation to assist in solving this problem through its investment and business expertise. After all, dealing with climate change and commensurate emissions reductions are ultimately financial issues.

Reinsurance can play a crucial role in grappling with broad societal issues. As an industry, we can raise awareness and change attitudes. We saw this first hand last year when we participated in the Carbon Disclosure Project with 35 financial institutions representing over $4 trillion in investments. The project wrote to the world's 500 largest companies by market capitalisation asking for the disclosure of investment-relevant information concerning their greenhouse gas emissions. The CDP study found that while 80 percent of respondents acknowledge the importance of climate change as a financial risk, only 35–40 percent were actually taking action to address the risks and opportunities. This is not acceptable risk mitigation.

Reinsurers make a living in part by understanding and anticipating risks. As an example, Swiss Re has climatologists and atmospheric physicists on staff and last year published "Opportunities and Risks of Climate Change." Once we understand the risks, we educate our clients and the public in an effort to mitigate these risks. GHG issues are just the latest example of an insurer addressing a risk that grows more prominent with every passing year.

[1] The Harvard Health Futures Project

Swiss Re's Greenhouse Gas Risk Solutions

Swiss Re is an industry pioneer in identifying and incorporating risk and capital management to assist clients in dealing with emissions constraints in the most effective and cost efficient manner. We have endeavored to raise awareness of GHG risks and opportunities by hosting well-received and broadly-cosponsored conferences in 2001, 2002 and 2003 at our Center for Global Dialogue in Ruschlikon, Switzerland and in 2002 in New York City. We are considering hosting an event in Washington, D.C. in 2004.

In 2001,we created Greenhouse Gas Risk Solutions.[2] This unit works to determine where, when and how Swiss Re can play a role in facilitating emissions reductions. For example, my unit focuses on several relevant activities:

- Providing clearing and pooling insurance geared to removing the counter-party and delivery risks that have hampered much of early stage emissions trading potential.
- Raising the credit rating of renewable/alternate energy projects through the insuring of construction, technical and operational risks in projects. This insurance has the effect of decreasing the cost of capital for greenhouse-gas-reduction projects.
- Assisting GHG emission reductions with investment asset management. For example, we are developing a project financing mechanism for energy efficiency projects in Eastern Europe.
- In conjunction with the Commonwealth Bank of Australia, we are developing a program for voluntary emissions reductions activities for U.S. and European corporations.

Swiss Re also focuses on risks from GHG emissions reductions to our current customers. For example, we concluded that an exposure potentially exists for Directors and Officers covers (D&O—Professional Liability insurance for senior management). Companies that are not complying with climate-change related regulations could create personal liabilities for directors and officers. Non-compliance with these GHG reduction requirements potentially represents a significant risk. We are educating companies and requiring them to address this issue to prevent losses. These actions are similar to those taken in the mid-1990s before the Y2K crisis was commonly acknowledged. As we know, non-compliance of IT systems would have caused untold losses to companies and shareholders. We consider GHG-related shareholder actions to be a distinct possibility.

Swiss Re has prepared a Directors and Officers questionnaire to be completed during policy renewals for corporate clients. The companies are asked questions concerning emissions, emissions reductions plans and their climate change strategy. The information provided serves as a factor for our risk and underwriting assessment.

Emissions reductions efforts

Worldwide, policy measures to stimulate reductions in GHG emissions are inevitable. From the emerging GHG regulation in the EU, Japan and Canada to the multitude of proposed U.S. Federal and state policies, as well as global Non Governmental Organizations initiatives, the public and other stakeholders are exerting increasing pressure for concrete action. Some companies have taken up the challenge and are voluntarily reducing their emissions footprint. But a long and demanding learning curve awaits many companies who have not made GHG reductions a part of their daily business practice. Unfortunately, for U.S. companies operating overseas they face certainty in being regulated for their emissions overseas but potentially a patchwork quilt of non-fungible future legislation and litigation at home.

At Swiss Re we believe that environmental performance is one indicator of overall business performance. Experience has taught us that proactive steps to improve environmental performance leads to better bottom line results. In our view, environment and economics are inseparable, and, as with many things, the secret to success is finding the right balance.

From Swiss Re's perspective, U.S. regulation of emissions has many benefits including better public health and environmental improvements. We believe the best way to lessen potential loss is through sound public policy utilizing market mechanisms which strike the right balance between environmental precaution and societal policy objectives.

[2] Please see: *www.swissre.com/emissions* for more detail

Conclusion

The issue of climate change is real, and we believe a domestic regulatory response is both necessary and inevitable. With this perspective in mind, we believe that we are better off as a company, and industry, if we develop and implement an effective moderate response now. If we wait 5–10 years, we may discover the need for a much more drastic and difficult response.

Thank you for the opportunity to testify before this committee. I am happy to answer any questions you may have.

The CHAIRMAN. Thank you very much, Mr. Walker.

Mr. Stephenson, let me get this straight, from your statement. The Administration states that it plans to determine, in 2012, whether the goal of reducing emissions intensity was met? Is that a correct statement?

Mr. STEPHENSON. Yes, and their goal is an 18 percent reduction in intensity.

The CHAIRMAN. So I calculate that to be the end of President Cheney's first term.

[Laughter.]

The CHAIRMAN. 2012, the Administration will determine whether the intensity—not the amount, but whether the intensity of greenhouse gas emissions has been reduced.

Mr. STEPHENSON. Right. And as you can see on the chart, they're simply slowing the growth of greenhouse gases, there's no reduction of greenhouse gas emissions.

The CHAIRMAN. Well, I don't think we have to spend anymore time on the Administration's proposal.

Mr. Podell, you paint a rather pessimistic picture about the prospects of this very important free-market initiative unless there is some kind of government-set regulation and goals. Is that fundamentally what you're saying here?

Mr. PODELL. Yes, Senator. I believe it's absolutely essential to get enough participants in the market so you've got a reasonable balance between buyers and sellers of emissions reduction credits.

The CHAIRMAN. Have you seen what they're doing in the EU?

Mr. PODELL. Yes, I'm generally familiar with what they're doing in the EU.

The CHAIRMAN. They seem to have a pretty thriving system going on there.

Mr. PODELL. They do. And it's largely because there is a regulatory thrust behind those activities.

The CHAIRMAN. Because goals need to be met.

Mr. PODELL. Absolutely. There's a real regulatory stick that is involved in getting corporations and other participants to deal with the issue. Whether that's in England or whether that's in the emerging EU situation, there is a push from the regulators to get participation.

The CHAIRMAN. Mr. Gorman, isn't it a little unusual for religious organizations to get involved in what is clearly a policy dispute here?

Mr. GORMAN. Well, I think, for us, it is primarily a religious and moral question, and that the details of legislation are really for you to work out. As I said, we are convinced that there is a clear scientific consensus. We're convinced there are fundamental values; intergenerational equity, stewardship, our sense of commitment to the future. This conversation cannot simply be a technical one, particularly inasmuch as it affects all of humankind.

It is unusual for us to move forward across such a breadth of support, from Catholic bishops, the Jewish community, and evangelical Christians, but it's some measure of what we think is really the deepest, most fundamental issues that are being addressed here. And we're here to urge you to continue to address this dimension of the challenge.

The CHAIRMAN. Mr. Walker, in your testimony—and I think it's an important point here—I quote, "the analysis indicates that climate change will impact various insurance lines, such as property and casualty insurance, and life and health insurance." Go over again, one, what is that effect, and how is significant is it?

Mr. WALKER. We believe it's actually quite significant, or potentially quite significant. What's interesting is that it crosses the lines of business. Generally, in insurance, when you do calculations on exposures, you calculate what basically the exposure would be, say, for a storm hitting a certain region, for property values. What the climate change actually potentially presents is the opportunity or the problem of crossing lines into life and health issues, also, which, as the largest reinsurer on the life and health side in the world, we had not actually correlated with our other parts of the business, at least in our calculations, or potentially are not correlated. And so the concern is that you have potential loss of both the property and casualty—storms, floods, droughts—as well as life and health issues—disease factors, mortality rates, et cetera.

The CHAIRMAN. The reason why it's an important point, Mr. Walker, is that we're always discussing, and appropriately, the cost of any regulations or mandatory reductions in greenhouse gases and other pollutants, but we very rarely discuss the impact of doing nothing. And I think that that's an important factor, not just the cataclysmic floods, et cetera, but the cost of insurance, the cost of rebuilding homes, the cost of moving. Senator Stevens, of Alaska, mentioned that some of the Indian tribes have had to move from where they were, inland.

So I think that perhaps what's missing from this debate, to some degree, is not only the cost of doing something, but the costs that are associated with doing nothing. And that's why I thank you for your testimony here today.

Senator Lautenberg?

Senator LAUTENBERG. Thanks, Mr. Chairman.

I wanted to ask Mr. Walker a question, also. Has Swiss Re—if you can tell us this—looked to offload the areas of coverage that it's presently taking care of on a reinsurance basis? Is it suggested within the company that you'd rather apply your opportunities in other places? Are there any other nations, besides America, that run less risk than we do from the results of the global warming, let's say, over the next decade?

Mr. WALKER. I would say we have not, at this point, looked to, say, make a region uninsurable at this point in time. It certainly could be a consideration down the line. I think there is some historic record, not from Swiss Re's point of view, but what the Outer Banks of North Carolina, for instance, in the Dune Road section of the Hamptons, for instance, being uninsurable, as far as commercially insurable, due to just frequency of storms.

Senator LAUTENBERG. Well, then, how about lines of business? Has that been—well, obviously, if you're saying areas are uninsurable, that's an option the company has, in terms of providing its backup insurance, the reinsurance, that is required. So you take those risks.

Mr. WALKER. Well, certainly, I mean, that would be an option in the future. I mean, to echo what Senator McCain said, I think the ability or the availability of insurance in certain regions may get affected in the future.

Senator LAUTENBERG. Yes.

Mr. WALKER. And I think that is going to be a big, very significant factor for the economy at some point in time.

The CHAIRMAN. Senator Lautenberg, could I interrupt? I have to go to the floor on the Iraqi issue. And could you conclude and shut it down?

