REORIENTING THE U.S. GLOBAL CHANGE RESEARCH PROGRAM TOWARD A USER-DRIVEN RESEARCH ENDEAVOR: H.R. 906

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

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REORIENTING THE U.S. GLOBAL CHANGE RESEARCH PROGRAM TOWARD A USER-DRIVEN RESEARCH ENDEAVOR: H.R. 906

THURSDAY, MAY 3, 2007

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 2:10 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Gabrielle Giffords [Acting Chairwoman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
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Subcommittee on Energy and Environment

Hearing on

Reorienting the U.S. Global Change Research Program toward a user-driven research endeavor: H.R. 906

Thursday, May 3, 2007
2:00 p.m. to 4:00 p.m.
2318 Rayburn House Office Building

Witness List

Dr. Michael MacCracken
President, International Association of Meteorology and Atmospheric Sciences, International Union of Geodesy and Geophysics

Dr. Jack Fellows
Vice President, University Center for Atmospheric Research (UCAR)

Dr. James R. Mahoney
Environmental Consultant, and
Former Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy Administrator of the National Oceanic and Atmospheric Organization (NOAA)

Mr. Franklin Nutter
President, Reinsurance Association of America, and Member, UCAR's Board of Trustees

Dr. Philip Mote
Climatologist, Office of Washington State, and
Affiliate Professor, University of Washington

Ms. Sarah Bittleman
Office of the Governor of Oregon, Theodore R. Kulongoski, on behalf of the Western Governors Association

HEARING CHARTER

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Reorienting the U.S. Global Research Program Toward a User-Driven Research Endeavor: H.R. 906

THURSDAY, MAY 3, 2007
2:00 P.M.–4:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, May 3, 2007 the Subcommittee on Energy and Environment of the Committee on Science and Technology will hold a hearing to receive testimony on H.R. 906, the *Global Climate Change Research Data and Management Act of 2007.*

Introduced by Representative Mark Udall and Representative Robert Inglis, H.R. 906 would replace the current law that formally established the U.S. Global Change Research Program (USGCRP) in 1990 and reorient the program to produce more user-friendly research and information. The USGCRP has advanced our scientific knowledge of the Earth's atmosphere and climate and has provided us with new data and information on the planet. However, scientific knowledge about the Earth's climate has expanded and improved since 1990. There is a need to apply the improved knowledge we have gained about climate to produce information that federal, State, and local officials, resource managers, and businesses can use to develop response, adaptation, and mitigation strategies to reduce their vulnerability to climate change.

The *Global Change Research and Data Management Act* would require the Administration to identify and consult with members of the user community in developing the USGCRP research plan. The bill would also establish a new interagency working group to coordinate federal policies on data management and archiving. The measure would also retain language from the original statute that establishes the USGCRP and call for the administration to produce a national assessment of climate change every four years.

USGCRP Background

History of the Current Law

U.S. Global Change Research Act of 1990 (Public Law 101–606) was signed into law by President Bush on November 16, 1990. However, prior to passage of this legislation Congress and the Reagan and Bush Administrations established programs, advisory bodies and mechanisms to undertake climate change research and develop climate change policy.

The Climate Program preceded the USGCRP and was established by the *National Climate Program Act* (P.L. 95–367) in 1978. The Climate Program was intended to conduct climate research, provide climate information, and to support policy decisions to "assist the Nation and the world to understand and respond to natural and human-induced climate processes and their implications" (P.L. 95–367, § 3). It was established as an interagency program coordinated through a National Climate Program Office within the National Oceanic and Atmospheric Administration (NOAA). By the mid-1980s Congress began to consider expanding the Climate Program. At the time, the program was thought to be producing high quality science, but it was not providing information that would lead to policy responses to threats from climate change.

In the 1980s, climate change policies were developed within the White House although there were a number of climate change advisory groups and other decision-making groups within individual federal agencies. President Reagan established five Councils in the White House. In 1985, these five Councils were consolidated within

two—a Domestic Policy Council and an Economic Policy Council.[1] Climate change policy was discussed within the Domestic Policy Council and first came to the attention of this Council because of public attention being paid to Congressional hearings being held to air concerns of the scientific community about the potential consequences of increasing greenhouse gases in the atmosphere.

In 1987, White House Science Advisor William Graham formed the Committee on Earth Sciences within the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET). The purpose of this Committee was to "increase the overall effectiveness and productivity of federal R&D efforts directed toward an understanding of the Earth as a global system" (CES 1987).

After several years of work, Congress passed, and President Bush signed, The *U.S. Global Change Research Act of 1990* (Public Law 101–606) which established the U.S. Global Change Research Program we have today. The Program is aimed at understanding and responding to global change, including the cumulative effects of human activities and natural processes on the environment, and to promote discussions toward international protocols in global change research. The law codified the interagency structure put in place by the Reagan Administration and defined the agencies that would participate in the program. The law also requires development of a series of 10-year Plans for the conduct of research on global change by the Federal Government to: "advance scientific understanding of global change and provide usable information on which to base policy decisions related to global change," an evaluation of the Plan by the National Research Council, the coordination of agency budgets for global change research, and a report to Congress every four years on the consequences of climate change.

While research Plans have been produced periodically by the Program and reviewed by the National Research Council as required by the law, the production of periodic assessments of the findings of the global change program and the effects of global change on natural systems and sectors of the economy has been lacking. There has been only one comprehensive report published since the beginning of the program satisfying this requirement of the law—the National Assessment on Climate Change published in 2001.

Current Administration Climate Change Initiatives

The current Administration has a number of initiatives that are related to past efforts conducted under the *Global Change Research Act.* The Climate Change Science Program (CCSP) is charged with integrating science on global change produced by federal agencies. The Program is producing a series of twenty one synthesis and assessment products on a range of subjects (*http://www.climatescience.gov/*). The Administration also has a Climate Change Research Initiative (CCRI) and the Climate Change Technology Program (CCTP), with NOAA and DOE designated as the lead agencies, respectively. The role of the CCRI is to reduce the significant remaining uncertainties associated with understanding human-induced climate change and facilitate full use of scientific information in policy and decision-making on possible response strategies for adaptation and mitigation. The role of the CCTP is to focus research and development efforts on the identification and development of technologies that will achieve the Administration's climate change goals.

This policy has three basic objectives: slowing the growth of emissions, strengthening science, technology and institutions, and enhancing international cooperation. However, in 1990, total U.S. GHG emissions were 1,671 million metric tons in carbon equivalents (MMTCE). In 2000, total U.S. GHG emissions were 14.1 percent above 1990 levels, or 1,907 MMTCE. Even if the Administration's climate change goals are met, U.S. emissions of greenhouse gases will continue to grow.

The requested budget for the major climate change programs in 2007 was estimated by the Congressional Research Service to be 4.9 billion dollars.[2] The participating agencies include virtually every department in the Federal Government: NASA, NSF, NOAA, DOE, USDA, DOI, HHS, EPA, the Smithsonian Institution and DOD. The core agencies that have contributed to climate change science are NASA, NOAA, NSF, and DOE.**

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[1] Brownstein, R. and D. Kirschtien. 1986. Cabinet Power. *National Journal* June 28 1582–1589. Referenced in: R.A. Pielke, Jr. 2001. *The Development of the U.S. Global Change Research Program: 1987–1994.*

[2] Congressional Research Service (2007). Climate Change: Federal Expenditures; January 22; p. 3; Table 1. RL33817.

**The FY 2007 request for the Climate Change Science Program (CCSP) is 1.7 billion dollars.

Current State Initiatives on Climate Change

Absent of coordinated federal direction on adapting to climate change impacts, regions and states have taken action on their own to develop integrated plans to serve multiple user communities. Many states view policies that address climate change as an economic opportunity, rather than a financial burden. These states are positioning themselves as leaders in emerging markets related to climate change: producing and selling alternative fuels, exploring geographic specific adaptation strategies, attracting climate action related businesses, and selling greenhouse gas emission reduction credits.

In addition, regional efforts have been successful coordinating initiatives across state boundaries. These regional plans eliminate duplication for states with similar geographic makeup and help businesses by bringing greater uniformity and predictability to State rules and regulations. For example, *Powering the Plains* is a regional initiative, involving participants from the Dakotas, Minnesota, Iowa, and Wisconsin, which aims to develop strategies, policies, and demonstration projects for alternative energy sources. The *Southwest Climate Change Initiative* will allow Arizona and New Mexico to work together to reduce greenhouse gases and address the impacts of climate change in the region. Other such projects include the Northeast *Regional Greenhouse Gas Initiative* (RGGI), *The Clean and Diversified Energy Initiative* launched by the Western Governors Association, *The West Coast Governors' Global Warming Initiative,* and the New England Governors' and Eastern Canadian Premiers' *Climate Action Plan.* These regional and State programs would greatly benefit from a user-driven Climate Change Research Program, as established in H.R. 906.

The USGCRP under H.R. 906

The USGCRP has continued to produce high quality science and advance our knowledge of Earth's climate system. However, the Program has not produced much in the way of substantive policy analyses or produced information in formats that are useful and accessible to the wide range of individuals and organizations who desire information about climate variability and change and its relationship to different concentrations of greenhouse gases in the atmosphere. It has not produced information that will assist decision-makers at the federal, State, and local level in the development of response, adaptation and mitigation strategies.

H.R. 906 directs the Program to develop assessments of vulnerability to climate change and to develop policy assessments that will evaluate alternative strategies for responding, adapting, and mitigating climate change that is projected to occur under different atmospheric concentrations of greenhouse gases.

The components of the core science programs of the USGCRP continue to produce useful scientific information and better, more refined understanding of the climate system. H.R. 906 does not eliminate these programs and activities. Instead, H.R. 906 shifts the emphasis to the production of information that is needed to develop strategies to cope with current climate change and to mitigate greenhouse gas emissions to reduce the magnitude of future climate impacts. To ensure the Program produces policy-relevant information, H.R. 906 includes a review of the Program by the National Governors Association's Center for Best Practices.

The major scientific debate is settled. Climate change is occurring. It is impacting our nation and the rest of the world and will continue to impact us into the future. The USGCRP should move beyond an emphasis on addressing uncertainties and refining climate science. In addition, the Program needs to provide information that supports action to reduce vulnerability to climate and other global changes and facilitates the development of adaptation and mitigation strategies that can be applied here in the U.S. and in other vulnerable locations throughout the world.

Witnesses

Dr. Philip Mote, Office of Washington State Climatologist and Affiliate Professor at the University of Washington

Dr. Philip Mote is a research scientist at the University of Washington, in the Climate Impacts Group (CIG), and an Affiliate Professor in the Department of Atmospheric Sciences. In addition, Dr. Mote works as a consultant at Northwest Research Associates specializing in the dynamics of the tropical upper troposphere and lower stratosphere. He received his B.A. in Physics from Harvard University in 1987 and completed his doctorate in Atmospheric Sciences at the University of Washington in 1994. His research interests include: Northwest climate and its effects on snowpack, streamflow, and forest fires. A frequent public speaker, he has also written over fifty scientific articles and edited a book on climate modeling, published in 2000. In 2003, Dr. Mote became the Washington State Climatologist.

Dr. Michael MacCracken, President of the International Association of Meteorology and Atmospheric Sciences of the International Union of Geodesy and Geophysics

Dr. Michael MacCracken is the Chief Scientist for Climate Change Programs with the Climate Institute in Washington DC. He received his B.S. in Engineering degree from Princeton University in 1964 and his Ph.D. degree in Applied Science from the University of California Davis/Livermore in 1968. His research has included numerical modeling of various causes of climate change (including study of the potential climatic effects of greenhouse gases, volcanic aerosols, land-cover change, and nuclear war) and of factors affecting air quality, including photochemical pollution in the San Francisco Bay Area and sulfate air pollution in the northeastern United States.

From 1993–2002, Dr. MacCracken was on assignment as senior global change scientist to the Office of the U.S. Global Change Research Program (USGCRP) and served as its first Executive Director from 1993–1997. From 1997–2001, he served as Executive Director of the USGCRP's National Assessment Coordination Office, which coordinated the efforts of 20 regional assessment teams, five sectoral teams, and the National Assessment Synthesis Team that prepared the national level reports that were forwarded to the President and to the Congress.

Dr. Jack Fellows, Vice President at the University Center for Atmospheric Research (UCAR)

Dr. Jack Fellows is the Vice President for Corporate Affairs at UCAR and the Director of UCAR's Office of Programs (UOP). As Director of the UOP, he is responsible for a broad range of scientific and educational programs that serve the atmospheric and related research and education community. Dr. Fellows received his Ph.D. in Civil Engineering from the University of Maryland.