And my thanks to the witnesses for their valuable input. I thank you for being here today. I think this has been a very good hearing.

Senator LAUTENBERG. And I'll take not more than 10 minutes, I promise.

The CHAIRMAN. Thank you.

Senator LAUTENBERG [presiding]. I happen to be familiar with one of the places that you mentioned in your testimony, and there is some very expensive real estate there. That area has been subjected to flooding in the past, as you know, because it sits between two bodies of water, the ocean and bay. I would imagine that you'd have to examine the kinds of coverage that you're going to give in these vulnerable areas.

Mr. Podell, the Chicago Climate Exchange—interesting idea—but this one of the places where you've built it and they still haven't come, realistically. And that challenges an adage that we hear, once you get it going.

From your experience, can you think of any scenario in which the Administration's voluntary reductions policy would help accomplish the goals of the Exchange?

Mr. PODELL. Well, as a practical matter, how long are you prepared to wait? Timing is rather critical here. I supposed it's conceivable that five, six, 10 years from now, if we just sort of limp along and do nothing, well, you know, clearly there may well be an increase in membership to a voluntary trading platform like the Climate Exchange. I think that's possible.

But what I think is missing now is that, sort of, critical push or impetus to get corporate America, in meaningful numbers, to participate in the Exchange. One makes all the arguments, as I outlined in my testimony, and many of which are persuasive and empirically true; but without there being a requirement on corporations to really cap and reduce their emissions, you're not going to get meaningful participation.

Senator LAUTENBERG. I agree. I came out of the corporate world before I came to the Senate, and I know something about that. I was at the 1992 conference in Brazil and saw the complaints registered by other countries. When the American representatives complained, about the forest-burning for farming and habitation, that kind of thing, the response was, "One of your workers in a chemical factory does more to damage the environment than one of our farmers taking an acre of forestland and burning it." And, "If you want to keep them from making a living," was the response of an interior minister at one of the countries, "then you should, by all means, provide the funds and perhaps we can let the forests go as they are." Stark reality. And I'm one of those very disappointed in the response that we, as a country, have taken to what I consider emergency needs that face us.

I've got nine grandchildren, another one on the way, and they're all very young. The one thing that I can leave them as a legacy that has durability, is to make sure that the air is clean, that they can fish and play in the water, that they can play on all kinds of ground that our wonderful industrial revolution left so toxic that we can't go near it. So this has been a large concern of mine.

I want to ask you, Mr. Gorman—the impact of the problems of the results of neglect of this problem probably affect different economic classes of the world's population. Could you, in a few words, describe what happens to perhaps the poorest of the poor?

Mr. GORMAN. Thank you for asking that, Senator.

You mentioned your grandchildren. I don't have to go any further than today's Washington Post, which compiles reports from the Associated Press and Reuters, and I'll just read two paragraphs, "'About 160,000 people die every year from the side effects of global warming, which range from malaria to malnutrition, and the numbers could almost double by 2020,' a group of scientists said yesterday. The study by scientists at the World Health Organization and the London School of Hygiene and Tropical Medicine said, 'Children in developing nations seem most vulnerable.'"

Senator LAUTENBERG. That is as a result of sticking your head in the sand and letting events go by.

Mr. Stephenson, thank you for your presentation. I've got a couple of charts here. Any one of them reflects what the greenhouse—the gray line, the greenhouse intensity percent under the White House proposal, kind of, to paraphrase, "live and let die."

[Laughter.]

Senator LAUTENBERG. I just invented that.

[Laughter.]

Senator LAUTENBERG. The red line is the increase in emissions and the projected real GDP percentage change under White House Fiscal Year 2003 budget. Look at the contrast here, how much attention we pay to it and the reality of the growth and the projected effects of the present policy. And this is the defining, the more markedly identified, of the intensity factor, just headed down at it looks like in a rapidly accelerating rate, if you just look out years. And the increase of emissions in—the GDP percents, thank you.

It's, again, a kind of a fantasy that persists around here that somehow or other things will get better if we do nothing. This is like having a very high fever or persistent coughing or some other physical symptom that sometimes send a person to the doctor, sometimes to the hospital, and sometimes, it's too late. We're practicing the same thing on a larger scale. I'm hoping that there is some way—and I commend Senator McCain for his interest, and

Senator Lieberman. And I guess the conclusion that we have to draw is that we'd better do something soon.

One of the things, when we had the scientists sitting there, I wanted to ask was, If we talk about changes in the ecosystem or changes that are not visible immediately, what might the short-term—look out 10 years from now—what can be the immediate effects? Higher water levels? Discomfort from the increasing temperatures? What else might we say that could take effect in your studies or your own view?

Mr. Stephenson? Anybody. Mr. Walker?

Mr. WALKER. Well, actually, the comment I would add is, for instance, changing disease factors. Paul Epstein, up at Harvard, Dr. Paul Epstein, has done a lot of work on changes in disease factors, such as West Nile virus, for instance, which had never appeared in the U.S. prior to the late 1990s. And those type of changes, you're seeing the effects. For instance, they had an outbreak of malaria in Toronto last year. Those type of changes, which they are unprecedented. And, in one sense, it's the easiest way, I would say, that you can explain climate change to someone, because it's very personal. They see these changes. They see these things that have not—that are out of the norm, that have not been a part of human experience, in a sense, in our lifetimes of experiences.

Senator LAUTENBERG. Anybody else want to——

Mr. GORMAN. Crop failure.

Senator LAUTENBERG. Huh?

Mr. GORMAN. Crop failure.

Senator LAUTENBERG. Crop failures could happen significantly within the next decade. We've seen it happen.

Mr. Stephenson, any comment from you?

Mr. STEPHENSON. I can't answer that question. I think you need the science panel back. But, in general, changes in climate, you know, in certain areas——

Senator LAUTENBERG. Dr. Schneider is back there. He smiling. But I can't do that.

Mr. STEPHENSON. I know. Certain areas that might have been farmable may no longer be, in the future. There is very real change, let alone to the wildlife, but to the health of the humans.

Senator LAUTENBERG. I will take my leave as interim Chairman and turn it over to my colleague, Bill Nelson, and say thank you very much, each one of you, for the contributions you're making by being here.

Senator NELSON (PRESIDING). You know, Senator, I've been looking forward to being Chairman of the Commerce Committee.

[Laughter.]

Senator LAUTENBERG. Would the Florida turnpike be getting wider?

[Laughter.]

Senator NELSON. Are we ready to mark up the bill?

[Laughter.]

Senator NELSON. I'd like to ask Mr. Walker some of the questions that I posed to the earlier panel about mid-1990s insurance companies weren't interested. Your company obviously has surveyed the rest of the companies for me.

Mr. WALKER. Well, it's actually a very good point that you made. I'm asked this question very often, and I guess I would explain two things. For instance, why Swiss Re, and where others are. I think part of why Swiss Re is involved is, as a reinsurer, we generally think a few years ahead of the curve. It's just the nature of our business. We have long-term relationships, generally, with our insurance companies, so we have to think three to 5 years out of the box. So, generally, reinsurers are a little further ahead. And Munich Re, for instance, as the largest reinsurer in the world, is very similar to us in their thinking on climate change.

But there's also a difference between European and U.S. insurance companies, and the Europeans have gotten this a lot quicker. They believe it's happening. The European insurance industry, while not as active as they could be, is starting to get there. If you just had to look at the financial initiatives, it's all European insurance companies and I think one or two U.S.

For the U.S. companies, it's very interesting, certainly from the business unit that I run, which looks at—looking at the greenhouse gas emissions issue, there his no counterpart of mine at all in the U.S. to speak with. The U.S. insurance industry has not even looked at the emissions reduction issue, let alone acknowledge climate change, per se. It's still a long way off, and I'm not sure why the reticence is. I believe if you ask them, on an underwriting basis, they are factoring in climate trends into their underwriting, but they're very reluctant to speak publicly about it.

Senator NELSON. What's it going to take to get American insurance companies to recognize this is a threat to their bottom line?

Mr. WALKER. Very good question. I'm not sure. Certainly, from an emissions issue, if there was legislation of some kind, there is a lot of business opportunities, as well as risks, for insurance companies. And the insurance industry will be fast, I think, to come into it, believing that there's a role for insurance to facilitate market mechanisms, trading, offset projects, et cetera.

On climate change, itself, I do believe they're factoring it in, and it's just a matter of, I guess, some leadership in some of the major insurance companies to actually come out publicly and state that this is something they're already doing so they'd believe it's happening. But so far we haven't seen it, to be real frank.

Senator NELSON. Well, that's what I certainly found out.

Mr. Gorman, to quote the ancient scriptures, "The Earth is the Lord's, and everything in it." Why do you think that so many people in the faith community do not have that recognition, that understanding, which you had quoted to us in several different passages in your testimony?

Mr. GORMAN. Well, Senator, thank you for that question, and I'll be leaving now.

[Laughter.]

Mr. GORMAN. I think the most relevant categories for this issue are fear, and—fear that there really isn't enough to go around, and faith, you know, that if we are prepared to move forward steadily in the direction of generosity and collaboration and solidarity, that it can move to the benefit of all. And I think, finally, it's really an issue of leadership, which you all address here. I don't think people in the faith community are any more or any less generous or selfish than anyone else. I think we are most moved by examples of love and compassion and caring for one another. And I think the unique contribution of the environmental challenge to religious life is that it holds up the totality of creation as something that we have some responsibility for future generations. People love what they most know, and people love their—the forests nearby and the farms and crops that might be lost and the children, whose well-being might be sacrificed.

We really see this issue as an issue that invites people to expand their vision and move from their hearts, out of their love for all of creation. And then we move forward. You know?

Senator NELSON. I would merely reflect, in conclusion, as we conclude this hearing, the image that is seared in my mind's eye of the view out the window of our spacecraft back at Planet Earth on the 24th flight of the space shuttle, when I was privileged to fly, of the Earth looking so beautiful and yet so fragile, so colorful, so creative, so much of a creation in the midst of nothing. Space being nothing. Space, an airless vacuum that goes on and on for billions of light years. And there's home. And home is the planet.

And with the naked eye, you can see how we are doing some of the destruction. For example, coming across South America, I could see—because of the color contrast, I could see where the rainforest was being destroyed, and then I could look to the East, to the mouth of the Amazon, and I could see the result of that, for the waters of the Atlantic were discolored for hundreds of miles from the silt that was coming down. Going over Madagascar, every outlet of every stream or river into the ocean was nothing but a discolored mass of silt as a result of the destruction of the vegetation on that island.

And I'll tell you what it did for me. It made me want to be a better steward of our planet, having seen it from that perspective.

Naturally, it's very difficult to have an experience like that and not have some spiritual dimension to it, as well. And that's why I was so struck by your comments, your testimony, that I think that there really is something to that, that people of faith ought to realize that we have a responsibility to be good stewards. That's why I want to see us go to Mars with a human mission, because I want to see if there are dry river beds and if there was water. And if water was there, was there life? And if life was there, was it developed? And if it were, was it civilized? And if it was, what happened? And how can we learn to be better stewards of what we have by finding out some other experience in the cosmos?

So, with those lofty thoughts, thank you all for participating.

The hearing is adjourned.

[Whereupon, at 11:45 a.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. JOHN F. KERRY,
U.S. SENATOR FROM MASSACHUSETTS

First, I want to thank Chairman McCain and Ranking Member Hollings for their continued interest in this subject and their support for holding this hearing.

Today we will hear from a distinguished group of individuals representing a wide variety of interests and sectors, including the European Union, eminent scientists, the General Accounting Office, the religious community, and the business and insurance sectors. Yet despite this wide variety of interests and perspectives, these witnesses appear to agree on one thing: that climate change poses a very real—and not an imaginary—threat to our environment, to our livelihoods, and to our well-being, and that concrete action must be taken now if we are to ever address the problem.

This Committee has held hearings on climate change now for many years, spanning multiple Congresses. And the one thing that has become clear is that there should be no dispute that human activities are a significant cause of global warming.

The United States has a global responsibility to be a leader in finding effective solutions to this problem, as we are responsible for 25 percent of all the greenhouse gases produced worldwide. Yet the policies of the Bush Administration appear to have taken several steps backwards, away from real solutions.

First, as is well known, soon after taking office, President Bush's Administration backed away from U.S. international commitments to support the Kyoto protocol on climate change that establishes measures for reducing greenhouse gases. At that time, the Administration still seemed to recognize that climate change was a real problem, and that human activities were connected to this phenomenon. In 2001, at the first hearing we held during the new Bush Administration, Dr. David Evans, a respected scientist and head of NOAA Research, presented compelling evidence that reaffirmed the steady growth in atmospheric CO_2—"increasing by more than 30 percent over the industrial era compared with the preceding 750 years". Dr. Evans summarized his assessment of the science in this way, "[E]missions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that are expected to affect the climate." He also said "*stabilizing concentrations means that we must ultimately end up with much lower net emissions.*"

Since Dr. Evans testimony before this Committee two years ago, the scientific evidence of increasing global temperatures associated with increasing atmospheric levels of CO_2, and the associated threats to our people and our environment, has continued to grow. Although the Administration tried to raise questions about the credibility of the most recent global science report of the IPCC, its own report, *U.S. Climate Action Report—2002,* only adds to the volume of evidence.

In response to recent attacks on the validity of science linking human activities to climate change, over 800 U.S. scientists declared their support for the latest findings of the IPCC and the National Research Council (NRC) with respect to climate change in an open letter to Senate majority and minority leaders Frist and Daschle (July 29, 2003). These findings include the conclusion that anthropogenic climate change, driven by emissions of greenhouse gases, is likely responsible for most of the observed warming over the last 50 years and that the Earth is expected to warm an additional 2.5 to 10.5 °F in the next century.

The Administration promised leadership in promoting an international alternative to the Kyoto protocol. However, such a proposal simply never materialized. Instead, in early 2002, the U.S. unveiled its own domestic strategy to address climate change: reducing "greenhouse gas intensity". The strategy calls for reductions to be achieved entirely through voluntary measures. As part of the strategy, the President has called for a review of progress in 2012 to determine if additional steps may be needed to achieve further reductions in out national greenhouse gas emission intensity, but has not set forth any proposal requiring mandatory steps to lower greenhouse gas emissions through 2012.

At a hearing held by this Committee last year, James Connaughton, Chair of the White House Council on Environmental Quality, testified that this "greenhouse gas intensity" approach would lead to *increasing* emissions. This should not come as a great surprise, given that the approach simply reduces the *ratio* of emissions to gross national product. The testimony today from the General Accounting Office confirms that not only will this approach continue to increase total emissions, but the entire "plan" is a sham—there are few concrete steps being taken, and no mechanisms in place to monitor any progress. Incredibly, apart from announcing this voluntary approach, the next step we can expect from the President's team is that they will be "checking back with us" in the year 2012! Truth in advertising would require this to be called the Bush "business as usual" plan.

Let me say, that there are many of us in the Congress—Democrats, Republicans, and Independents—who were very disappointed that the President turned his back on his campaign commitment to address the problem of CO_2 emissions when he took office. The United States is the largest producer of CO_2 in the world—utilities and transportation account for two-thirds of our emissions. Yet, this Administration fails, repeatedly, to acknowledge the threat of increasing CO_2 emissions or to present to the Congress any real policies, programs, or strategies to deal with this threat. To their credit, states have leapt into the void—Massachusetts adopted the first CO_2 cap and trade program, and now California has passed a law to reduce greenhouse gas emissions from automobiles.

There will always be some "uncertainty" in science—but it is not an excuse for no action in the face of risk. We cannot delay.

But it's worse than delay—we are slipping backward. The Administration's Energy Policy seeks to promote national energy security by simply increasing the development of oil, gas, coal, and other fossil fuels for energy production. The Administration has officially opposed any provisions in the energy bill that would address climate change, has pressed back on provisions that promote renewable sources of energy, and other measures that are aimed at responsibly fixing this problem. By contrast, states and other nations are moving forward with concrete plans. I am particularly pleased that a representative from the European Commission has come to inform the Committee of its plans to institute greenhouse gas emissions reductions and begin its cap and trading program as soon as 2005.

In sum, this is an issue that cannot be ignored, and action is being taken on many levels. Yet this Administration is not only putting its head in the sand, but its policies—by its own admission—will lead to an increase in emissions of greenhouse gases by the United States. I commend the witnesses today for appearing before the Committee to inform us what is going on in the real world—of science, policy, and business—on the question of what action is needed to address climate change.

ATTACHMENT

THE STATE OF CLIMATE SCIENCE: OCTOBER 2003

A LETTER FROM U.S. SCIENTISTS

October 1, 2003

United States Senate
Washington, DC 20510

Dear Senators Frist and Daschle:

Two years have elapsed since the publication of the most recent reports by the Intergovernmental Panel on Climate Change (IPCC) and the National Research Council (NRC) on the state of the science of climate change and its impacts on the United States and the rest of the world. As scientists engaged in research on these subjects, we are writing to confirm that the main findings of these documents continue to represent the consensus opinion of the scientific community. Indeed, these findings have been reinforced rather than weakened by research reported since the documents were released.

In brief, the findings are that:

1) Anthropogenic climate change, driven by emissions of greenhouse gases, is already underway and likely responsible for most of the observed warming over the last 50 years—warming that has produced the highest temperatures in the Northern Hemisphere during at least the past 1000 years;

2) Over the course of this century the Earth is expected to warm an additional 2.5 to 10.5 °F, depending on future emissions levels and on the climate sensitivity—a sustained global rate of change exceeding any in the last 10,000 years;

3) Temperature increases in most areas of the United States are expected to be considerably higher than these global means because of our nation's northerly location and large average distance from the oceans;

4) Even under mid-range emissions assumptions, the projected warming could cause substantial impacts in different regions of the U.S., including an increased likelihood of heavy and extreme precipitation events, exacerbated drought, and sea level rise;

5) Almost all plausible emissions scenarios result in projected temperatures that continue to increase well beyond the end of this century; and,

6) Due to the long lifetimes of greenhouse gases in the atmosphere, the longer emissions increase, the faster they will ultimately have to be decreased in order to avoid dangerous interference with the climate system.

Evidence that climate change is already underway includes the instrumental record, which shows a surface temperature rise of approximately 1°F over the 20th century, the accelerated sea level rise during that century relative to the last few thousand years, global retreat of mountain glaciers, reduction in snow cover extent, earlier thawing of lake and river ice, the

The State of Climate Change Science: October 2003

increase in upper air water vapor over most regions in the past several decades, and the 0.09°F warming of the world's deep oceans since the 1950's.

Evidence that the warmth of the Northern Hemisphere during the second half of the last century was unprecedented in the last 1000 years comes from three major reconstructions of past surface temperatures, which used indicators such as tree rings, corals, ice cores, and lake sediments for years prior to 1860, and instrumental records for the interval between 1865 and the present.

On the subject of human causation of this warmth, the NRC report stated that, "The IPCC's conclusion that most of the observed warming of the last 50 years is likely to have been due to the increase in greenhouse gas concentrations accurately reflects the current thinking of the scientific community on this issue." Indeed, computer simulations do not reproduce the late 20th century warmth if they include only natural climate forcings such as emissions from volcanoes and solar activity. The warmth is only captured when the simulations include forcings from human-emitted greenhouse gases present in the atmosphere.

In summary, the main conclusions of the IPCC and NRC reports remain robust consensus positions supported by the vast majority of researchers in the fields of climate change and its impacts. The body of research carried out since the reports were issued tends to strengthen their conclusions.

Sincerely,

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RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO ANTONIO J. BUSALACCHI, JR., PH.D.

Question 1. As you mentioned in your testimony, National Academy of Sciences member Ralph J. Cicerone of the University of California at Irvine was quoted in the *Washington Post* article on the ice-shelf breakup as saying:

> "But even though this ice melt and permafrost thawing [probably happened] too fast to be due to global warming, this is [a] prototype of what we should expect after the next few decades. . . . This is a good dress rehearsal for the kinds of things we could see later."