Dr. Fellows began his career as a research faculty member at the University of Maryland, where he conducted research in the use of satellite data in hydrologic models. In 1984, he spent a year in the U.S. Congress as the American Geophysical Union's Congressional Science Fellow. While in Congress, he split his time between the personal office of George Brown (D–CA) and the House Science and Space Subcommittee and worked on a range of policy issues, including water resources, satellite remote sensing, and general oversight of federal research and development funding. After this, he spent 13 years in the Executive Office of President's Office of Management and Budget (OMB) overseeing budget and policy issues related to the National Aeronautics and Space Administration, the National Science Foundation, and federal-wide research and development programs. During this period with OMB, he helped to initiate the U.S. Global Change Research Program and to coordinate funding from the participating federal agencies in the new interagency research program.

Mr. Franklin Nutter, President of the Reinsurance Association of America and Member of UCAR's Board of Trustees

Mr. Franklin Nutter has been an active member of the UCAR Board of Trustees and prior to that served on the NCAR Advisory Council and the Weather Coalition, a group of private companies, associations, and universities advocating for the advancement of weather research and applications. He received his Juris Doctorate from the Georgetown University Law Center and a Bachelor's degree in economics from the University of Cincinnati.

Mr. Nutter has been President of the Reinsurance Association of America (RAA) since May of 1991. Through his involvement as President, he coordinated events with the UCAR Corporate Affiliates Program. During his distinguished career in the insurance and reinsurance industries, Mr. Nutter has promoted the use of weather and climate models and has helped to advance the atmospheric sciences. An expert on societal impacts of severe weather and climate change, Mr. Nutter has been called upon to address the U.S. Climate Change Science Program Planning Workshop, the Pew Center Workshop on the Timing of Climate Change Policies, and the AGU's Coastal Hazards Reduction Workshop.

Ms. Sarah Bittleman, Office of the Governor of Oregon, Theodore R. Kulongoski, on behalf of the Western Governors Association

Ms. Sarah Bittleman is the Director of the Governor of Oregon's Washington D.C. office. She assumed this position a year ago after having spent 10 years on Capitol Hill as a staffer for both Republicans and Democrats, in both the House and the Senate and in personal offices as well as the Committee on Energy and Natural Resources. She followed the climate change debate closely in all her positions on the

Hill, most recently drafting a forest carbon sequestration bill as the Natural Resources Counsel for Senator Ron Wyden of Oregon. Ms. Bittleman has a Masters in Public Administration from East Carolina University as well as a JD from Tulane University in New Orleans.

Dr. James Mahoney, Environmental Consultant

Dr. James Mahoney currently serves as an environmental consultant, providing scientific and professional advice to a number of organizations. From April 2, 2002 to March 30, 2006 he was Assistant Secretary of Commerce for Oceans and Atmosphere, and Deputy Administrator of the National Oceanic and Atmospheric Organization (NOAA). During this period, Dr. Mahoney served as the Director of the U.S. Climate Change Science Program (CCSP).

Dr. Mahoney received a B.S. degree in Physics from LeMoyne College and a Ph.D. degree in meteorology from the Massachusetts Institute of Technology (MIT). His career has involved more than forty years of continuous focus on environmental management and the Earth sciences, with an emphasis on the atmospheric, climate, hydrological and oceanographic areas. After completing his Ph.D., he joined the Faculty of Public Health at Harvard University, in its Department of Environmental Health Sciences. Dr. Mahoney entered the public service in 1988 as Director of the National Acid Precipitation Assessment Program, working in the Executive Office of the President. NAPAP was charged with recommending sound approaches to controlling acid rain effects, while providing for continued energy and economic security for the Nation.

Ms. GIFFORDS. [Presiding] The Committee will come to order. Good afternoon, everyone. I want to take a moment to welcome you, and to recognize the Subcommittee's hearing called today to receive testimony on House Resolution 906, the *Global Climate Change Research Data and Management Act of 2007*.

This is an important bill that will help us to better address climate change in the country, and I want to thank my colleagues, Representative Mark Udall and Ranking Member Bob Inglis, for taking action and introducing this legislation.

Through bills like H.R. 906, Congress is starting to take action to address the global conundrum that is climate change. It is not an exaggeration to say that the world's future depends on our response. The clock is ticking, and Congress must work across party lines to pass concrete solutions as soon as possible. I think this bill represents just that kind of needed bipartisanship.

[The prepared statement of Ms. Giffords follows:]

PREPARED STATEMENT OF REPRESENTATIVE GABRIELLE GIFFORDS

Good Afternoon. I want to welcome everyone to today's Subcommittee hearing called to receive testimony on H.R. 906, the *Global Climate Change Research Data and Management Act of 2007*. This is an important bill that will help us to better address climate change in this country, and I want to thank my colleagues, Representative Mark Udall and Ranking Member Bob Inglis, for taking action and introducing this legislation.

Through bills like H.R. 906, Congress is starting to take action to address the global conundrum that is climate change. It is not an exaggeration to say that the world's future depends on our response. The clock is ticking, and Congress must work across party lines to pass concrete solutions as soon as possible. I think this bill represents just that kind of needed bipartisanship.

H.R. 906 would reorient the U.S. Global Change Research Program to produce more user-friendly research and information. In addition, the Act would require the Administration to identify and consult with members of the user community in developing the USGCRP research plan.

I believe that there is a real need to apply the improved knowledge we have about climate to produce information that federal, State, and local officials, resource managers, and businesses can use. Managers can then utilize that research to develop response, adaptation, and mitigation strategies to reduce their regions' vulnerability to climate change.

Let's look at how H.R. 906 could impact the West and Arizona specifically. According to the IPCC and conversations of my own with distinguished climate scientists from the University of Arizona, I understand climate change could permanently reduce the flow of the Colorado River, lead to more severe, prolonged droughts, and cause water shortages for millions of people. More than 25 million people in Arizona and six other states depend on the Colorado River for water and power. Forest fires and invasive species are projected to increase, and we could face an influx of environmental refugees from around the world. This would drastically affect our quality of life.

What steps are currently being taken to develop response strategies to reduce the Southwest's vulnerability to climate change? In February of 2006, the Governors of Arizona and New Mexico signed an agreement to create the Southwest Climate Change Initiative. Under the agreement, our states will collaborate to reduce greenhouse gas emissions and address the impacts of climate change in the Southwest. However, in order to do that, our State planners need relevant data to make the best decisions on how to respond.

That's where H.R. 906 comes in. Climate change is happening in the Southwest, but Arizona can help moderate the change. With the new user-driven data provided by the reorientation of the U.S. Global Change Research Program, State legislatures, local officials, resource managers, and businesses could all begin to adjust their plans to help Arizona avoid the worst of the impacts of climate change.

I take the challenge of addressing global warming very seriously, and it is one of my highest priorities in Congress. This will not only result in a stronger economy, innovative technologies, and the creation of hundreds of thousands of jobs, but also a more stable and sustainable world.

I want to welcome our entire distinguished panel to this morning's hearing. I look forward to your testimony and to your recommendations for improving H.R. 906.

Ms. GIFFORDS. At this time, I would like to recognize the author of the legislation, Representative Udall, for some opening remarks.

Mr. UDALL. Thank you, Madam Chairwoman. Good afternoon to the panel and my colleagues who have joined us here.

I want to begin by thanking Chairwoman Giffords for holding this hearing on H.R. 906, the *Global Change Research and Data Management Act of 2007,* that I introduced earlier this year, with my colleague and our Ranking Member, Mr. Inglis.

I look forward to working together as this bill moves forward. The U.S. Global Change Research Program has been in existence in some form since the late 1970s. Support for the diverse array of climate-related sciences in the 11 agencies of the Federal Government has expanded our knowledge of Earth's land, water, and atmospheric systems. The outstanding science produced by our nation's scientific community has gained the U.S. worldwide recognition as a leader in climate science.

This research has been shared with the rest of the world through international scientific organizations, such as the World Meteorological Organization and the Intergovernmental Panel on Climate Change. The evolution of global science and the global change issue sparked the need to make changes to the 1970 *National Climate Program Act,* and gave us the *Global Change Research Act of 1990.* It is now time for another adjustment to alter the focus of the program governed by this law.

The debate about whether climate change is occurring, and about whether human activity has contributed to it, is over. As our population, economy, and infrastructure have grown, we have put more pressure on the natural resources we all depend upon. Each year, fires, droughts, hurricanes, and other natural events remind us of our vulnerability to extreme weather and climate changes. The human and economic cost of these events is very high. With better planning and implementation of adaptation strategies, these costs can be reduced.

For all of these reasons, we need the USGCRP to produce more information that is readily usable by decision-makers and resource managers in government and in the private sector. People throughout the country and in the rest of the world need information they can use to develop response, adaptation, and mitigation strategies to make our communities, our businesses, and our nation more resilient and less vulnerable to the changes that are inevitable.

We must also move aggressively to reduce greenhouse gas emissions if we are to avoid future increases in surface temperature that will trigger severe impacts that we cannot overcome with adaptation strategies. We need economic and technical information, as well as information about system responses and climate responses to different concentrations of greenhouse gases in the atmosphere. The USGCRP should be the vehicle for providing this information.

Madam Chairwoman, we have a very distinguished panel of witnesses here today, several of whom have a great deal of experience with the USGCRP. I look forward to your testimony, and welcome your suggestions for improvements to H.R. 906. Our goal is to en-

sure that the excellent science produced by this program is expanded and translated into user-friendly information to deliver the solutions our nation needs to address the challenge of climate change.

Thank you, Madam Chairwoman.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

Good afternoon. Thank you, Chairwoman Giffords for holding this hearing on H.R. 906, the *Global Change Research and Data Management Act of 2007* that I introduced earlier this year with my colleague and our Ranking Member, Representative Inglis. I look forward to working together as this bill moves forward.

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The evolution of global science and the global change issue sparked the need to make changes to the 1978 *National Climate Program Act,* and gave us the *Global Change Research Act of 1990.* It is now time for another adjustment to alter the focus of the program governed by this law.

The debate, about whether climate change is occurring and about whether human activity has contributed to it, is over. As our population, economy, and infrastructure have grown, we have put more pressure on the natural resources we all depend upon. Each year, fires, droughts, hurricanes, and other natural events remind us of our vulnerability to extreme weather and climate changes. The human and economic cost of these events is very high. With better planning and implementation of adaptation strategies these costs can be reduced.

For all of these reasons, we need the USGCRP to produce more information that is readily usable by decision-makers and resource managers in government and in the private sector. People throughout this country and in the rest of the world need information they can use to develop response, adaptation, and mitigation strategies to make our communities, our businesses, and our nation more resilient and less vulnerable to the changes that are inevitable.

We must also move aggressively to reduce greenhouse gas emissions if we are to avoid future increases in surface temperature that will trigger severe impacts that we cannot overcome with adaptation strategies. We need economic and technical information as well as information about system responses and climate responses to different concentrations of greenhouse gases in the atmosphere. The USGCRP should be the vehicle for providing this information.

We have a very distinguished panel of witnesses here today, several of whom have a great deal of experience with the USGCRP. I look forward to your testimony and welcome your suggestions for improvements to H.R. 906. Our goal is to ensure the excellent science produced by this program is expanded and translated into user-friendly information to deliver the solutions our nation needs to address the challenge of climate change.

Ms. GIFFORDS. Thank you, Mr. Udall.

And now, I would like to recognize our distinguished Ranking Member, Mr. Inglis of South Carolina, for his opening statement.

Mr. INGLIS. I thank the Chair, and I thank the Chair for holding the hearing, and Mr. Udall, for giving me the opportunity to work with him on this bill.

This is an opportunity of bipartisan cooperation, and I think it makes sense, because this is a bill that can increase our awareness and our preparation for the impacts of climate change. Of course, I hope we can also move forward and develop a consensus on mitigation, as well, and the necessary start of that is the attempt to build consensus, and so, I thank Mr. Udall for doing that and pur-

suing this bill, and I am happy to be with him on the bill, and very excited about hearing from the witnesses here today.

And you know, our current climate science programs at the National Oceanic and Atmospheric Administration and the National Science Foundation and the National Aeronautics and Space Administration and the U.S. Geological Survey have made great gains in deepening our understanding of global climate change, from what is causing it, to how our country and others might be affected.