Do you agree with this statement and can you elaborate?

Answer. Yes, I do agree with this statement. There is general consensus among climate scientists that the magnitude of climate change will be greatest in the Arctic, potentially resulting in significant changes to the Arctic sea ice cover. This general agreement is derived in part from numerous general circulation model projections that indicate that the Arctic climate is particularly sensitive to global warming. In addition, we have some observations showing that changes may already be taking place in the Arctic. Analysis of recently declassified data from U.S. and Russian submarines indicates that sea ice in the central Arctic has thinned since the 1970s, and satellite data indicate a 10–15 percent decrease in summer sea ice concentration over the Arctic as a whole. Satellite measurements also indicate that the time between the onset of sea-ice melting and freeze-up has increased significantly from 1978 through 1996, and the number of ice-free days have increased over much of the Arctic Ocean. A decline of about 10 percent in spring and summer continental snow cover extent over the past few decades also has been observed. Looked at in total, the evidence paints a reasonably coherent picture of change, but the conclusion that the cause is greenhouse warning is still open to debate; many of the records are either short, of uncertain quality, or provide limited special coverage.

Question 2. You mentioned in you statement that greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise.

(a) What type of environmental impacts can we expect from rising surface air temperatures and subsurface ocean temperatures?

Answer. A number of secondary effects are expected to accompany changes in global mean temperature. These include increases in rainfall rates and increased susceptibility of semi-arid regions to drought. For example, warmer temperatures would increase evaporation rates and thereby accelerate drying of soils following rain events. This effect will likely be most important in semiarid regions such as the Great Plains. The impacts of these changes will depend on the magnitude of the warming and the rate with which it occurs.

(b) Are these impacts consistent with the other type of events such as Ward Hunt Ice Shelf breakage and the shifting of certain species of plants, insects, birds and fish to higher latitudes which you described in your testimony?

Answer. Yes.

Question 3. Can you elaborate on why the Arctic region in considered the "canary in the coal mine?"

Answer. As mentioned in the response to the first question, there is general agreement that the magnitude of climate change will be greatest in the Arctic, potentially resulting in significant changes to the Arctic sea ice cover. Thus, we might expect to see significant impacts of climate change first in the Arctic.

Question 4. In July 2002, Dr. John Marburger, the Director of the Office of Science and Technology Policy, testified before this Committee about the 2001 National Academy Report that "Even a cursory reading of the report indicates that the uncertainties are real and they are significant." In your statement, you state that "Despite the uncertainties, however, there is widespread agreement that the observed warming is real and particularly strong within the past twenty years." What factors have led to the "widespread" conclusion that the Earth's climate is really warming?

Answer. As is explained in the 2001 National Academy Report *Climate Change Science,* there is wide scientific consensus that climate is indeed changing. Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. This conclusion is based on the instrumental record of surface air temperatures and subsurface ocean temperatures for the recent past. Instrumental records from land stations and ships indicate that global mean surface air temperature warmed about 0.4–0.8 degrees C (0.7–1.5 degrees F) during the 20th century. The ocean, which represents the largest reservoir of heat in the climate system, has warmed by about 0.05 degrees C (0.09 degrees F) averaged over the layer extending from the surface down to 10,000 feet, since the 1950s. In addition to these direct measurements, proxy records—which can be derived from ice cores, tree rings, and corals—indicate that today's global mean temperatures and levels of carbon dioxide (CO_2), a key greenhouse gas, are at their highest levels of the last 450,000 years. The observed change in temperature is consistent with our understanding of how Earth responds to greenhouse gases present in the atmosphere.

A diverse array of evidence supports the view that global air temperatures are warming. The warming trend is spatially widespread and is consistent with the global retreat of mountain glaciers, reductions in snow-cover extent, the earlier spring melting of ice on rivers and lakes, the accelerated rate of rise of sea level during the 20th century relative to the past few thousands years and the increase in upper-air water vapor and rainfall rates over many regions. A lengthening of the growing season also has been documented in many areas, along with an earlier plant flowering season and earlier arrival and breeding of migratory birds. Some species of plants, insects, birds and fish have shifted toward higher latitudes or higher elevations, often together with associated changes in disease vectors.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ERNEST F. HOLLINGS TO ANTONIO J. BUSALACCHI, JR., PH.D.

The Need for Science and Technical Advice in Congress

From 1972 to 1995, Congress had its own bipartisan, scientific and technical analysis organization called the Office of Technology Assessment (OTA). The office was shut down for economic reasons. The OTA's function was to do analysis for committees and to provide consultations for congressional staff and members, providing a needed level of expertise on complex science and technology issues.

Question 1. If such an advisory office still existed, do you think it would benefit Congressional understanding of climate change science (*i.e.,* is it the nature of the science causing debate or is it the people interpreting the science)?

Answer. The leadership of the National Academy of Sciences supported the original creation of OTA and was on the record for the preservation of the OTA at the time of its cancellation. If OTA were in existence today, it would certainly be able to play a positive role in providing Congress with additional understanding of the scientific aspects of climate change science.

Question 2. Do you see a need for increased scientific advice at the congressional level?

Answer. The National Academy of Sciences has long supported the need for multiple means for providing scientific advice to Congress, the Executive Branch, and the American public.

Question 3. Do you think the National Academy of Sciences, universities, and other institutions successfully fill the gap left by the removal of the OTA, with respect to climate change?

Answer. The National Academy of Sciences and other institutions have served a valuable and successful effort to inform the Congress since the demise of OTA. However, the absence of OTA has been a real loss for Congress because OTA was an important and useful source of in-house scientific and technical advice for committees and members. OTA reports were produced by a different process from that of reports from the National Academies. The National Academies found OTA reports to be informative and useful for our own work.

Question 4. Do you think the lack of scientific and technical expertise at the congressional level puts us at a disadvantage? How about at the international level?

Answer. In a complex and important issue such as climate change, it could be said that there is no such thing as too much objective and high quality scientific information and advice.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO ANTONIO J. BUSALACCHI, JR., PH.D.

Delay of Action and Costs to Society

Despite the President's declaration to cut U.S. greenhouse gas intensity by 18 percent in the next ten years, we have heard in previous testimony from Mr. James Connaughton, head of CEQ, that his proposal will result in steadily increasing GHG emissions.

Question 1. Speaking as a scientist, doesn't each decade that we delay in reducing greenhouse gas emissions commit us to enduring greater warming in the future and make it exceedingly difficult to stabilize atmospheric GHG concentrations?

Answer. The course of future climate change will depend on the nature of the climate forcing (*e.g.,* the rate and magnitude of changes in greenhouse gases, aerosols) and the sensitivity of the climate system. Each decade that we continue to emit greenhouse gases commits the Earth to some amount of warming. Indeed, because of inertia in the climate system, we are already committed to some warming due to emissions during the last century. Model projections have been conducted that compare the impacts of continued increases in greenhouse gas emissions to those of stabilizing greenhouse gas emissions at levels below the business-as-usual case. The models in which emissions continue to increase show more significant impacts than those where emissions are stabilized.

Question 1a. Doesn't this mean that either mitigation or adaptation will come at a much greater cost to society in the future?

Answer. I am not an expert in the economic impacts of different climate change response options and the National Academies have not yet conducted any studies on this topic. Economic analysis of response options is the type of research that should be supported at the interface of the U.S. Climate Change Science Program and the U.S. Climate Change Technology Program

Voluntary Approach and UNFCC

As you know, the U.S. signed and ratified the UN Framework Convention on Climate Change in 1992, which set as its goal "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

The UNFCC further stated that "such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change. . . " . But according to testimony before this Committee in July of last year and the U.S. Climate Action Report, U.S. greenhouse gas emissions will increase under the Bush plan by 43 percent between 2000–2020, despite improvements in greenhouse gas intensity.

Question 2. Is the "emissions intensity" voluntary approach to greenhouse gas emission reductions currently advocated by the Administration is sufficient to put us on track to achieve greenhouse gas stabilization in a timely manner?

Answer. Present increases in greenhouse gas emissions are incompatible with greenhouse gas stabilization.

Question 2a. If we continue on the current path—with emissions rising annually—when would we achieve this goal? Ever?

Answer. It is difficult to answer this question because scientists are still trying to determine what level of greenhouse gases in the atmosphere would "prevent dangerous anthropogenic interference with the climate system." At this time, the goal is only qualitative and therefore doesn't lend itself well to a quantitative response. In fact, no single threshold level of greenhouse gas concentrations in the atmosphere exists at which the beginning of dangerous anthropogenic interference with the climate system can be defined. Some impacts have already occurred, and for increasing concentrations there will be increasing impacts. The unprecedented increases in greenhouse gas concentrations and those anticipated in the future, constitute a real basis for concern.

Question 2b. Can actual emissions reductions on such scale and time-frame be achieved solely through any type of voluntary action?

Answer. The utility of voluntary emissions control programs is a matter of socioeconomic research, outside my expertise in climate science.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ERNEST F. HOLLINGS TO DR. TOM M.L. WIGLEY

The Need for Science and Technical Advice in Congress

From 1972 to 1995, Congress had its own bipartisan, scientific and technical analysis organization called the Office of Technology Assessment (OTA). The office was shut down for economic reasons. The OTA's function was to do analysis for committees and to provide consultations for congressional staff and members, providing a needed level of expertise on complex science and technology issues.

Question 1. If such an advisory office still existed, do you think it would benefit Congressional understanding of climate change science (*i.e.,* is it the nature of the science causing debate or is it the people interpreting the science)?

Answer. I was one of those very saddened, Senator Hollings, when the OTA was eliminated. having worked with many of its staff on climate and energy issues over the years. They checked facts, reviewed the literature broadly and produced credible assessments—not always liked by those who preferred spin to balanced assessment. Fortunately, in the climate arena at least, there are many other assessment bodies of high credibility you can turn to, even in the absence of a good in-house body like OTA was. These include the Intergovernmental Panel on Climate Change (IPCC) internationally (but with major U.S. scientific and administrative input), and the U.S. National Research Council, whose many reports say virtually the same things about the science and impacts of climate as the IPCC. That is, both reflect the strong consensus of mainstream climate scientists on the likelihood of human interference in the natural climate and its potential for some problematic outcomes if we do not attempt to slow down this threat—via policies, like the McCain Lieberman bill. Of course, the assessments do not take positions on particular policies, except to evaluate the differential climatic implications of various options.

Question 2. Do you see a need for increased scientific advice at the congressional level?

Answer. I think the greatest need is to have a reasonable debate of parties who put the nature of the science above special interests. Unfortunately, the latter have dominated both the media and congressional hearing rooms for 15 years with a cacophonous "end of the world" versus "good for you" debate over climate change, though the vast bulk of the knowledgeable scientific community would rate the two polar extremes as the lowest probability outcomes. My personal wish is you could hear nothing but opinions of those dedicated to honest and balanced assessment of the literature rather than the selective special-interest spin all too prevalent in debates on climate change over the past 15 years. I appreciate your questions, and admit a great personal frustration being constantly forced to respond to non-scientific polemics from those dabbling in climate science with an agenda and spouting seemingly technically competent arguments that would not pass muster at any decent per reviewed journal. Fortunately, the IPCC and NRC are mega peer reviewed, and are clearly the most credible sources for Congress right now on climate and other related technical issues.

Question 3. Do you think the National Academy of Sciences, universities, and other institutions successfully fill the gap left by the removal of the OTA, with respect to climate change?

Answer. Please see remarks above in answer to part 1 of your question. Basically yes, I argued.

Question 4. Do you think the lack of scientific and technical expertise at the congressional level puts us at a disadvantage? How about at the international level?

Answer. Yes, Senator Hollings, I worry about this, as a veteran of testimony before congress since 1976. I find many staffers dedicated and honest, but too easily persuaded by less-than objective but credible-sounding *un*sound scientific arguments of special interest PhDs. This is a very difficult job to do—be highly literate in the subtleties of complex issues like climate change—but if our leaders are to make decisions commensurate with their values—those of the public that elected them—then it is imperative that those in the process of decisionmaking know enough about what the potential consequences and probabilities are of various policies, so they can make the trade-offs between investing present resources as a hedge against potential future risks or not. So a greater number of staff that can be more discerning about who is credible and who is spinning would be helpful. At a minimum, some staff should be fully able to understand technical assessment reports of the National Research Council and IPCC to help members fathom these complex issues. So yes, I think a few more specialists in understanding complex system scientific issues in the Congress would aid the process of putting decision making on a firmer scientific foundation.

As to international disadvantages, I don't see more knowledgeable government scientists or policy analysts in European or Australian institutions than here, but perhaps there is better communication between parliamentarians and the technically competent governmental and academic worlds in Europe than in the U.S., where so much of the Congressional debate is highly polarized. and frankly, as I said above. not very reflective of the debates the scientist have—the public debate being captured by extreme special interest views in the U.S. to a degree far exceeding what I observe in Europe.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO DR. TOM M.L. WIGLEY

Level of Scientific Justification for Action

The Climate Action Report states: "Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing global mean surface air temperature and subsurface ocean temperature to rise". It also states: "the best scientific information indicates that if greenhouse gas concentration continue to increase, changes are likely to occur".

We also are already seeing the effects of climate change, according to recent studies shrinking ice sheets, shifts in species ranges, and loss of snow covet on Mt. Kilimanjaro -to name only a few of many examples of the frightening consequences of climate change.

Question 1. Do we not have sufficient conclusions and studies to justify some level of mandatory reductions in greenhouse gases?

Question 1a. If not, why not?

Question 1b. What additional evidence—short of flooding of the National Mall—must we gain to have sufficient justification for mandatory reductions in greenhouse gas emissions?

Answer. We need to separate out two aspects of this question. First, science can provide the "what ifs"—what if we do not have enforceable incentives to cut greenhouse gas emissions. by how much will concentrations rise and what might that imply for impacts on environment and society. In other words, science assesses the risks of alternative policies. Second. is the value laden political exercise of deciding how much risk should we take before trying to hedge against potentially ham1ful or irreversible prospects. Science can—and has—told us that climate change beyond a few degrees further warming will have a much greater likelihood of dangerous outcomes than keeping it below a few degrees. The latter is much less likely to happen without climate policies like the McCain-Lieberman bill than with climate policies. Thus, the value choice is whether to hedge—*i.e.,* adopt a precautionary principle to hedge against dangerous possibilities, whose severity increases with delay in dealing with the problem. That is the risk-management gamble 1we take if we ignore the problem and hope it will turn out on the low side of the current uncertainty range. Of course, if our luck—in truth, the luck of our children and grandchildren and nature—is bad, we will have much greater damages by doing nothing than by hedging.

However, sensible policies also solve more than one problem at once. So cutting greenhouse emissions via more efficient or renewable systems reduces health-damaging air pollution in cities, and can reduce dangerous dependence on foreign supplies of oil. Such "win-win" strategies are usually the cheapest and most politically acceptable hedging strategies, and in my personal opinion we knew enough science—a better than even chance for serious climate damages from business-as-usual—that we should have Implemented climate policies 15 years ago (as I said to this committee in testimony in 1989 and again this month—see my written testimony on Oct. 1, 2003, for references).

In terms of how much shock it will take to wake us up, the 1988 heat waves were the first such shock, and moved this problem from a largely academic setting to congressional hearing rooms and media programs. Since then a contentions and too often special interest driven polemical debate has arisen, pitting "end of the world" pessimism versus "CO_2 is good for the environment" optimism—the former from "deep ecology" groups and the latter from the fossil fuel industry and their ideological supporters. This debate has confused many, as it is technical and shrill. But the vast bulk of the knowledgeable scientific community that specializes in climatology has agreed over the past 10 years that effects of human activities are already discernible in the observational record, that plants and animal are already responding and will be greatly disturbed if the trends continue for decades more, and that cost effective solutions need not cost more than a year's delay in achieving phenomenal income growth—hundreds of percent improvement—and can eliminate the global warming risk (see the discussion in my testimony to this committee on Oct. 1, 2003). Thus, in my personal view we have had many clear signs of potential trouble and to risk more and greater threats seems foolish in view of the available cost-effective steps that can be taken now to lower the threat and provide co-benefits such as greater energy independence and reduced air pollution.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO JOS DELBEKE

State Carbon Cap Programs & Federal Coordination

As you may know, the state of Massachusetts was the first state to initiate a mandatory cap on CO_2 emissions from its six highest-emitting power plants, and plans to reduce their emissions further. In addition, Oregon has placed CO_2 limits on new power plants.

Question 1. Given the potential for a patchwork of state carbon cap and trade programs, what role could the Federal Government play?

Answer. This question reminds me very much of the situation we have been faced with in Europe a few years ago. We have witnessed two out of 15 Member States establishing national greenhouse gas trading programs—Denmark in 2001 and the United Kingdom in 2002. It was striking to see how different these national schemes turned out to be designed. In order to prevent such a patchwork of national trading schemes developing against the backdrop of the EU common market the Commission has taken the initiative and proposed a Directive in order to coordinate or harmonise the most crucial choices at European level while leaving other choices to the discretion of Member States. I see therefore the role of the Federal Government in ensuring that crucial program design variables are coordinated or harmonized.

Question 2. What roles are particularly appropriate for the states?

Answer. In the EU scheme the Member States' roles are quite far-reaching when it comes to implementation and administration of the scheme. Member States decide on initial allocation of allowances (both the total quantity of allowances to allocate and the distribution between covered installations), build and maintain the electronic allowance registries, check for compliance and levy financial penalties for non-compliance. It could imagine that a similar sharing of tasks could be appropriate in the U.S. context.

Answer 3. What would be useful to see in such a system—consistent national criteria, standards, information coordination?

Answer. I believe all the elements mentioned in the question would be useful. The approach we are taking in Europe contains all these elements together with the approach to periodically review what the best arrangements are to run the scheme. The experience collected in implementation may well make us decide to adapt the mix of these elements over time.

Question 4. What is a good model for such a coordinated state-national system?

Answer. The most appropriate model of state and national action depends on the institutional circumstances. The European Union is a unique construct and the sharing of tasks in our scheme are very much a reflection of the institutional structure. One of the major differences I see between EU and the U.S. in this context is the absence of greenhouse gas emission targets in the 50 U.S. states. In view of this an appropriate model for the U.S. would probably differ in foreseeing more of a Federal role with regards to initial allocation. As far as the maintenance of allowance registries is concerned, it may be preferable to consider this as a Federal function in the US.

Cost to Business of Emissions Reductions

One of the rationales given by the Bush Administration for rejecting any measures to require actual reductions in greenhouse gas emissions is that these will result in enormous costs to the U.S. economy, to the point that no mandatory requirements are acceptable. CEQ Chairman James Connaughton's testimony in a previous hearing stated that compliance with Kyoto would cost the United States $400 billion and 4.9 million jobs.

Question 5. Do you agree with this assessment?

Answer. Many economic assessments of implementing the Kyoto targets have been carried out over the year's since the adoption of the Kyoto Protocol. If the estimate is on an annual basis I have strong doubts about the figure, as this would imply that the cost would be about 5 percent of annual economic output of the U.S. economy. The most authoritative overview of economic studies is the review undertaken by the IPCC for the Third Assessment Report which concluded that most cost estimates are in the range of 0.1 to 1.1 percent of GDP, assuming the use of the flexible mechanisms and 0.2 to 2 percent of GDP without their use.

Question 6. Are you aware of any examples where requirements to address pollution either had little negative impact on the economy, or even provided areas for economic growth?

Answer. I think there are many examples of environmental measures which have improved society's well-being. Both European and U.S. societies are characterized by quite a high level of environmental protection—when it comes to issues as air and water quality, waste management etc.—as well as by a high standard of living. If environmental policy would be to the detriment of economic development we should have become poorer after three decades of strong societal interest and advances in environmental policy.

Question 7. Won't U.S. industries be at a disadvantage if other countries develop more environmentally efficient technologies?