The sheer volume of data calls for an intelligent data management system which is designed to fulfill the needs of its users. The program must meet the additional challenge of presenting the data in a relevant form to users that have non-scientific backgrounds, like State and local government operators.

So, in South Carolina, I have been hearing from fishermen and hunters, who are particularly concerned about fish and animal population changes that could threaten our local ecotourism businesses. South Carolina's tourism business is actually the largest industry in our state, especially at our coast, and so, we are aware of the goose that is laying the golden eggs down at our coast, and we want to make sure that it continues to lay them there.

So, this bill, as I say, the opportunities for building awareness and preparation, I think will help, and I am happy to be part of it and happy to hear from the witnesses, and I yield back.

[The prepared statement of Mr. Inglis follows:]

PREPARED STATEMENT OF REPRESENTATIVE BOB INGLIS

Good afternoon. Thank you, Ms. Chairwoman, for holding this hearing on ways we might improve our climate science programs to make local users a part of the process.

Our current climate science programs at the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the United States Geological Survey (USGS) and other agencies have made great gains in deepening our understanding of global change—from what is causing it to how our country and others might be affected. The sheer volume of data calls for an intelligent data management system, designed to fulfill the needs of its users. The program must meet the additional challenge of presenting the data in a relevant form to users that have non-scientific backgrounds, such as State and local governments.

In South Carolina, I've been hearing from fisherman and hunters who are concerned about fish and animal population changes that could threaten local eco-tourism businesses. South Carolina's tourism industry, the largest economic generator in the state, will need more information about changes to the coast as they plan for the future. These folks will also need the ability to let the climate programs know what's useful and where they require additional information.

I believe we can find a bipartisan consensus to take action on improving our climate science programs. This issue has the potential to affect all of us and we must ensure that local users are informed and have a say in the process to get the information they need.

I'm pleased that Dr. James Mahoney could be with us today. Dr. Mahoney is the former Director of the U.S. Climate Change Science Program and former Deputy Administrator for NOAA. His academic and professional experience makes him a valuable addition to this panel. I'm encouraged by the constructive feedback in his written testimony, and I thank him for coming to share his insight.

Thank you again for holding this hearing, Ms. Chairwoman, and I look forward to hearing from all of our distinguished witnesses as to how we can most effectively structure our climate science programs.

Ms. GIFFORDS. Thank you, Mr. Inglis.

I ask unanimous consent that all additional opening statements submitted by Subcommittee Members be included in the record. Without objection, so ordered.

It is my pleasure now to introduce this excellent panel of witnesses that we have with us here this afternoon. First, we have Dr. Michael MacCracken, who is the Chief Scientist for Climate Change Programs at the Climate Institute here in Washington, D.C. Dr. MacCracken served as the Executive Director for the U.S. Global Change Research Program from 1993 to 1997, and he has brought with him a stack of documentation that he can't leave with us, but I am sure he is going to speak about in terms of the data that exists.

Second, we have Dr. Jack Fellows, who is the Vice President for Corporate Affairs at the University Center for Atmospheric Research in Boulder, Colorado, and the Director of UCAR Office of Programs. Dr. Fellows helped to initiate the U.S. Global Change Research Program when he worked in the Executive Office of the President's Office of Management and Budget. Thank you for being here, Dr. Fellows.

Dr. James Mahoney currently serves as an environmental consultant, providing scientific and professional advice to a number of organizations. From April 2, 2002 to March 30, 2006, he was Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy Administrator of the National Oceanic and Atmospheric Organization. During this period, Dr. Mahoney served as the Director of the U.S. Climate Change Science Program. It is so terrific having you here today. We had a chance to speak a little bit earlier. We are thrilled that you are here with us. Thank you, Dr. Mahoney.

Mr. Franklin Nutter is the President of the Reinsurance Association of America, and a member of the University Center for Atmospheric Research's Board of Trustees. Good to see you, Mr. Nutter.

Dr. Philip Mote is a Washington State climatologist, and an Affiliate Professor at the University of Washington. His research has focused on Northwest climate and its effects on snowpack, streamflow, and forest fires. Thank you, Dr. Mote.

And Ms. Sarah Bittleman is the Director of the Governor of Oregon's Washington, D.C. office, and is testifying today on behalf of the Western Governors Association, and I know that Arizona's Governor, Janet Napolitano, obviously is very active with that association as well.

So, welcome to all of you. Let me just say that we do have a series, a short series of votes that we don't know when they will come, but we believe that we should be adjourned by 4:00. So, my goal is to make sure that the testimony is limited to five minutes, which goes by very quickly, and you will see the indication, in terms of the lights.

It is important that we get through, because we have, obviously, a panel of wonderful witnesses. We have got questions, but I just want to make sure that we don't lose Members, because I know that we are going to be leaving for the weekend, and I want to make sure that we keep everyone here as long as we can.

Your written testimony will be included in the record for the hearing, and when all six of you have completed your testimony,

we will begin with questions, which will be, again, for five minute increments.

So, Dr. MacCracken, if we can begin with you, please.

STATEMENT OF DR. MICHAEL C. MACCRACKEN, PRESIDENT, THE INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC SCIENCES OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS; CHIEF SCIENTIST FOR CLIMATE CHANGE PROGRAMS, CLIMATE INSTITUTE, WASHINGTON, DC

Dr. MACCRACKEN. Thank you, Madam Chairman.

I was asked to address two questions during my testimony, having to do with lessons learned during the National Assessment that took place, and what are some specific tasks necessary to get an ongoing assessment process.

I also want to just say a few words about the program in general. I think the USGCRP is a very unique activity. It is trying to get agencies working together. I came in as the first Executive Director of the office to get the ten agencies really participating and working together, and my job description said and you don't have control of the money, so you have to make it happen, which is by driving it with ideas.

I think a great deal was accomplished with some inspired leadership. There were international field programs that combined the activities of NASA with their satellites and NOAA with their aircraft and ships, and NSF with their capabilities, and so, we learned a lot about El Niño and the ozone hole and things.

What has happened since, unfortunately, even though there are more and more questions coming up, the budget has been dropping. The proposal, I think, for Fiscal 2008 is about 25 percent below in sort of even dollars what it was in the 1990s, even though there are more questions. And so, we are ending up doing less. So, I think to get the program going, what is needed is some highly qualified leadership to get the funding up again, and then, to work hard on the assessment activity.

So, for the assessment activity, what I brought here, and what the Chairwoman commented upon, was the reports that came out from the National Assessment, which you have heard. There aren't many places where they are compiled. This is one of the few sets. But what was talked about, and what is sometimes talked about in the bill is the report that is delivered to Congress, and that turned out to be this report, and then, there was a supporting thicker report.

But at the same time, what was going on was a process all around the country. There were sort of 20 regions that held workshops. There were five sectoral studies, and so, each of those was an ongoing activity, and so, there is Alaska, and there is health, and there were forests, and Great Lakes, and a whole host of activities going on there, because global changes start at the global scale. When you look at it, how we are changing the global atmosphere, impacts start at the local scale, and you just have to have the local people involved.

There was an EPA assessment that went on in the late '80s, where they tried to basically study five representative regions, one

of them being California, where I was. They appointed a panel of, I think, 12 or 13 scientists. It had one Californian on it. It got no attention whatsoever in the state. What happened in this last assessment go round was the activity was based at the University of California Santa Barbara, and when they had the workshop, they had a majority of members of the Energy Commission there, the California Air Resources Board, and a whole bunch of other groups. They involved local people. And California's effort took off, even though there wasn't enough money provided to them to, in the end, publish their report. They got so many people going, and so many people interested in the critical problems.

So, I think it is really important to do that. There are just all kinds of people who are interested. Planners want to know about what is going to happen to the likelihood of floods. Farmers and hunters and fishermen in South Carolina want to know what is going to happen to the temperature of the streams, or the state of the forests, and if they are going to dry out so much that you get fires. There is just a lot of information that can be provided.

Indeed, there are uncertainties, and there is a lot more research to be done, but there is an awful lot of guidance that one can give with respect to these activities. And so, in the testimony, I go through a number of steps that I think need to be taken. One is to be make sure that you call not just for a report for Congress, but for a capability for the country to address and face up to the impacts of the issue. Insist, as you do, that there is stakeholder involvement. Insist, as you do, to use the words "global change" instead of "climate change." That is a subtle difference, but it means you are really going to do climate change in the context of everything else, not just do climate change all by itself, which isn't particularly useful. Do consider mitigation and adaptation.

I think it is going to be important to find a way to provide funding that goes for assessment. As we were dealing with the agencies, it was hard for them to consider assessment research, and yet, the definition in the *Global Change Act* and in this bill have assessment as under research. That doesn't work very well. Some of them legally say they can't do it, and so, I think you are really going to have to find a way to provide separate funding.

I think there needed to be these strong regional components, and we tried to work up to 20. We ended up being able to fund 15, and couldn't find funding for sort of the other five, that we thought covered the country. And there were a couple of reports, like the one in the Southwest for Native peoples, that the report got all done, but there was never funding around to publish it. It was very unfortunate at the end.

So, we need, I think, some regional centers. I think it is also important to look nationally, and look at some sectors, so we looked at agriculture and water resources and human health, and coasts, and forests. And so, there are those, but there are a whole host of additional ones to be looking at, the rural communities, extreme events, and other things. And then have an international, I mean an independent synthesis that can be done, so—the signal is down there, but——

Let me just conclude by saying I think a lot can be done in a year, but you can't get all the way there in a year, and if you try

and do it all in a year, you won't be doing the kind of effort that you really need to have happen.

[The prepared statement of Dr. MacCracken follows:]

PREPARED STATEMENT OF MICHAEL C. MACCRACKEN

Introduction

Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to participate in today's hearing on H.R. 906, the *Global Change Research and Data Management Act of 2007.* I am honored to testify before you today in both my capacity, since 2002, as Chief Scientist for Climate Change Programs at the Climate Institute[1] here in Washington, D.C., and as the executive director of the Office of the U. S. Global Change Research Program (USGCRP) from 1993 to 1997 and of USGCRP's National Assessment Coordination Office from 1997–2001.[2] My detail as senior scientist with the Office of the USGCRP as senior scientist for climate change concluded in September 2002.

Prior to my detail from the University of California's Lawrence Livermore National Laboratory (LLNL) to the Office of the USGCRP in 1993, my research at LLNL beginning in 1968 focused on computer simulation of climate change and air pollution. In addition, from 1974–1987 I served as deputy division leader and from 1987–1993 as division leader of LLNL's Atmospheric and Geophysical Sciences Division. While at LLNL, I gained valuable experience in facilitating interagency cooperation by leading or co-leading cooperative research programs among the DOE national laboratories and across the campuses of the University of California. In none of these cases, including with the Office of the USGCRP and NACO, did I have control of the funding to force cooperation; leadership, in each case, was primarily through the offering of ideas that would attract the various participants to work cooperatively together. A biographical sketch is appended to this statement.

In inviting me to testify, I was asked to address two questions:

1. What lessons did you learn from your experience as Executive Director of the National Assessment Coordination Office of the U.S. Global Change Research Program about the importance of regional, State and local participation of a National Assessment?
2. What are the specific tasks necessary to develop an on-going dynamic National Assessment process and what financial resources are needed to support them?

In addressing these questions, I will also be drawing on my experiences participating in various ways in the assessment activities of the Intergovernmental Panel on Climate Change (IPCC), the Arctic Climate Impact Assessment, the City of Aspen, and related efforts.

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[1] The Climate Institute is a non-partisan, non-governmental 501(c)(3) organization that was established under the leadership of John Topping in 1986 to heighten national and international awareness of climate change and to identify practical ways for dealing with it, both through preparing for and responding to the ongoing and prospective changes in climate and by reducing emissions and slowing the long-term rate of change. These goals are pursued, among other ways, through preparation of papers, presentation of talks, and organization of symposia, conferences, roundtables, and special briefings. These have been carried out not only in the U.S., but also in Canada, Australia, Japan, Europe, and more than two-dozen developing countries. To accomplish this, the Climate Institute taps into its vast network of experts and alliances in the U.S. and internationally. In all of these efforts, the Institute strives to be a source of objective and reliable information, promoting global climate protection through practical and cooperative approaches. The Board of Directors, to which I was recently elected, governs the activities of the Climate Institute. The Board, which is currently led by Mr. William Nitze, is made up of academic, business, environmental and scientific leaders from several nations, and the Institute's Board of Advisors, which plays a critical advisory role, is also very broadly based. The Climate Institute receives financial support from membership, private and corporate contributions, grants, and contractual services for government agencies, nonprofit organizations, and publication sales. My service with the Climate Institute has been on a volunteer basis.

[2] The U.S. Global Change Research Program (USGCRP) was established by the *Global Change Research Act of 1990.* Throughout my detail with the USGCRP, it was managed by the interagency Subcommittee on Global Change Research (SGCR), which was made up of research program managers from NSF, NASA, NOAA, DOE, EPA, DOI, USDA, HHS, DOD, and the Smithsonian Institution plus representatives from OSTP, OMB, and, on occasion, other offices of the Executive Office of the President. To facilitate interagency research cooperation, the SGCR established the Office of the USGCRP in 1993, which has continued since 2002 as the Office of the Climate Change Science Program. The National Assessment Coordination Office was created by the SGCR in 1997 and then closed in 2001 at the end of the U.S. National Assessment.

Facilitating an Integrated National Research and Assessment Program on Global Change

The *Global Change Research Act of 1990* (GCRA90) is relatively unique in its establishment of an interagency research program; when effectively directed, the cooperative efforts led to very positive results and accomplishments. Growing out of interagency activities and planning beginning in about 1988 (with roots reaching back even further), establishment of the USGCRP energized cooperative interagency activities, with each agency bringing their strengths to the collaborative effort, thereby creating an impressive and comprehensive national and international research program. GCRA90's requirement to prepare an integrated research plan and OMB's requirement that the agencies collectively approve the budget increments of any particular agency served to encourage cooperation and maintain budget discipline in the early days of the program.

During the 1990s, the collective interagency budget approached $2B a year, and significant research efforts could be accomplished. For example, international field programs that combined the satellite and other capabilities of NASA, the aircraft and ship capabilities of NOAA, the university research and field experiment capabilities of NSF, and similar contributions from other countries led to much more comprehensive and complete data sets for analysis by scientists in all nations, thus promoting, at lower cost to the US, more complete and faster insight into such phenomena as the El Niño, the ozone hole, oceanic uptake of carbon, and more. Improvement of climate models and transfer of such models to the new generations of massively parallel computers was accelerated by combining the strengths of DOE and its laboratories with the modeling expertise of NSF, NASA, and NOAA—each effort prompting the others to do better. The sharing of data and model results allowed other agencies to draw on the results for studies of ecosystem change, hydrology, agriculture, and more. There were many other examples that, when the overall effort was adequately funded, significantly advanced scientific understanding in ways that have and can continue to benefit society.

With more and more scientific questions coming up, however, the budget was held to roughly level dollars starting in the mid 1990s as a step to bring the overall budget deficit under control, leaving only the scientific benefits of working together in win-win ways and Executive Office encouragement to drive interagency cooperation. Even though budgets were tight, the agencies recognized the importance of having an assessment activity and jointly sponsored the U.S. National Assessment from 1997–2001.

With the GCRP budget becoming significantly smaller[3] (e.g., within EPA and NASA), with the erosionary effects of inflation, with the significance of the decrease being somewhat hidden by changing the set of ongoing agency activities included in the USGCRP budget (e.g., within NOAA), and with the CCSP having less knowledgeable and inspirational leadership, much less is seeming to be accomplished. Scientists are spending far too much of their time writing proposals, fewer young scientists are being supported, the observation program is deteriorating, agencies have been very slow to get activities going on important new questions (e.g., research on hurricanes and their relationship to climate change), the U.S. is falling behind the rest of the world and not doing its share in supporting cooperative international research programs, and the overall national assessment activity is far below what it was and should be given the situation being faced by the American public. While there is indeed still much research to be done (enumerated most recently in the *Strategic Plan for the U.S. Climate Change Science Program* completed in 2003), and I certainly support sustaining a strong interagency research program with greater funding, just listing what should be done is not enough.

In addition, the *Strategic Plan* did not even call for a comprehensive decision support program, which is both very disappointing and a real disservice to those who are experiencing climate change now and who will be exposed to much greater change in years to come. The Administration is not even providing sufficient support to investigate the uncertainties that it claims are important, much less the many areas deemed important by the national and international scientific community and the public, just at a time when the pace of climate change and its impacts are accelerating.

The main change that is needed, in my view, is highly qualified leadership, restoration of the very strong research effort that had been going on, and a significant commitment to openly, forthrightly, and expeditiously provide the best possible information to the American public through a comprehensive decision support and as-

[3] See their enumeration of the budget at *http://www.climatescience.gov/infosheets/highlight2/default.htm#funding* and *http://www.usgcrp.gov/usgcrp/budgets/funding1989-2008byagency.htm*

sessment activity. Interagency cooperation can be encouraged by ensuring each agency has a strong research program and then, for interagency activities, allocating responsibilities across the agencies, with each taking on a proportional share of the tasks that it can capably undertake and fund. Shared responsibility has the effect of ensuring a real stake in the collective effort by all of the agencies. Although I have been disappointed in OSTP's leadership for the past few years, my recommendation is nonetheless maintain responsibility for the interagency coordination under OSTP and the science adviser, and to keep the research on climate change science separate from that on energy technologies to avoid potential biases and to ensure effective management.

Building a Useful and Effective National Assessment Capability

Assessments are too often thought of only as reports, as, for example, the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the WMO and UNEP reports on Stratospheric Ozone, the Arctic Climate Impact Assessment (ACIA), and the US National Assessment. Indeed, GCRA90 and H.R. 906 both focus on the delivery of a report to Congress.

For the assessment activity to be useful, however, it has been widely recognized for some time that a much grander vision and process is needed, both in terms of the set of stakeholders that are included and in establishing the type and scope of activities that need to be undertaken. While provision of information to Congress to support policy development is certainly important, preparing for and adapting and responding to the impacts of climate change must start locally and regionally—each region is distinct, and each type of impact manifests itself in different ways in different places and for different sectors of the economy. While there are certainly some areas where national policy steps are warranted, there will be many where individuals, public and private sector organizations, local communities, states, and regions will need to respond. USGCRP activities need to serve all of these scales and stakeholders, not dictating what policies to follow, but providing information and capabilities needed by those experiencing the impacts so that they can prepare for and adapt and respond to future conditions.

Local planners will want information on likely changes in precipitation amount and flooding rains; farmers and farm cooperatives will want information on changes in season length and temperature, not just for their own farms, but for those of their local and distant competitors; coastal zone managers will want information on likely changes in sea level, storms, estuarine temperatures, and more; water resource managers will want information on likely changes in snowpack and runoff, and the chance of floods and drought; community health planners will want information on changes in location of freezing conditions and the frequency of extreme heat waves; industry will want information on changes in extremes that might affect their businesses and shipping; those preparing environmental impact statements will want information on the degree of change in a particular location; those doing economic analyses will want information across the region, and lots more.

In addition to providing information for stakeholders, the program needs to have an associated outreach and educational activity, helping to inform people about the changes ahead so that they can make decisions that will be robust over time and not lead to wasteful investments. As for other parts of the economy and society, information, even somewhat uncertain information, can be very valuable. In that Congress created the *Global Change Research Act* as an application-oriented research effort, I believe that the USGCRP has an obligation to make information available as it is produced, and not hold back such information until the changes being studied have occurred or the very high degree of confidence that the scientific community ultimately strives for has been obtained.

Reflections on the U.S. National Assessment Experience (1997–2001)

Over the four-year period, significant progress was made in moving toward creating a broad and comprehensive National Assessment capability. We realized that we needed to create opportunities for real people (referred to collectively as stakeholders) to meet with scientists and specialists to learn about and discuss the information that the research is providing, have the opportunity to ask questions and to contribute their detailed knowledge and expertise, get information in the form and type that they need to make their own analyses, and to make their own judgments about whether the degree of confidence and uncertainty that scientists have in this information will make it useful to them.

Certainly, a top-down effort by USGCRP could set the process in motion by helping to sponsor meetings and by carrying out illustrative analyses of the larger-scale impacts. However, top-down reports tend to lack the detailed, local knowledge of an area and generally inadequately treat the social, economic, and demographic issues

that would be expected to make a climate impact report of real relevance to city and regional planners; reports about local issues published by agencies in Washington are just not perceived to have the credibility of reports coming from local experts. Quite clearly, strong bottom-up regional efforts based at local academic institutions are much more credible than national level efforts, especially when analyses are done at local to regional scales by local and regional experts.

A second approach to evaluating impacts is to look nationally, or even internationally where appropriate, at particular economic or resource sectors. For many sectors, national policies exist and commercial entities are very active or interested, making a national perspective most appropriate. As a result, the National Assessment set up a series of sectoral studies. Because many of those in industry consider their ability to adapt and prepare for climatic fluctuations and changes a component of their proprietary business information, it also became clear that, for some types of sectoral studies, the assessment would need to be left to the private sector (and in the field of weather-related issues, there is already a strong private sector capability). Industry participants might well want to receive information, but did not want to have to explain their requests.

So, building on experiences from already ongoing efforts by NOAA to help water resource managers and others in the Pacific Northwest make use of the improving predictability of El Niño and La Niña events, the SGCR decided to create an ongoing, nationally distributed assessment capability, not only to prepare the periodic national-level report, but to also provide ongoing decision support and assessment capabilities to both regional and sectoral stakeholders.

During 1997 and 1998, the USGCRP agencies sponsored 20 primarily university-based teams across the country to organize workshops that would provide an opportunity for the scientific and stakeholder communities to come together.[4] Guidance was also given to make sure that a broad array of stakeholders were invited, and the OSTP Director sent letters to each governor and each Member of Congress from the area inviting their participation. Each workshop posed a set of four questions[5] as a way of seeking to identify the most important impacts likely to affect each particular region.

Based on the issues identified and the capabilities for analyzing and summarizing the likely impacts in these areas, fifteen of the groups were funded to conduct regional assessments,[6] and of these, all but three completed their studies over the next couple of years and, in addition to significant outreach to regional stakeholders, published reports summarizing likely impacts.[7]

Following a national-level workshop in the fall of 1997 and in response to guidance from the director of the OSTP regarding fulfillment of the GCRA90 requirement for a national assessment, the USGCRP agencies established the National Assessment Synthesis Team (NAST) as a federal advisory committee in early 1998. Working with the agencies, NAST organized sectoral assessment teams covering agriculture, forests, human health, water resources, and coastal area and marine resources. Each of the five sectoral teams was based at a university and co-chaired by a university and government laboratory scientist. While it was recognized that there were additional sectoral topics meriting coverage (and even mentioned specifically in GCRA90), the particular choices were made because it was recognized that other sectoral topics would likely depend on the results from these areas (e.g., assessing impacts on the energy sector would require estimates of changes in water resources). In addition, because the intent was that assessment activities would be ongoing, holding off for a few years seemed prudent, especially because the most im-

[4] Workshops were held covering the following areas: New England and Upstate New York, Metropolitan East Coast, Mid-Atlantic, Central and Southern Appalachians, Southeast, South Atlantic Coast and Caribbean, Great Lakes, Eastern Midwest, Northern Great Plains, Central Great Plains, Southern Great Plains, Rocky Mountains/Great Basin, Southwest-Rio Grande Basin, Southwest-Colorado River Basin, California, Pacific Northwest, Alaska, Pacific Islands, and Native Peoples/Native Homelands.

[5] 1. What are the long-term environmental and resource problems now faced in the region? 2. How would climate change amplify or moderate them or introduce new stresses? 3. What further information is needed to address these questions? 4. What win-win strategies might help to address the problems being faced?

[6] The five areas for which proposals and funding did not come together were: Central and Southern Appalachians, Eastern Midwest, South Atlantic Coast and Caribbean, Southern Great Plains, and Southwest-Rio Grande, although some additional joint study did go on for the last two areas. The Native People/Native Homelands workshop led to a proposal covering only the Southwest.

[7] While much was accomplished in the three regions that did not ultimately publish assessment reports, a shortfall in funds did prevent the publication of the draft reports for the California and Native Peoples-Southwest regions. The Northern Great Plains region carried out its outreach activities via other means than publishing a hard-copy report.

portant aspects of these issues would be getting covered in the regional assessments.

To provide the technical information needed to underpin the regional, sectoral, and national assessments, the USGCRP agencies also funded initial, but quite limited, activities relating to projection of climate, vegetation cover, economic development, and technology development. In addition, to provide overall coordination and facilitation among the regions, sectors, agencies and NAST, the SGCR established the National Assessment Coordination Office (NACO). NACO's activities included providing staff support to the NAST, organizing annual meetings of leaders of all the assessment teams, issuing newsletters, maintaining a Web site, and, especially, understanding and communicating the interests and concerns among the groups and with the agencies which, for legal and contractual reasons, were in a number of cases unable to work directly with the groups they were sponsoring.