Answer. One of the pillars of European climate policy is the premise that the challenge represented by climate change will necessitate a movement to an increasingly carbon-constrained global economy over the coming decades. In such an economic environment efficient carbon management and the development and deployment of low-carbon technologies will be among the key sources of competitive advantage. The earlier policy sets the right incentives for industries to start the transition to the low-carbon economy the smoother the transition process will turn out to be.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO DR. STEPHEN H. SCHNEIDER

Question 1. You were also highlighted by Senator Inhofe as being a critic of the Intergovernmental Panel on Climate Change (IPCC) results. Would you care to clarify your comments concerning the IPCC range of expected temperature increases over the next 100 years?

Answer. A *general comment* first on Senator Inhofe's overall approach to discussing the climate issue, then I will specifically respond to the temperature increase issue you raise.

It is indeed correct as the Senator suggests that I have criticized a few aspects of IPCC assessments, but then so too have nearly all scientists or policy analysts who honestly observe the complex issues involved. In fact, IPCC Lead Authors themselves are among the most vigorous critics of their own evolving assessment reports—as they should be. That is why IPCC assessments undergo several rounds of rigorous internal and external peer review—to maximize the likelihood of balanced assessment.

However, criticizing pieces of a whole hardly constitutes disagreeing with the principal conclusions and the overarching credibility of most of the IPCC analyses. It is misrepresenting my views to characterize them as even implying that IPCC has exaggerated or failed to describe the state of the science fairly at the time the assessment reports were completed in 2000. In fact, work of my own (see Testimony of Stephen H. Schneider to Senate Commerce committee on Oct. 1, 2003) or by the MIT group Senator Inhofe mentions, shows we all believe that IPCC may have *underestimated* the potential for large climate change by restricting itself to existing climate models available in 2000, and that several more recent papers (*e.g.,* Andronova and Schlesinger, 2001 or Forest *et al.,* 2001) show that climate may indeed be both more or less sensitive to greenhouse gas increases than IPCC could have known in 2000 when the Third Assessment was prepared. Thus, if anything, since the 2000 assessment—which may in fact be *conservative in its conclusions—new* research could as well increase the likelihood of higher warming as lower warming in 2100. Such is the nature of complex problems in which humans dump their wastes into the atmosphere at a faster rate than science can understand the consequences.

In addition, to criticize the international scientific community for not providing "a definitive scientific answer" to the question of what constitutes "dangerous" global warming is to misunderstand the nature of sound science—in which it is rare to have "definitive" knowledge of any complex system (and to so claim would be dishonest, which IPCC did not do). For example, in his July 28, 2003 floor speech, Senator Inhofe says:

> According to the U.N.'s Intergovernmental Panel on Climate Change, Kyoto will achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."
>
> What does this statement mean? The IPCC offers no elaboration and doesn't provide any scientific explanation about what that level would be. Why? The answer is simple: thus far no one has found a definitive scientific answer. (Inhofe, 2003)

This statement is erroneous in several aspects, and calls into question the credibility of the research apparatus Senator Inhofe relies upon to determine what is sound science. First of all, it was the UN Framework Convention on Climate Change (UNFCCC—see: *http://unfccc.int/*), signed by President Bush (Sr.) and ratified by the U.S. Senate about 10 years ago, which stated the object of the Convention was to stabilize greenhouse gas concentrations so as “to prevent dangerous anthropogenic interference . . .” IPCC has steadfastly insisted that what is “dangerous” is a value judgment, not a scientific conclusion, so the Senator’s quote that “thus far no one has found a definitive scientific answer” about what is “dangerous” is a contradiction in terms since it is not science, but policymakers, that must decide what constitutes a “dangerous” threat. The job of scientists—such as in IPCC or U.S. National Research Council assessments—is to discuss what consequences might occur at various greenhouse emissions levels and what is the likelihood and impacts of such potential consequences. That is responsible scientific assessment. The above quote is both incorrect in its assertion about what IPCC said about Kyoto and is not about science, let alone “definitive” science, an impossibility in principle about a complex problem assessing future possibilities.

Specific response on warming to 2100

Senator Inhofe refers to my Commentary in Nature (Schneider, 2001), correctly noting that:

> In his article, Schneider asks, “How likely is it that the world will get 6 degrees C hotter by 2100?” That, he said, “depends on the likelihood of the assumptions underlying the projections.” (Inhofe, 2003)

The Senator continues:

> But as Schneider wrote, the group drafting the IPCC report decided to express “no preference” for each temperature scenario.
>
> In effect, this created the assumption that the higher bound of 5.8 degrees Celsius appeared to be just as likely as the lower of 1.4 degrees Celsius. “But this inference would be incorrect,” said Schneider, “because uncertainties compound through a series of modeling steps.”
>
> Keep in mind here that Schneider is on the side of the alarmists. (Inhofe, 2003)

This is an unfortunate mischaracterization of the context of my commentary, since it implies that IPCC has overestimated the likelihood of future temperature rises, when in fact they made no probability estimates—and I expressed a wish that they had tried, as difficult as that exercise would be. First of all, I praised the IPCC for have a wide range of possible emission scenarios—to honestly represent the divergence of possible futures that are reflected in the scientific and policy literature. Second, I also approved of the IPCC using several climate models to estimate the warming from each emission scenario, as using only one model would be misleading. However, the “incorrect inference” that Senator Inhofe quotes me saying was my concern about the assumption some analysts *outside of the IPCC* might make: namely, that if there was a uniform probability distribution implied over both emissions scenarios and climate sensitivity estimates, that some might misinterpret that as implying a uniform probability distribution of 2100 temperature warming estimates. What I actually said was:

> The most typical assumption is a uniform probability distribution across storylines (scenarios). This might seem to imply a uniform probability distribution in an outcome that really matters to policymakers: the likelihood of a given temperature rise in 2100. But this inference would be incorrect, because uncertainties compound through a series of modeling steps. Uncertainties in emissions scenarios feed into uncertainties in carbon-cycle modeling, which feed into uncertainties in climate modeling, which drive an even larger range of uncertain climate impacts. This “cascade of uncertainties” (7) is compounded by the very wide range of emissions offered by the SRES authors. (Schneider, 2001)

In other words, I did not assert that IPCC overestimated anything, just that they put the burden on outsiders to estimate probabilities, and in my view the excellent expertise IPCC assembled should undertake the exercise in the next assessment. Moreover, I showed that under two differing sets of assumptions, there would be about a 20 percent or 40 percent probability of 2,100 temperatures exceeding a large warming threshold (I used 3.5 °C to be conservative, though IPCC (2001) noted warming over 1.5 °C raises serious potential threats for some systems and regions). I said that such different probabilities imposed a burden for decision makers to interpret. I also said quite emphatically and explicitly that the probability distributions I showed in my Figure 1 in that paper were simply illustrations of the potential for misinterpretations—I even put quotation marks around the word "frequency" to be sure nobody misinterpreted the graph as being based on subjective probabilistic analysis, rather than being what is was: a demonstration of how it is too easy for there to be misinterpretations. This is what I actually said about that:

> The sensitivity of the likelihood of threshold crossing occurrences is thus quite sensitive to the particular selection of scenarios and climate sensitivities used. Arbitrary selection of scenarios or sensitivities will produce distributions that could easily be misinterpreted as containing subjective probabilistic analysis when in fact they do not—until judgments are formally made about the likelihood of each scenario or sensitivity. For this reason the word "frequency" appears with quotation marks on Figure 1, as it is not a justifiable probability distribution given that the subcomponents are arbitrarily chosen without a "traceable account" (Moss and Schneider, 2000) of the logic of the selection process. (Schneider, 2001)

I concluded my commentary in *Nature* by expressing my concern:

> The special report leadership was not wrong, of course, about how difficult it would be to attempt to assign subjective probabilities to radically different visions of the future. However, in the probability vacuum that followed its assertion that all scenarios were "equally sound", we are facing the even more worrying prospect of dozens of users selecting arbitrary scenarios and climate-model sensitivities to construct frequency charts that purport to enlighten policymakers on the likelihood of "dangerous" warming. In the risk-management dilemma that constitutes climate change policymaking, I would definitely put more trust in the admittedly subjective probability estimates of the SRES team than the myriad special interests that have been encouraged to make their own selection. Meanwhile, while we wait for IPCC to decide whether to reassemble the team for this controversial labor, climate policymakers and advisers will have to be vigilant, asking all advisors to justify the threshold they choose for predicting "dangerous" climate change, as well as to provide a "traceable" account (Moss and Schneider, 2000) of the basis of their selection of emissions scenarios and climate-model sensitivities, as these jointly determine the probability of future risks. (Schneider, 2001)

Thus, Senator Inhofe's interpretation that "Schneider's own calculations, which cast serious doubt on the IPCC's extreme prediction", is not a proper characterization of my intent or analysis. In fact, I specifically argue in a number of places (summarized in my Oct. 1, 2003 Testimony to the Senate Commerce Committee) that the sword of uncertainty cuts two ways: IPCC is as likely to have underestimated the likelihood of climate change crossing dangerous thresholds as having overestimated it, and that a better characterization of probabilities would be a useful exercise for the next IPCC assessment.

Finally, I fail to see how my very conservative approach to characterizing openly the uncertainties of climate projections—and my advice on how to improve the situation published in highly visible journals (like *Nature*)—could possible be characterized fairly by anyone as "Schneider is on the side of the alarmists" or is "an outspoken believer in catastrophic global warming", the ad hominem assertions of Senator Inhofe. I am indeed an "outspoken believer" that *both* mild or catastrophic global warming outcomes remain plausible. That is why I advocate the use of more probabilistic formulations of the potential risks (*e.g.,* Schneider, 2001) and consideration by the policy communities of possible hedging strategies against the more serious possibilities—just like most business, medical or military assessment groups would do when they face deep uncertainties and an uncomfortable chance of potentially risky outcomes.

Question 2. You mentioned in your statement the next area of research is climate sensitivity probabilities. You also mentioned that MIT has started work in this area. Can you explain the importance of this area of research? Today, we get the weather forecast in terms of probabilities. Is this an attempt to get climate data in the same format?