While a great deal was accomplished, the most challenging problem was funding. Fulfilling the legal requirement for a report to Congress and supporting such a broad assessment activity was really an unfunded mandate. There was not time, and little likelihood, to move a request for sufficient funding for each agency through the OMB and Congressional budget process, especially to cover activities occurring over a number of years. There was also some question about whether assessment really fits within the definition of research that prevails in some agencies. To bypass the need for coordinated interagency funding approval, the assessment activity was subdivided into about 30 components (e.g., support a regional assessment, support a sectoral assessment, etc.) and each of the eight active agencies was asked to find the resources to assume responsibility for the several specific tasks most closely related to their mission (e.g., USDA supported the agriculture and forest sectors, etc.). We ended up getting about 25 of the 30 components funded. A key issue for future assessments will be addressing this problem, because the unevenness of the funding that different agencies could and did make available led to unevenness, discontent, bewilderment, and even jealousy across the participating groups.

Despite the complexity and problems associated with the overall effort, a great deal was accomplished. The overall effort, which entailed planning workshops, building of stakeholder interfaces, regional and sectoral analyses and studies, national synthesis, and, for all reports, extensive review, took four years. There was a significant level of coordination achieved, both through exchange of information among teams at workshops and e-mail, and with some direction from the NAST. Most of the reports (and a lot of related publications) were completed and distributed in 1999 and 2000 (regional reports by the regions; sectoral by the sectoral groups; and the national reports through SGCR and OSTP). The reports remain available over the Web at *http://www.usgcrp.gov/usgcrp/nacc/default.htm,* and the national level reports are also available from Cambridge University Press.

Except for the relatively few regions and sectors where new funding was provided (e.g., in California, where the findings of the regional assessment raised such interest that the state established its own program), these reports remain today the most comprehensive set of information about the likely impacts of climate change on the U.S. In addition, the National Assessment set of activities served as the primary basis for the summary of impacts that was included in the IPCC's chapter on North America in its Third Assessment Report, in the National Academy of Science's 2001 report prepared in response to a series of questions from President Bush, and in the impacts and adaptation chapter of the *U.S. Climate Action Report—2002,* which, after word-by-word approval by all the key government agencies and the Executive Office of the President, was submitted in late May 2002 as the official U.S. Government communication under the UN Framework Convention on Climate Change that the U.S. ratified in 1992. Quite clearly, the National Assessment process from 1997–2001 served many purposes, from local and regional to national and international.

Rebuilding a National Assessment Capability

As mentioned above, it was envisioned that an integrated regional-sectoral-national assessment activity would continue on well beyond 2001, building on progress spurred by the ongoing research program, interacting continuously with stakeholders, and periodically issuing reports that represented snapshots of understanding at that point. Instead, the Climate Change Science Program, which came to encompass the USGCRP, chose to focus its resources primarily on further reducing uncertainties relating to the science of climate change rather than building capabilities for evaluating the implications of climate change for people and the environment. There is indeed much research to be done (on climate extremes, on hurricanes, on ecosystem responses, and in other areas listed in the CCSP research strat-

egy[8]), and I certainly support additional funds for addressing the major scientific uncertainties, but much is reasonably well understood, and I believe it is particularly unfortunate for the American public (and also in violation of the GCRA90) to not also be sponsoring a strong national assessment activity. Unfortunately, except for a relatively small number of ongoing activities, the focus of which has in some cases moved away from climate change, most of the regional, sectoral, and national assessment capabilities created for the National Assessment have largely been discontinued. As a result, capabilities will have to be rebuilt if our nation is going to have available the information needed to effectively and economically prepare for and adapt to the changes that lie ahead. If this is not done, the progress being made through the scientific research will simply not be effectively communicated to and usable by most stakeholders.

To rebuild and expand the national assessment capability so that it is providing information across the country of the kind and quality that California is putting together to address key climate impacts on its citizens, infrastructure, and economy, several steps need to be taken:

1. **Call for a national assessment capability:** It needs to be made explicit in H.R. 906 that the assessment process is more than preparation of a national-level report to Congress. Indeed, it needs to be stated that what is needed is a widely distributed national assessment capability that can benefit private and public sector organizations, local and State governments, and the public at large. As explained below, this effort needs to have regional, sectoral, and national components.

2. **Ensure a broad scope:** GCRA90 and H.R. 906 both properly call for assessments of global change, not just climate change; that is, in addition to dealing with long-term climate change, the stated intent is to deal with issues that include, for example, the individual and coupled impacts of changes in stratospheric ozone, large-scale changes in atmospheric chemistry, ocean acidification, deforestation and desertification, shifts in species ranges and loss of biodiversity, changes in population and demand for water and other ecosystem services, natural influences such as major volcanic eruptions, and more. For the first National Assessment, we used the threat of "climate change" as a means to initiate consideration of broader concerns over global change and sustainability. This was accomplished by having the first discussion question inquire about other large-scale, long-term issues, influences, and trends (e.g., the overdrawing of underground aquifers in some regions). The second question then inquired about how climate change might exacerbate or ameliorate the consequences of the various factors leading change, or how it might introduce new stresses or opportunities. The assessment activity needs to avoid considering climate change in the absence of how society and the environment are otherwise changing; they will only be useful to real people if done in the context of all types of changes that are going on. Fully addressing global change and sustainability will likely to require even broader interagency cooperation and budget coordination than at present.

3. **Allow coupled consideration of mitigation and adaptation:** GCRA90 separated mitigation from adaptation, yet it became clear during the National Assessment that they are coupled in certain ways. Changes in water resources will affect the potential for generation of biomass; changes in climate may well affect wind power resources and demand for energy; changes in land cover for energy generation will affect surface albedo, dust loading, and even air pollution; changes in location of icing could affect transmission lines; etc. Certainly, the technology research programs are best kept separate, but choices regarding particularly renewable energy technologies and their implications need to be considered jointly with issues of impacts and adaptation.

4. **Provide separate funding:** Whether at NSF where research is defined as something new or at USDA where land-grant funds are allocated for other purposes and seemingly can't be diverted, borrowing and begging from the research budgets of various agencies did not work well, having to struggle to overcome long-standing agency and recipient relationships. At the same time, putting all of the additional funds in one agency would tend to reduce

[8] It is not, of course, enough to list the scientific question in the plan. What has to be done is to have an effective research program to address the key questions, and this is not happening across the various elements, especially in aspects critical to identifying and evaluating the impacts of climate change.

overall credibility, as was the perception when EPA alone was funding early assessment activities in the late 1980s. For credibility, multiple agencies, each with their particular interests and capabilities, need to share the responsibilities and ownership of the assessment activities.

5. **Provide for national baseline information:** Regional, sectoral, and national assessments will all require developing a set of scenarios of projected changes in climate, ecosystems, demographics, technology, economics, and energy technologies. A problem with the first National Assessment was that these activities were inadequately supported and got started too late to really get the information to assessment teams when it was needed. Each of these efforts can be started up quickly, perhaps most effectively under the oversight of national panels set up under the auspices of a relevant professional society or foundation. Major data sets that are generated can likely best be maintained and made available through, for example, national or agency laboratories or centers. There is also a need for research funding to develop the capability for generating much more useful projections and scenarios, and to find the means to allow for consideration of societal evolution, alternative policies, etc. This will require a coupling of the assessment and research planning efforts. The assessment component of this effort is likely to require several million dollars per year, especially to support the running of regional models and the involvement of the social science community.

6. **Generalize the time horizon:** GCRA90 called for looking 25 and 100 years ahead. This was too limiting. Many stakeholders want to have projections for only 10 years in the future, even though scientists would say, and the stakeholders understand, that natural variability and events such as volcanic eruptions could cause fluctuations larger than the expected changes over these short time scales. The reason even limited confidence estimates can be important is that businesses are not dependent on conditions being exactly at the expected mean value; for reasons of competitive edge and to avoid government regulation if failure happens too often, resource-related businesses are typically able to flexibly adapt to conditions that span 90 percent or more of the possible range of monthly to seasonal climatic variations (e.g., have enough capacity and reserves to be able to ensure enough natural gas or heating oil for all but the very coldest years, after which they might need to resort to significant price increases or extra transport of fuel, or to pleas to the public for conservation, or, in the direst situations, not meeting the demand). In that many businesses already have developed an adaptive capability to deal with a reasonable range of extremes, a projected trend in the mean can be used to plan how best to plan for changes in the likelihood of extreme events (e.g., to ensure sufficient electric power during heat waves). For other groups, for example those planning buildings or developing new paving materials, information out to 50 years is more important. The assessment activity therefore needs to recognize that different groups are likely to need widely divergent information, from changes in the mean to changes in the extremes.

7. **Insist on stakeholder involvement and an applications-oriented effort:** It really needs to be made clear that the national assessment activity is an applications-oriented, mission-directed part of the overall USGCRP. Too often, assessments are being done by pulling researchers away from their research. That can be fine for a short time and for scientific review papers, but that is not how this part of the program should be conducted. The assessment effort needs to be designed to maintain an ongoing interface with stakeholders, and to develop the tools and information that stakeholders need, taking account of the special knowledge and situations that are being analyzed. As such, the activity needs to have a philosophy and operating approach that is akin to NOAA's existing regional climate centers. While new information and insights will and can be generated by the assessment process, this effort needs to be informed by research, but driven by stakeholders.

8. **Insist on and support a network of regional decision-support centers:** A wide range of impacts that matter happen where people live. As one approach to estimating impacts, it is essential to have a place-based focus in the assessment process; those who best know and can relate to a region are those who live and do their work there. The National Assessment struggled a lot with the question of what a region is, and ended up with ones of

varying size and rationale.[9] The most important considerations ended up being that the regions included people facing similar problems and that the participants in the region were able to get together for one-day information, coordination, and outreach meetings (getting stakeholders to devote more than one day is very difficult, given the long-term nature of the benefit they can expect). For the first National Assessment activity, keeping in mind that the U.S. is responsible for islands in the Caribbean and Pacific, it seemed that 20 regions was about the right number.

For the National Assessment, the USGCRP agencies were generally only able to provide enough funding to get a team established that drew members from one university. A number of the regions were able to reach out and build broader teams by attracting separately supported participants from land and sea grant programs, from government laboratories, and simply because of the uniqueness of this first effort; on-going efforts, however, are going to require more substantial support for each center (likely of order $1–2M per year per region—and if regional modeling is involved, substantially more).

Ideally, I believe that regional centers (or virtual centers or cooperative regional programs) are needed that draw on capabilities from multiple universities, laboratories, stakeholder organizations, and other expertise in a region, thereby creating a regionalized science, assessment, and decision-support capability. Such centers (or capabilities) need to be able to do more than just review existing scientific literature. They need to be able to carry out and analyze the large-scale changes that characterize and drive global and national change, and then apply this large-scale information in local and regional analyses using the available and calibrated local and regional models.

For the assessment and decision-support aspect of the effort, the Regional Integrated Sciences Assessment (RISA) teams that have been established by NOAA in a few regions provide an example of what will be needed (and about which Dr. Phil Mote will testify).[10] The scope of capabilities, however, will need to be strengthened so that these regional centers can address issues of changes not only of climate, but also for ecosystems, water resources, health, agriculture, demographics, economic development, transportation, and more. To achieve both breadth and flexibility as the set of issues change, it may be best to establish a virtual regional center rather than a specific center at a fixed location (California seems to have been able to do this), or to base administrative coordination efforts at a government laboratory or major center within the region, with expertise distributed across a set of universities.

Getting such activities up and going across the country will take at least a few years, but really does need to occur so that all regions can have the types of information now available for those few regions that are supported. Required funding for roughly 20 regional activities likely needs to be roughly $20M per year.

9. **Call for and support sectoral assessments:** While many of the impacts are regionally distinctive, our nation is interconnected in many ways. The National Assessment sponsored five sectoral assessments, but recognized that many more were needed and hoped that they would be initiated as part of ongoing activities. There have been a few efforts to do this, with, for example, EPA continuing to sponsor assessments of the significance of climate change for human health and air and water quality, and DOT for issues relating to climate and transportation infrastructure and operation. But the CCSP's efforts have so far been quite limited, forcing the initiation of other modest and generally underfunded efforts (e.g., GAO, at Congressional request, on Public Lands; a few environmental groups for various regions; and

[9] We considered trying to subdivide the U.S. by watershed, by agency defined administrative region, by political boundary, and more. In the end, recalling the book *The Nine Nations of North America* that focuses on the common interests and values of those in particular areas, and even considering whether the boundaries of major football conferences might help define this, we ended up using no single criterion and allowed fuzzy boundaries for regions.

[10] The four regional centers sponsored by DOE's National Institute for Climatic Change Research (NICCR) provide an example of how regional research can be focused and coordinated across several universities in a given region, although their core set of activities is not as focused as for the RISA centers.

a number of groups on defense and national security implications); fully supported studies are needed.

Establishing on-going panels that are expected to regularly update their analyses and assessments would likely work best, with a sustained capability maintained in order to be responsive to new questions, inquiries, and research results. The overall objective would be to help those in each sector have the information they need to cost effectively prepare for and adapt to ongoing and prospective climatic and environmental change.

In addition to the areas for which initial assessments were done, areas that are particularly worthy of study include extreme events (e.g., hurricanes), energy, transportation, infrastructure, business and commerce, trade and international economics, recreation and tourism, wildlife and migrating species, drylands and deserts, public parks and natural lands, national security, international interconnections including environmental refugees, urban areas, rural communities, and more.

To lead such efforts, partnerships between independent professional or research organizations and government research entities would likely be most effective, and might be a means that would allow these teams to deal with proprietary information and to develop recommendations on policies that could help ease impacts and promote adaptation in the sector analyzed. Funding for a set of such activities should likely start at a level of about $5–10M.

10. **National vulnerability assessment:** The National Assessment Synthesis Team (NAST) was established to provide high-level direction for and integration across the distributed assessment activities. NAST's responsibility included carrying out the national synthesis by considering the larger picture, encouraging learning and interaction across the separate activities, and looking for gaps and weaknesses. Having NAST organized as a federal advisory committee[11] created credibility and allowed for openness in its activities, including in its review process.[12] Insisting that such an independent structure be used in the future is important for many reasons, especially credibility; it is fine to ask for an Administration evaluation of the resulting report, but the vulnerability assessment should not be a formal Administration or interagency document.

    It is unclear whether an entity similar to NAST could be sustained on a continuing basis using mainly volunteer members who actually are also responsible for writing the report; quite likely some support will be needed for member support, for special studies, and for support staff. Finding a way to have NAST's members be both widely representative of stakeholders (including representing the interests of the agencies and Congress) while also having the needed distribution and depth of expertise will be a challenge. Funding required is likely $2M per year, including support for national level meetings.

11. **Overall Facilitation and Coordination:** The SGCR established the National Assessment Coordination Office (NACO) to ensure effective coordination across all of the various parts of the effort; this involved both a service and a subtle independent voice supporting the overall vision for what is wanted. Some sort of similar function will be needed for future assessments, including especially promoting coordination, cooperation, and exchange of information across the regions, sectors, agencies, and national assessment team. For reasons of credibility and acceptance, it will be important to find a way to make sure this is done on an interagency basis.

12. **Timing:** GCRA90 and H.R. 906 both provide for an assessment every four years. While periodic reports can be useful, they can also be very disruptive to an ongoing assessment process if every part of the process must focus

[11] Although NAST operated legally under the auspices of NSF, its functioning, oversight, and interactions were handled on an interagency basis, giving it broader independence and credibility. The independence also allowed each agency to separately consider NAST's findings and integrate them into their various roles and priorities. Based on experiences of trying to get all agencies to approve every word of official government reports, it is important that this not be required.

[12] Having a *Federal Register* review in addition to an extensive expert review served, in my view, a very useful role. However, an open review can also create difficulties because open release of a draft report tends to draw more media attention that release of the final findings.

on meeting the same timelines. For this reason, rather than setting tight timelines and a common, coordinated schedule for all parts of the process as is done for IPCC assessments,[13] NAST understood that, while there was a need for the various regional and sectoral teams to conduct some common analyses for national integration, each region and each sector also needed some flexibility in undertaking their own studies for their own audiences. Thus, the national synthesis effort was set up as, essentially, a "snapshot" at a particular time and focused on a particular aspect of global change, initially climate change. We envisioned there being future snapshots to catch up with other aspects of the issue.

For the future, I would think it useful to continue to ask for periodic national-level reports—indeed, that the needed report called for in the GCRA90 has not been provided is very unfortunate. While there should not be an expectation that each report will cover every aspect of global change, coordination across successive reports should be done to ensure that Congress really does periodically have an up-to-date synthesis of the key national issues. To accomplish this, what would be most useful, I would think, would be to receive, over time, a series of reports from different perspectives and taking different crosscuts of the issue—one time focused on climate change, another time on ecosystem services and vitality, another time on water resources and drought, etc., and then, in addition, having an integrated executive synthesis. Neither scientific understanding nor climate normally changes fast enough to justify generating a full set of reports in each region and sector on the same material every four years; however, an up-to-date synthesis should always be available.

13. **Policy and technology evaluation for adaptation:** Unlike GCRA90, H.R. 906 calls in section 107(5) for the vulnerability assessment to analyze "the adoption rates of policies and technologies available to reduce the vulnerability of society to global change. . ." This looks to me to be a useful new component of a national-level assessment. Such analyses should also be useful as a foundation for covering this subject in the quadrennial submission of the U.S. Climate Action Report. The National Assessment was not very successful at getting at the issue of adaptation to various impacts; having a special effort, at a reasonable funding level, would likely be very helpful.

14. **Communication, education and outreach program:** While the National Assessment planned a communication, education, and outreach component, there were inadequate funds to do very much. A key problem was that the agencies involved just did not feel they were empowered to use funds designated for research for these purposes, especially when the research funding was very tight and there were many issues that needed to be addressed. In some way, the legislation needs to call for such activities and find ways to make sure that funding can be provided, even if through the agency education allocations, etc. Funding should be at $1–2M per year.

15. **Policy assessment:** Section 108 of H.R. 906 calls for a policy assessment that documents current policies across the country for both adaptation and mitigation, analyzes the effectiveness of these policies, and identifies and evaluates the need for additional policies. I would suggest that the adaptation component of this assessment not related to the emission or uptake of greenhouse gases be made part of the national vulnerability assessment so as to make the remaining effort more focused and manageable. With respect to the mitigation assessment, to ensure credibility, it will be important to have this assessment done by an independent panel organized under the auspices of a university, foundation, or research or policy center. Required funding is likely a few million per year.

What Can Be Done in a Year?

The fact that we have gone seven years without a full assessment would certainly seem a good reason to ask that the next assessment be completed in a year. However, insisting on such a rapid timetable could well lead to such an inadequate re-

[13] In addition to requiring very tight coordination and essentially the superseding of all other activities and stakeholder interactions, scheduling all reports to finish simultaneously also has the unfortunate side effect of leading to peaks of attention on the issue every several years rather than promoting ongoing attention to the need to build adaptive capacity.

sult that it would impair progress in getting to the comprehensive national capability that we need. Much, however, can be done in a year:

A coordinated, interagency effort to prepare, review, and publish a plan for a comprehensive national assessment;

In that historical and scenario-based information will be required on climate, land cover, demographics, technology, and economics, steps should be required to initiate such efforts;

The existing set of regionally based activities should be expanded;

Key agencies should be encouraged to initiate sectoral assessment activities on a number of new topics; and

Agency budgets should be augmented to provide for their participation in a greatly expanded assessment activity.

In my view, establishing the national capability over the next one to two years and then pushing for the next national-level synthesis within three years would be possible while assuring that useful information would be starting to get to stakeholders relatively quickly.

In addition, the Administration should be called upon to complete the seriously overdue Climate Action Report, with the process including an adequate time for expert and public review of the draft and Congressional evaluation of the result.

BIOGRAPHY FOR MICHAEL C. MACCRACKEN

Michael MacCracken has been Chief Scientist for Climate Change Programs with the Climate Institute in Washington, D.C., since 2002; he was also elected to its Board of Directors in 2006. Both of these positions are held on a volunteer basis.

Dr. MacCracken received his B.S. in Engineering degree from Princeton University in 1964 and his Ph.D. degree in Applied Science from the University of California Davis/Livermore in 1968. His dissertation used a 2–D climate model to evaluate the plausibility of several hypotheses of the causes of ice ages. Following his graduate work, he joined the Physics Department of the University of California's Lawrence Livermore National Laboratory (LLNL) as an atmospheric physicist. His research in the ensuing 25 years included numerical modeling of various causes of climate change (including study of the potential climatic effects of greenhouse gases, volcanic aerosols, land-cover change, and nuclear war) and of factors affecting air quality (including photochemical pollution in the San Francisco Bay Area and sulfate air pollution in the northeastern United States). At LLNL, he also served as deputy division leader for atmospheric and geophysical sciences from 1974–1987 and then division leader from 1987–1993.

From 1993–2002, Dr. MacCracken was on assignment as senior global change scientist to the interagency Office of the U.S. Global Change Research Program (USGCRP) in Washington, D.C., also serving as its first Executive Director from 1993–1997. From 1997–2001, he served as Executive Director of the USGCRP's National Assessment Coordination Office, which facilitated and coordinated the efforts of 20 regional assessment teams, five sectoral teams, and the National Assessment Synthesis Team (which was constituted as a federal advisory committee) that prepared the national climate impact assessment report that was forwarded to the President and on to Congress in late 2000. During this period with the Office of the USGCRP, Dr. MacCracken also was a co-author/contributing author for various chapters in the IPCC assessment reports and helped coordinate the official U.S. Government reviews of the second and third assessment reports of the Intergovernmental Panel on Climate Change.

When Dr. MacCracken's assignment with the Office of the USGCRP concluded on September 30, 2002, he simultaneously retired from LLNL. In addition to his activities with the Climate Institute, he served on the integration team for the Arctic Climate Impact Assessment from 2002–2004. Dr. MacCracken is also near completing a four-year term (2003–2007) as president of the International Association of Meteorology and Atmospheric Sciences (IAMAS), members of which are the national academies of science or their equivalent in about 50 nations. As president of IAMAS, Dr. MacCracken also serves on the executive committees of International Union of Geodesy and Geophysics (IUGG) and of the Scientific Committee for Oceanic Research (SCOR). From 2004 to 2005, he served on a panel of the Scientific Committee on Problems in the Environment that prepared a report on what is known about the likelihood and consequences of an asteroid or comet impact, and from 2004–2007 on a scientific expert group convened by Sigma Xi and the UN Foundation at the request of the UN's Commission on Sustainable Development to suggest the best

measures for mitigating and adapting to global climate change (report available at *http://www.confrontingclimatechange.org*).

Dr. MacCracken is a fellow of the American Association for the Advancement of Science (AAAS) and a member of the American Meteorological Society, the Oceanography Society, and the American Geophysical Union, among other organizations. His affidavit relating global climate change and impacts on particular regions was recently cited favorably by Justice Stevens in his opinion in the recent decision in Massachusetts et al. versus EPA.

Ms. GIFFORDS. Thank you, Dr. MacCracken. Dr. Fellows, please.

STATEMENT OF DR. JACK D. FELLOWS, VICE PRESIDENT, UNIVERSITY CENTER FOR ATMOSPHERIC RESEARCH

Dr. FELLOWS. Thank you, Madam Chairman, Chairwoman.

I would like to thank the Subcommittee for the opportunity to testify on H.R. 906, in addition to my personal involvement in the creation of the U.S. Global Change Research Program. And I wanted to mention that UCAR, this consortium of 70 universities, has been involved in this program for over 15 years as well.

The Subcommittee asked me to address the following questions: What are the major strengths and weaknesses of the U.S. Global Change Research Program? Are the current program funding levels adequate for adaptation and mitigation research and characterizing national vulnerability to climate change? And how can we ensure that resource managers and policy-makers' needs are met by the program?

Let me start by describing the current U.S. Global Change Research Program strengths. The program has always been focused on producing the sound, scientific basis for policy-making. It has developed a unique interagency mechanism that provides a critical mass and focus for planning, and it is periodically peer reviewed. It has also made an effort to tie research and observational strategies to user needs, and it has clearly advanced the science over the last 17 years.

Although it is not perfect—it does have some weakness—it has been impacted by political influences over the years, climate politics, overshadowed by other priorities. Over its history, its leaders have not always been given the support and tools to make the tough decisions and tradeoffs between program and agency priorities. It has been difficult at times to track the progress of the program, and it could clearly be more responsive to user needs.