Answer. As noted in my answer to question 1 above, one important question policy makers ask of climate scientists is by how much might it warm up at some future time given various levels of greenhouse gas concentrations—precisely the question posed in the UNFCCC "dangerous interference" quote. At least two factors contribute greatly to uncertainties over the amount of warming projected: scenarios of greenhouse gas emissions and the climate sensitivity (*i.e.,* by how much the temperature will rise given a fixed—usually doubling—increase in the concentration of CO_2). Up to about 2000, most assessments tried to bracket uncertainties in these factors by providing scenarios of emissions and ranges of climate sensitivity. That is what led IPCC to give its well-cited 1.4–5.8 °C temperature increase range for 2100. Several authors/groups have argued that more than ranges are needed for helping policy makers, since the likelihood of any particular warming is also necessary to make informed risk-management decisions. Thus, a probabilistic analysis is desirable, if possible, to produce credible risk assessments. Several early attempts have been made since the IPCC Third Assessment in 2000. These include: Wigley and Raper, 2001, Schneider, 2001 and recently Webster *et al.,* 2003.

An important part of the attempt to provide probabilistic assessments is estimation of climate sensitivity as a probability distribution. Recently, several groups have attempted to derive such distributions, by matching the range of emissions of greenhouse gasses and aerosols and comparing them to the actual temperature rises over the past 50 years. Such attempts to scale climate sensitivity by actual observed temperature changes has resulted in a substantial expansion in the range of climate sensitivity from most previous assessments. Up to 2000, it was typically believed the most likely range for climate sensitivity was 1.5 to 4.5 °C warming for a doubling of CO_2. Now, two studies, for example, Andronova and Schlesinger, 2001 (from the University of Illinois at Champagne-Urbana) and Forest *et al.,* 2001 (from MIT) derive climate sensitivities well above and below the heretofore "canonical" range of 1.5–4.5 °C. That is why I said in my formal testimony to the Commerce Committee on Oct. 1, 2003 (and in answering question 1 above), that recent analyses have actually expanded uncertainty, not reduced it, for the climate sensitivity assessment. Of course, eventually more research will narrow uncertainties, but at the moment we face an even larger range of potential warming outcomes and thus the probability of exceeding thresholds that some might consider "dangerous" has actually *gone up,* not down since the Third Assessment Report.

The Webster *et al.* 2003 work (from MIT) has tried to incorporate several major uncertainties via probability distributions and produced, like Schneider, 2001 and Wigley and Raper, 2001, a probability distribution for warming in 2100, that essentially encompasses the IPCC range, but shows the possibility of both greater than 5.8 °C or less than 1.4 °C warming. I believe that this new approach—expressing the important elements of projected climate change in probabilistic terms—will become the method of choice for the research community over the next decade. Early results still show a very wide distribution, but hopefully over the next two decades uncertainties can be substantially narrowed. Of course, whether the now-expanded possibility for warming over several degrees should motivate policy actions—what I personally believe constitutes a sound hedging strategy—is the value judgment policy makers will be facing in the decades ahead. Hopefully, the new probabilistic presentations will put risk management judgments on a firmer scientific basis.

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Voluntary Approach and UNFCC

As you know, the U.S. signed and ratified the UN Framework Convention on Climate Change in 1992, which set as its goal *"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."*

The UNFCC further stated that *"such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change . . .".*

But according to testimony before this Committee in July of last year and the U.S. Climate Action Report, U.S. greenhouse gas emissions will increase under the Bush plan by 43 percent between 2000-2020, despite improvements in greenhouse gas intensity.

Question 3. Is the "emissions intensity" voluntary approach to greenhouse gas emission reductions currently advocated by the Administration is sufficient to put us on track to achieve greenhouse gas stabilization in a timely manner?

Question 3a. If we continue on the current path—with emissions rising annually when would we achieve this goal? Ever?

Question 3b. Can actual emissions reductions on such scale and time-frame be achieved solely through any type of voluntary action?

Answer. In short, Senator Kerry, the answers to all three questions above are "No". But I will explain briefly why in each case.

First, to *emissions intensity,* a measure of the emissions of greenhouse gasses per unit economic product (GDP). There are three factors that can reduce (*i.e.,* improve) intensity: 1—more efficient energy supply and end uses; 2—a transformation of the economy away from materials and energy intensive activities to more service/information based activities (*e.g.,* moving logs around in diesel trucks is much more energy intensive per unit economic product produced than moving electrons around in the microchips of computers); 3—a switch from high carbon emitting energy sources like coal burning to less emitting sources like natural gas burning, or even less emitting energy systems like renewables or deep earth sequestration of CO_2. (produced by a closed cycle fossil fuel plant that produced hydrogen as the energy carrier and buried the CO_2 underground). The latter will take financial incentives to produce the necessary RD investments, and this bill will certainly provide such incentives.

The problem with the President's plan is that he promised to accomplish what will happen anyway without his intervention—that is, for the transformation of the economy to a more efficient, more infom1ation based entity. In fact. the emissions intensity improvement he proposes as his climate "plan" are about what historic levels of emissions intensity have been from the natural evolution of the economy—in other words, little value added to the emissions profile we would get with no plan.

More importantly, emissions intensity is only a part of emissions. Emissions are the product of population size, times affluence (GDP/capita) times emissions intensity. Since the GDP and population sizes are projected to go up dramatically in the next few decades by the Administration's own figures, then the total emissions will go up too, even with a decrease in emissions intensity offsetting some of the increase, but by no means all. In other words, the Administration "plan" is an emissions increase plan, whereas the McCain-Lieberman bill is a true emissions reduction plan, and its passage would send signals to the very able technologists in the U.S. to work harder on development of lower priced. low-carbon-emitting energy systems and accelerated emissions intensity improvements well beyond those that would be achieved by passive—*i.e.,* no action-policies like that the U.S. is now advocating.

Greenhouse gas stabilization. Stabilization of greenhouse gasses requires not only reductions of emission, but also eventual reductions to near zero. How long we take to get there and how much we emit in the interim detem1ines the ultimate stabilization levels. Most scenarios of emissions project a doubling of CO_2 over pre-industrial levels sometime in the mid-21st century if we follow a "business-as-usual" policy of no required reductions, and a possible tripling or more of CO_2 concentrations by the end of the century—threatening climatic impacts that are truly catastrophic in their potential. In order to "merely" double CO_2, we need to cut emission by about half below typical business-as-usual projections in the next five decades and to near zero by century's end. Anything less is likely to produce more than a doubling of CO_2 by the time it stabilizes. Doing nothing just ups the final stabilization levels once society finally decides to prevent further warming.

Can voluntary action work? I must admit I am very skeptical about voluntary actions that have no private and immediate gains. It is the same to ask a company to cut its bottom line for the good of the planet without fair rules to require it in general as it is to ask motorists to obey speed limits and traffic lights on a voluntary basis without police enforcement. It simply is unrealistic to expect compliance or enhancement of R&D on efficient and lower cost decarbonized energy systems without incentives. and the pleading of politicians is a very unlikely incentive for most cost-conscious businesses. It is necessary in my personal opinion, to charge for the dumping of wastes into the atmosphere, just as it is a well-accepted principle to charge for dumping of solid wastes in municipal landfills. The "free sewer" that the air has become cannot be cleaned up without rules—just like it took rules to clean some of the criteria air pollutants from many of our cities and some of the acid rain from many of our industries. The McCain-Lieberman bill does this for greenhouse gases, and thus is a step in the right direction.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO ETHAN J. PODELL

Voluntary Approach and UNFCC

As you know, the U.S. signed and ratified the UN Framework Convention on Climate Change in 1992, which set as its goal "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

The UNFCC further stated that "such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change. . . ."

But according to testimony before this Committee in July of last year and the U.S. Climate Action Report, U.S. greenhouse gas emissions will increase under the Bush plan by 43 percent between 2000–2020, despite improvements in greenhouse gas intensity.

Question 1. Is the "emissions intensity" voluntary approach to greenhouse gas emission reductions currently advocated by the Administration is sufficient to put us on track to achieve greenhouse gas stabilization in a timely manner?

Answer. An "emissions intensity" approach will not reduce the total level of GHG emissions, which is the key problem to address. If a person is trying to lose weight, what counts is the number indicated on the scale, not the ratio of fat content to each gram of food consumed.

Question 1a. If we continue on the current path—with emissions rising annually—when would we achieve this goal? Ever?

Answer. I do not believe there is any way that an intensity-standard will ever be useful in reducing what is now already a dangerous level of GHG concentrations in the atmosphere.

Question 1b. Can actual emissions reductions on such scale and time-frame be achieved solely through any type of voluntary action?

Answer. The evidence we have so far from the marketplace is that a voluntary system can not achieve any meaningful reductions in GHG emissions in the U.S.

State Carbon Cap Programs & Federal Coordination

Question 2. As you may know, the state of Massachusetts was the first state to initiate a mandatory cap on CO_2 emissions from its six highest-emitting power plants, and plans to reduce their emissions further. In addition, Oregon has placed CO_2 limits on new power plants. Given the potential for a patchwork of state carbon cap and trade programs, what role could the Federal government play?

Answer. A proliferation of state GHG reduction programs has the very real potential for increasing costs and adding confusion. The most efficient approach is to create a Federal standard along the lines of the SO_2 trading program established by the 1990 amendments to the Clean Air Act.

Question 3. What roles are particularly appropriate for the states?

Answer. Climate change is truly a global problem. At the very least it is a national problem requiring a Federal policy. Congress should adopt a mandatory GHG cap-and-trade system. We complicate and Balkanize the task by allowing the states to design multiple systems. The states have taken the lead on climate change, given the absence of leadership from Washington on this issue. I would hope that what state action leads to here eventually is a Federal cap and trade program for GHG. The states can be helpful to catalyze this process but I don't think a plethora of state GHG reduction plans by themselves are going to prove very effective.

Question 4. What would be useful to see in such a system—consistent national criteria, standards, information coordination?

Question 5. What is a good model for such a coordinated state-national system?