Let me turn to whether or not the program has adequate funding for adaptation and mitigation and characterizing national vulnerability. To discuss the budget, I will be referring to the Financial Year '07 "Our Changing Planet" document. It is a report that is produced by the program every year. That report covers the years Financial Year '05 to '07. During these years, the funding was roughly at about $2 billion a year. This is not easy to do a critical analysis of balance. Typically, National Research Council takes a couple years to do this.

But the program does have five goals, and the first three are focused largely on scientific advancement, and the last two on adaptation, mitigation, and vulnerability analysis. Those last two goals represent about 25 to 30 percent of the current budget, and that is about $300 million annually.

So, in my own judgment, I think that the balance is probably roughly right, and it actually includes a range of synthesis and assessment products that focus on national vulnerability, all the way from urban environments that we live in to even Arctic ice, and Mr. Inglis, I know you have traveled to the Antarctic, and you have experienced those ice conditions.

One balance issue that I would like to point out is between Financial Year '05 and '07, the observational support actually decreased by almost 30 percent, from $500 million to about $700 million. These were largely NASA science cuts due to other Administration priorities that have weakened the program, right at the time when we really need this kind of environmental observation. This reduction was actually highlighted in a recent National Research Council report that warned that our national environmental observation systems are at risk.

Let me turn to whether or not we can ensure that resource managers and policy-makers' needs are being met in this program. The program has actually had a long history of engaging stakeholders. The program sponsored, in 2001, a National Assessment, of which researchers and stakeholders worked together, in 20 regions of the United States, to help identify user needs. Most of the synthesis and assessment products that came out of this effort continued to be an important part of the program, and involved the stakeholders.

But despite all these efforts, I do think that H.R. 906 would increase user input, and particularly, on the planning and priority setting of the program. So, in summary, I would say that H.R. 906 is very timely. It is an important piece of legislation. We have learned a lot since 1990 on how to run an interagency program, and the demand for this information is clearly increasing.

If there is anything I would recommend about H.R. 906, it has to do with improving the interagency process itself. The bill does need to further highlight the priority of this program, so that it doesn't get diluted by other things. It is still a surprise to me that there is no aspect of this program included in the American Competitive Initiative, even though most of our economy is weather-sensitive or climate-sensitive.

The bill also ought to identify, I think, a Director of this program and an Office of this program, and give them the tools and support and clout to be able to make the tough decisions, in terms of developing priorities.

So, with that, I will conclude my remarks, Madam Chairwoman, and I would be happy to answer questions when we get to it.

[The prepared statement of Dr. Fellows follows:]

PREPARED STATEMENT OF JACK D. FELLOWS

Introduction

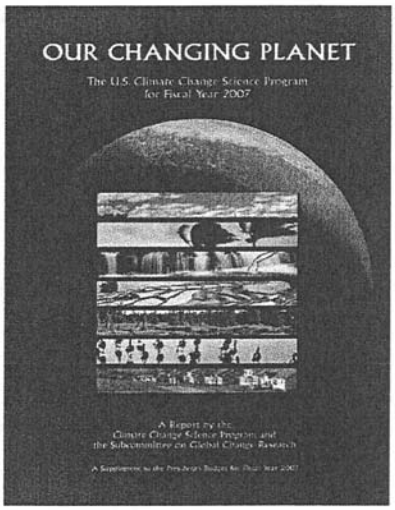
My name is Dr. Jack D. Fellows and I submit this written testimony for the record of the House Subcommittee on Energy and Environment. I am the Vice President of Corporate Affairs at the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado. UCAR is a 70-university member consortium that manages and operates the National Center for Atmospheric Research and additional programs that support and extend the country's scientific and education capabilities related to weather and climate. The UCAR community has been a major contributor to the U.S. Global Change Research Program (USGCRP) for more than 15 years.

In the invitation extended to me to participate in today's hearing on H.R. 906, the *Global Change Research and Data Management Act of 2007,* I was asked to address the following questions:

1. What are the major strengths and weaknesses of the current U.S. Global Change Research Program?
2. Are the current levels of funding for research to support the development of adaptation practices, characterization of ecosystem, community, and economic vulnerability, and mitigation strategies adequate?
3. How can we best ensure that information needs of resources managers and policy-makers at the State and local level are met by the U.S. Global Change Research Program?

In addition to addressing these three questions, I will also include my comments on how H.R. 906 can contribute to these three areas. My testimony today expresses my own views on H.R. 906 and is based on my own experiences and involvement in the USGCRP since its inception. I was a co-author of the very first USGCRP "Our Changing Planet" (OCP) report that accompanied the President's 1990 Budget and from my vantage point at the Office of Management and Budget (OMB) at that time, I assisted the Congress in its enactment of the *Global Change Research Act of 1990* (P.L. 101–606), which codified the USGCRP into law.

While the USGCRP formally started in 1989, it actually began in early 1987 with some informal budget crosscuts when I was at the OMB. Those early crosscuts showed that over $1 billion of agency programs were related to global change type research. Shortly after these crosscuts, the Office of Science and Technology and OMB lead an interagency effort to improve the coordination of these programs. For over 15 years, the OCP reports have annually summarized the efforts of this critically important interagency research effort to better understand both the natural and human-induced changes occurring on our planet. The USGCRP has changed over the years both in research focus and structure. In 2001, the Bush Administration created the Climate Change Science Program (CCSP) that became the umbrella program for both the USGCRP and the Bush Administration's Climate Change Research Initiative. In July 2003, the Bush Administration released the "Strategic Plan for the U.S. Climate Change Science Program" to guide the CCSP program. I will be using the FY07 OCP report for the basis of my testimony today. The USGCRP does not change radically from year to year and the FY07 OCP report is a particularly relevant report to address the three questions I have been asked to address.



USGCRP Major Strengths and Weaknesses?

My own view is that the USGCRP has been instrumental in improving our knowledge of how our planet works and how human activities impact it. That said, I believe the program does have exceptional strengths and a few things that must be addressed to realize the goals outlined in H.R. 906.

The major strengths of the USGCRP include:

1. Its primary goal has not changed since its inception—to provide a sound scientific basis for developing national and international policy on global change issues.
2. It has provided an important interagency mechanism for developing research priorities and budgets and coordinating the program's implementation.
3. It has provided a "critical mass" and "focal point" both within the federal and academic research and policy communities to ensure this important science is discussed, debated, reported, and remain a national priority.
4. It has periodically been independently reviewed (e.g., the National Academy of Sciences) and been responsive to those reviews.
5. It has tried to tie these interagency research efforts to societal and user needs.

The major weaknesses of the USGCRP include:

1. The program has been subject to rather substantial political influences over the years (e.g., avoidance of certain research areas, overshadowed by other Administration priorities, disjointed congressional oversight, etc).
2. The interagency process has not always had the leadership and clout to really ensure that the highest research priorities are addressed or all agency contributions were included (program priorities versus agency priorities).
3. It has not been as responsive to user needs as it could have been.
4. There has been difficulty in tracking budget categories and progress over time as cited in the 2006 GAO report entitled "Climate Change: Greater Clarity And Consistency Are Needed in Reporting Federal Climate Change Funding."

Are Current Funding Levels Adequate to Support Adaptation and Mitigation Research and Characterize Ecosystem, Community, and Economic Vulnerability?

In FY07, the USGCRP had five key goal areas (see box). While some of the wording has changed over the years, these goals have been surprisingly stable for many years. That said, U.S. climate research has historically been focused on Goals 1–3, which have emphasized improvements in fundamental understanding of the climate systems, its driving forces, and the tools to make predictions about climate variability and change. As the science has improved and its applicability to societal needs has become more evident, the importance of Goals 4–5 have clearly increased. The FY07 report has pages and pages of highlights of progress in all these goal areas. Between, FY05–07, the USGCRP funding has been between $1.7–1.8B. It is difficult to critically assess the specific program balance of such a large program. National Academy of Science panels have spent over a year doing this kind of analysis and even those reviews are largely done a high-level. That said, the CCSP Goals and Funding Percentage box above shows that the funding for Goals 4–5 are roughly 25–30 percent of the overall research funding (not including observations). I believe this is substantially up from the early years of the program, represents a reasonable balance in the program, and I expect will increase with time given policy and user demand for this type of research and information. It has just been in the last five years or so that the science has mature enough and the Goal 4–5 capacity capable enough to undertake the over $300 million annually being invested in the Goal 4–5 areas today. The USGCRP currently has 21 Synthesis and Assessment Products that are clearly applicable to national vulnerability, including weather and climate extremes, abrupt climate change, coastal sensitivity to sea level rise, ecosystem discontinuities, global change effects on agriculture, water resource, and energy production, human health impacts, best-practice in characterizing uncertainty, decision support systems for selected economic sectors and regions, adaptive management strategies, and many others.

CCSP Goals and Funding Percentage for FY05-07

Goal 1: Improve knowledge of the Earth's past and present climate and environment, including its natural variability, and improve understanding of the causes of observed variability and change. **18-21%**

Goal 2: Improve the quantification of the forces bring about changes in the Earth's climate and related systems. **27-28%**

Goal 3: Reduce the uncertainty in projection of how the Earth's climate and related systems may change in the future. **24-25%**

Goal 4: Understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes. **14-15%**

Goal 5: Explore the uses and identify the limits of evolving knowledge to manage risks and opportunities related to climate variability and change. **13-15%**

	FY07 Dollars in Millions		
Goal	Research	Observations	Total
1	240.60	206.80	447.40
2	304.80	156.20	461.00
3	283.20	170.80	454.00
4	160.10	41.80	201.90
5	150.70	0.00	150.70
Total	1,139.40	575.60	1,715.00

One issue I wish to point out is the USGCRP observations budget has dropped from over $772 million in FY05 to roughly $575 million in FY07 (a 33 percent decrease). This is largely due to substantial reductions in NASA's science budget and a problem highlighted in the recent National Research Council's "Earth Science and Application from Space: National Imperatives for the Next Decade and Beyond." This is an example where other Administration priorities have weakened the USGCRP program and interagency process. We should consider very carefully whether it is in our best interest to allow our observational capabilities to decline. I believe that in the very near future, policy-makers will begin to take actions to address the climate change issues documented in recent international reports. It would seem to me that observing capabilities will be even more important in the future as tools for policy-makers so that they can assess the impact of the important policy choices they make in response to climate change—which is why it is so hard to understand why this Administration has allowed such a steep decline in the funding of our observing capabilities. It is quite possible that some of the stakeholders input required in H.R. 906 would also agree with the need to maintain these observational capabilities.

How can we best ensure that information needs of resources managers and policy-makers at the State and local level are met by the USGCRP?

In 2001, the USGCRP sponsored the first U.S. National Assessment entitled "Climate Change Impacts on the United States: the potential consequences of climate variability and change." This assessment was required by the *Global Change Research Act of 1990* and involved teams of researchers and stakeholders working in 20 regions across the U.S. Much was learned from this first assessment in terms of national vulnerability, stakeholder needs, and how to best do assessments in the future. Many of the FY07 Synthesis and Assessment Products are outgrowths of this assessment and continue to solicit resource manager and policy-maker needs at all levels. So, the USGCRP continues to make substantial progress in making its investment relevant to stakeholders. But, is it enough given the urgency and political interest in this important science and policy issue? I'll try to address this in the next section of my testimony. I do believe that the type of reports and oversight recommended in H.R. 906 will go a long way to ensuring that resource managers and policy-makers needs are met by the USGCRP.

How H.R. 906 can help in these three areas?

Overall I believe that H.R. 906 is a timely and important piece of legislation. We have learned a lot about climate science since 1990. Given increased awareness of the risks posed by climate change there is significant demand for data, information, models, and tools to help decision-makers and resources managers cope with climate change. Thus, the USGCRP has an unprecedented opportunity to provide even more "decision support" to stakeholders. Also, we have grown wiser on how to run interagency science programs over the past 17 years. Given this increased demand for information and improved management approaches, I believe it is the right time to consider replacing the 1990 Act with H.R. 906. The type of program outlined in H.R. 906 is a significant step in the right direction for the following reasons:

1. It builds on the existing USGCRP strengths and minimizes or even eliminates the weaknesses mentioned above;

2. It seeks more "balance" between the physical and mitigation/adaptation research components; and
3. It promotes further stakeholders engagement at all levels.