Cost to Business of Emissions Reductions

Question 6. One of the rationales given by the Bush Administration for rejecting any measures to require actual reductions in greenhouse gas emissions is that these will result in enormous costs to the U.S. economy, to the point that no mandatory requirements are acceptable. CEQ Chairman James Connaughton's testimony in a previous hearing stated that compliance with Kyoto would cost the United States $400 billion and 4.9 million jobs. Do you agree with this assessment?

Answer. There will in the short run be some costs to the economy to reduce GHG emissions, but there will also be short run cost savings from energy efficiency and conservation. Over a somewhat longer time frame (5 years from implementation), there is reason to believe that a mandatory GHG cap-and-trade program will lead to reduced energy costs across the economy.

Question 7. Are you aware of any examples where requirements to address pollution either had little negative impact on the economy, or even provided areas for economic growth?

Answer. There are any number of examples here. First, look carefully at the ramifications of the SO_2 trading program over the past 8 years. Second, look at the growth in sales in the U.S. of the Toyota Prius, a hybrid gas/electric vehicle. Sales have gone from 1,500 vehicles per year to nearly 50,000 vehicles per year in a matter of a few years. In a larger sense, reducing GHG emisssions is another way of accomplishing greater energy efficiencies. Energy efficiency is a real business and a growth business. By enacting legislation such as S. 139 not only will Congress engage the United States in climate change mitigation, but we will lend support to many businesses and emerging technologies focused on energy efficiency solutions.

Question 8. Won't U.S. industries be at a disadvantage if other countries develop more environmentally efficient technologies?

Answer. We absolutely will be at such a disadvantage. There is a very compelling case to be made for how energy efficient technologies are likely to be one of the real worldwide growth businesses of the next decade. As a policy objective, the U.S. Government should take an active role in promoting those American businesses which are engaged in this sector. Europe and Japan are already ahead of us in many respects in developing businesses and technologies which address energy efficiency opportunities. Washington needs to engage on this issue, and do it quickly.

Economic Effects of Greenhouse Gas Limits

Question 9. If U.S. companies take steps to reduce greenhouse gas emissions, will it help them compete in the international marketplace?

Question 10. Given our experience in the SO_2 cap and trade program, and the growing interest in international trading, what is the likely effect on the U.S. economy of capping and trading greenhouse gas emissions?

Question 11. From your knowledge of international efforts, how have other countries benefited from carrying out greenhouse gas reduction strategies similar to the ones you have outlined here?

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO JOHN B. STEPHENSON

State Carbon Cap Programs and Federal Coordination

Question 1. As you may know, the state of Massachusetts was the first state to initiate a mandatory cap on CO_2 emissions from its six highest-emitting power plants, and plans to reduce their emissions further. In addition, Oregon has placed CO_2 limits on new power plants.

- Given the potential for a patchwork of state carbon cap and trade programs, what role could the Federal Government play?
- What roles are particularly appropriate for the states?
- What would be useful to see in such a system—consistent national criteria, standards, information coordination?
- What is a good model for such a coordinated state-national system?

Answer. There are advantages and disadvantages to state-focused and federal-focused efforts to reduce greenhouse gas emissions. Four arguments in favor of a uniform national regulatory standard for dealing with an environmental or other problem with widely dispersed effects may be cited. (1) The broader the scope of a cap-and-trade program (in terms of the number of firms, the geographic scope, and so forth), the more cost-effective that program is expected to be. (2) Inconsistent state regulations can raise the costs of firms that conduct business in more than one state because they would need to comply with different states' standards. (3) The existence of inconsistent state regulations may somewhat affect states' attractiveness to business, possibly leading firms to relocate from a state with more stringent regulations to a state with less stringent regulations or, at a minimum, to expand more in a state with less stringent regulations than in a state with more stringent regulations. (Note that the state vs. Federal issues may also apply at the national vs. international level.) (4) Large-scale greenhouse gas emissions reductions will be necessary to have an impact on the atmosphere. If a significant share of U.S. sources were not involved in making reductions, the environmental impact would be weakened.

On the other hand, there are also arguments in favor of state-focused regulation. (1) Different states may have different perceptions of an environmental threat and may have different inclinations to deal with the threat. A state that views climate change as a serious threat can take action by itself without having to wait for the sort of consensus needed for Federal regulation. (2) Even among states with a consistent assessment of a threat, different states may have different traditions about how to deal with a threat, for example, how much regulation is appropriate, which regulatory tools are most appropriate, and whether regulations should operate at the county or state level. (3) Some states may view carbon dioxide control as also having local health benefits that would differ by location. That is, controls on carbon dioxide could lead to lower emissions of other byproducts of burning fossil fuels, such as nitrogen oxides, sulfur dioxide, and particulate matter, which can harm human health. (4) Commitments by states may influence future actions by producers or other states. For example, if a particular state adopts a regulation to control greenhouse gas emissions, this action may induce other states to follow suit, because manufacturers would find that it is less expensive to build one type of energy-consuming device than to configure different models for sale in different states.

The Federal Government is primarily responsible for efforts to deal with any transboundary effects of pollutants. We are not aware of any international environmental issue that involves a significant state role.

Voluntary Approaches and the U.N. Framework Convention on Climate Change

Question 2. As you know, the United States signed and ratified the United Nations Framework Convention on Climate Change, which set as its goal "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The Framework Convention further stated that, "such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change. . . ."

But, according to testimony before this Committee in July of last year and the U.S. Climate Action Report, U.S. greenhouse gas emissions will increase under the Bush plan by 43 percent between 2000–2020, despite improvements in greenhouse gas intensity.

- Is the "emissions intensity" voluntary approach to greenhouse gas emission reductions currently advocated by the Administration sufficient to put us on track to achieve greenhouse gas stabilization in a timely manner?
- If we continue on the current path—with emissions rising annually—when would we achieve this goal? Ever?
- Can actual emissions reductions on such scale and time-frame be achieved solely through any type of voluntary action?

Answer. While the United States is the world's largest emitter of greenhouse gases, stabilizing atmospheric concentrations depends on more than U.S. emissions trends. It may be useful to consider U.S. emissions trends and concentrations separately.

U.S. emissions are projected to increase 43 percent, and intensity is projected to decrease 30 percent through 2025, according to the Energy Information Administration's (EIA) baseline projections. (Under the President's February 2002 climate initiative, which runs through 2012, intensity would decrease more and emissions would increase less than in these baseline projections.) As a general matter, stabilizing U.S. emissions would require that the average annual increase in GDP and the average annual decrease in intensity be roughly equal. Because EIA projects that GDP will increase 3 percent a year through 2025, a similar rate of decrease in intensity would be required to counterbalance it. However, such a rate would be substantially higher than in the recent past (2.1 percent a year between 1980 and 2000) and in the baseline forecast for the next two decades (1.5 percent a year between 2001 and 2025).

Stabilizing atmospheric concentrations of greenhouse gases would involve both the United States, currently the world's biggest emitter, and the other nations of the world. In 2001, the United States accounted for about 24 percent of the world's carbon dioxide emissions, according to EIA, and it is expected to account for about 22 percent in 2025; the U.S. share is declining because emissions in the rest of the world are increasing faster than U.S. emissions. Thus, stabilizing U.S. emissions would not be sufficient to stabilize atmospheric concentrations. That would require stabilizing worldwide emissions, a less likely prospect. Moreover, because greenhouse gases have long lifetimes, atmospheric concentrations would not stabilize until decades after worldwide emissions are stabilized.

According to Dr. John Reilly, Associate Director for Research in the Joint Program on the Science and Policy of Global Change at MIT, the 18-percent reduction in U.S. emissions intensity envisioned by the President's climate initiative would not have a measurable effect on atmospheric concentrations in 2012, owing to the short timeframe. (This 18-percent includes the 14-percent reduction expected to occur anyway, plus the additional 4-percent reduction under the President's climate initiative.) However, he said that—under certain conditions—this approach could have an effect. The conditions are that (1) the initiative be extended over many years and (2) other major emitting countries attain similar goals.

The effectiveness of voluntary programs in stabilizing greenhouse gas emissions in the relatively near-term would depend on various factors. These would include: (1) the extent to which emitters, including private individuals and firms, believe that climate change—or the threat of potential regulation—is urgent and that they can help address that threat by reducing their emissions and (2) the costs they would bear for reducing their emissions.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO CHRISTOPHER WALKER

Delay of Action and Costs to Society

Despite the President's declaration to cut U.S. green house gas intensity by 18 percent in the next ten years, we have heard in previous testimony from Mr. James Connaughton, head of CEQ, that his proposal will result in steadily *increasing* GHG emissions.

Question 1. Speaking as a scientist, doesn't each decade that we delay in reducing greenhouse gas emissions commit us to enduring greater warming in the future and make it exceedingly difficult to stabilize atmospheric GHG concentrations?

Question 1a. Doesn't this mean that either mitigation or adaptation will come at a much greater cost to society in the future?

Answer. The answer to both questions is "yes", and I elaborated on them in answering the above questions, so will not repeat that here. But let me make one distinction here I did not make above. We must distinguish between policies that cause immediate abatement and policies that invest in the means to make abatement cheaper in the future. While I believe there are opportunities to implement immediate abatement actions at low costs—plugging inefficiencies and reducing air pollution at the same time is already a good economic policy—the bulk of the abatement of CO_2 relative to most business-as-usual projections will be in the decades ahead as new discoveries and learning-by-doing lowers the price of substituting current polluting systems with cleaner less emitting alternatives. But, and here is the point, *such low-carbon-emitting systems will not invent themselves,* will not create a better learning curve if we do not immediately invest in research, development and early deployment to learn how to do it better and cheaper at a massive scale later on. *Doing nothing is the worst policy,* but we should not expect to have a major cut in emissions instantly, as that will take some time and effort to bring about in the most cost effective manner. But, incentives to foster that investment in discovery and efficiency should have been in place two decades ago—we'd have the fruits of it now had we been more farsighted—but to delay and do little will only increase costs over time and increase risks of large and potentially dangerous climate changes in the decades ahead.

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