Many of the bill's provisions are fully consistent with the recommendations in the 2004 National Research Council report entitled: "Implementing Climate and Global Change Research: A review of the final U.S. Climate Change Program Strategic Plan." The only suggestions I have that might further strengthen the bill include:

1. **Leadership, Priorities, and Management.** Given the possible dire consequences of climate change, I find it puzzling that there is no mention of weather and climate in federal priorities like the American Competitiveness Initiative. A significant portion of our nation's economy is impacted by weather and climate and this area of research and education is preparing the next generation of environmental leaders that will contribute to both our nation's safety and to our economy. For the USGCRP leaders to make progress, this program must be recognized as a key priority in both the Administration and Congress. Without this level of recognition, the USGCRP leaders will not have the clout to make sure the program stays focused on the highest research and policy priorities. This bill would be even stronger if it required the USGCRP interagency committee to have: (1) a clear budget process linking tasks to agency and program budgets, (2) a USGCRP Director with sufficient authority to ensure that agency programs reflect USGCRP priorities and make tough tradeoffs among competing agencies desires and evolving program needs, (3) a timeline with clear and realistic deliverables, and (4) a Director that is clearly held accountable to deliver on the program's goals. This would make for an effective interagency enterprise and reflect what we have learned about interagency efforts over the past 17 years. The flip side of this is to not make it so rigid and centralized that it will actually undermine the interagency process—always a danger! One the greatest frustrations and challenges in putting together an integrated USGCRP while I was at OMB was that there is no equivalent integrated oversight mechanism in the Congress. Many people spent enormous amounts of time in the Executive Branch putting this together and then having it looked at in a completely non-integrated manner on the Hill. Today, the restructuring of the committee jurisdictions has improved the integrated oversight of the USGCRP, but this is something to keep a watchful eye on.
2. **Reporting.** Within one year of the Act's enactment, the Program must produce: (1) a 10 year research plan that reflects user needs at the federal, State, regional, and local levels, international coordination recommendations, categorize user need information needed to develop policies to reduce societal vulnerability to global change, and identify needed global observations; (2) a vulnerability assessment for the U.S. and the world that goes well beyond research; and (3) a policy assessment that documents the mitigation and adaptation policies being used at the federal, State, and local levels, evaluate them, and recommended others, (4) a data management plan, and (5) an annual report. This level of analysis and reporting is likely to be very challenging within one year and would probably benefit from a different sequencing. The research plan would be greatly enhanced from the vulnerability and policy assessment. Perhaps the research plan due date should be delayed to take advantage of a combined vulnerability/policy assessment that involves both the research plan participants and people of very different perspectives and skills (e.g., economists, policy researchers, etc). There is a much greater chance that the research plan's goals and priorities will be responsive to user needs with this input.
3. **Research and User-Need Balance.** This bill should help refocus the USGCRP to better reflect user needs. That said, it shouldn't eliminate important basic research that could lead to a major scientific breakthrough due to over emphasis on user-driven requirements. Whether this happens or not will likely be due to individual interpretation of the bill. While loosely implied, this kind of balance is not directly addressed in the bill and should be. Another way to look at this is that there should be balance between researcher-driven research that may lead to unforeseen breakthroughs and a more top-down approach to managing programs and setting priorities.
4. **Other.** Unlike Title 1, there is no reference to user needs in the Title II data management section. It would make sense that many of these data be relevant to user needs. Lastly, Title I Page 5 Lines 22–23 should include the

obvious agencies involved in the Program just like the data management section (Title II Page 18 Lines 9–19).

I want to thank the Subcommittee for the chance to provide this testimony and your stewardship of the Nation's weather and climate enterprise. There will be tremendous opportunities in the future for international climate leadership and for a broad range of research and technology opportunities that will have substantial return to our nation's economy. The future strength of our nation depends on today's investments in these programs.

BIOGRAPHY FOR JACK D. FELLOWS

Education

Ph.D (1984), M.S. (1976), B.S. (1975) Civil Engineering, University of Maryland. Focus: hydrology, geographical information systems, and remote sensing.

Dr. Fellows began his career as a research faculty member at the University of Maryland, where he conducted research in the use of satellite data in hydrologic models. In 1984, he spent a year in the U.S. Congress as the American Geophysical Union's Congressional Science Fellow. While in Congress, he split his time between the personal office of George Brown (D–CA) and the House Science and Space Subcommittee (George Brown was the Chair at the time) and worked on a range of policy issues, including water resources, satellite remote sensing, and general oversight of federal research and development funding. He helped write legislation that was enacted regarding the commercialization of land remote sensing satellites. After this fellowship (and largely because of it), he spent 13 years in the Executive Office of President's Office of Management and Budget (OMB) overseeing budget and policy issues related to the National Aeronautics and Space Administration, the National Science Foundation, and federal-wide research and development programs. During this period with OMB, he helped initiate the U.S. Global Change Research Program.

Jack has two roles at UCAR. Since 1997, Jack has been the Vice President of UCAR's Corporate Affairs; he's responsible for a broad range of corporate activities, including development of corporate policies and programs, liaison with the Federal Government, management of UCAR's consortium of over 100 national and international universities, and UCAR (*http://www.ucar.edu*) funding raising, advocacy, and communications activities. UCAR is a $200M+ per year corporation with over 1,300 employees.

He is also the Director of UCAR's Office of Programs, responsible for overseeing a broad range of scientific and educational programs that serve the atmospheric and related research and education community, including building digital libraries (DLESE and NSDL), providing real time data to over 160 universities via the Internet (Unidata), training our nation's operational forecasters via distance learning and other media (COMET), and building a multi-national constellation of six micro-satellites to measure critical weather, climate, and space weather parameters (COSMIC), helping children around the world learn how to take and analyze environmental measurement (GLOBE), providing administrative and research services to the atmospheric science community (JOSS). These are all research, education, or technology programs that the research and education community have asked UCAR to manage based on its excellent management background and capability. UOP is $40M per year organization with over 400 employees.

Jack Fellows was awarded the Edward A. Flinn III Award in 1997. The Flinn Award is given to those individuals who personify the Union's motto "unselfish cooperation in research" through their facilitating, coordinating, and implementing activities.

Ms. GIFFORDS. Thank you, Dr. Fellows. Dr. Mahoney, please.

STATEMENT OF DR. JAMES R. MAHONEY, ENVIRONMENTAL CONSULTANT; FORMER ASSISTANT SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE, DEPUTY ADMINISTRATOR OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND DIRECTOR OF U.S. CLIMATE CHANGE SCIENCE PROGRAM

Dr. MAHONEY. Thank you, Chairwoman Giffords, and so, I address, of course, the entire panel, with Ranking Member Inglis in

particular, and I want to cite Mr. Udall, and the Chair of the main Committee, too.

I am delighted to have the chance to address you today, and I am a more recent veteran of these skirmishes, having spent four years in trying to make the interagency process work to a sensible outcome, so I associate myself very much with the comments that Dr. MacCracken made before, as well as those of Dr. Fellows just before me now.

I will mention one of them here again just as a highlight, so that it won't be necessary for me to turn to it in my own comments quite as much, and that is I also bring the message that I would urge the Committee, and at the end of the day, the Congress, to make a more explicit position about how this program should be managed. On one hand, that is, after all, a function of the executive branch. But it isn't a function of the executive branch only, to say that to be successful, a program like this must have a reasonably funded management and coordination office, with a sense of permanence to it, and that the budget lines brought forward through OMB, and ultimately, those that survive in the President's budget up here to the Hill, have to recognize this kind of program very directly.

One of the key weaknesses that I certainly observe in all the recent years is that there has been no move away from the concept that this is a program conducted in 13 parts by, now, 13 collaborating agencies, and with that view, they all must take—they must set their own priorities, and take them internally, and then up to OMB, and that leaves no place to really solidify the view about the priorities for the whole program.

So, if I were to give any one message to this committee, even recognizing the separation of powers, so that I wouldn't propose that the Congress ought to explicitly lay out chapter and verse of organization and management, but I think some guidance being given by the Congress would be very helpful, because it is a long-term battle, and it pained me a great deal to see the lack of progress that was made in a number of areas, because it wasn't possible to break through some of these problems along the way.

With that, let me press on to the rest of my comments very quickly here as well. Since the Chair already introduced us, I won't take any more time on that, and I will pass directly to the point that I have a series of comments, that I divide into three parts. One is some overall comments. The second is a set of comments on structure and resources for the program, and then, the third is some other suggestions, as well. In my overall comments, the first is perhaps the most important.

I certainly agree that the *Global Change Research Act of 1990* is ready for a significant update, and I certainly agree with the sense of the current draft bill, focusing on much more user interaction, much more assessment work and the like as part of that, so I simply applaud those efforts as, to my best lights, as being very much in place.

Second point, an overview, though, I want to raise the very important caution that we need to be careful that we don't just flip from one extreme to the other, in other words, that we don't deemphasize the science, to the point, by saying that what we need to

do is assessment and user interaction, which we must do, but if that all simply came at the expense of the underlying science, I would assert strongly that what we know now, yes, the question about human causation of global change is settled, but there are so many other very important science questions about regional impacts, abrupt climate change, and we could go on and make a list that would consume all the time here. So, what I would suggest that what the, hopefully the Congress, this committee first, and then, ultimately, the Congress would deal with in this, is something that recognizes the great need to pick up the user involvement, and get going on that kind of assessment work, but to mate that with this continuing strong commitment to the underlying science.

And then I, also, as an overview comment, cite back some of the areas where I see the benefit of the things the Committee, that this bill, the current train has brought along, the requirements for stakeholder involvement, the major emphasis on improved data management, and a clear mandate for developing policy analysis statements as a basis for understanding our climate information.

I would cite, somewhat in hindsight, that one of the reasons that the Climate Change Science Program was not able to address as much as it might have wanted of some of the underlying scientific information use questions was that there was no framework to put that against in terms of either one or more, or a set of policies that are worth examining. So, treating those things are a very good point.

Now, I will very quickly go to a close. I have got a comment on structures and resources. First of all, there is no specific funding mechanism, neither authorization, nor other guidance about approaches to funding in the bill, and I would commend that to your attention, given the great difficulty of making a long-term multi-agency program run. There continues to be a great need to assure the independence of the science. I think that is there in large part with the call for continued involvement with the National Academy. The Academy's involvement with the current program is now well in place under contract, and presumably, this bill will do nothing to take that out of place.

I look to see major OMB involvement in this activity, because it can't simply look at the pieces and the various lines, but it has to look at the program altogether, and as my colleagues have already commented, too, there is a clear need for the bill to say something directly about the importance of a coordination office, and its location in government, and its funding.

And then, just the last closing comments. I believe some of the timelines now set out in the bill, and the first year, in particular, are unrealistic. There is a call for five different reports to be done in the first year, and there is just no way. I would bet a dime and make $0.20 on my bet, that that would not happen in one year. So, I would suggest that you might want to take another look at phasing those somewhat.

Second, there is a need to call for a solid communication and education strategy in the bill, too, since this deals so much with user involvement with the information, yet there is still no call for that kind of communication capability, and that was absolutely the

poor orphan of everything we tried to do in recent years, so I would hate to see that get left off without any kind of mandate in the law, when this is done.

And finally, there is a need to coordinate the reports and output from this program with the international activities and other U.S. Government reporting activities in the climate area, too. Simply to say, as my very last point, since the IPCC, for example, which is just releasing its Fourth Assessment, and which will start a six-year process toward its Fifth Assessment, it would be helpful for the bill to recognize something that would alternate phase between the international assessments and the major reporting responsibilities in the states, because many of the same group of scientists, hundreds of U.S. scientists are involved in both of those activities. Many of them are the same people, and the quality is better if the pain is stretched out a little bit.

Thank you very much.

[The prepared statement of Dr. Mahoney follows:]

PREPARED STATEMENT OF JAMES R. MAHONEY

Chairman Giffords, Ranking Member Inglis and Members of the Subcommittee: thank you for your invitation to address the subcommittee today on the important issue of *"Reorienting the U.S. Global Change Research Program toward a user-driven research endeavor: H.R. 906."* I am James R. Mahoney, and I currently serve as an environmental consultant, providing scientific and professional advice to a number of organizations. From April 2, 2002 to March 30, 2006 I was Assistant Secretary of Commerce for Oceans and Atmosphere, and Deputy Administrator of the National Oceanic and Atmospheric Administration (NOAA). During this period I was also the Director of the U.S. Climate Change Science Program (CCSP), involving 13 federal agencies conducting and overseeing total annual budgets of approximately $2 billion dedicated to scientific research, Earth system observations, computer simulations of future climate conditions, and evaluation of possible adaptation and mitigation actions to address climate change. I reluctantly retired from my federal appointment approximately one year ago because of continuing significant health problems.

In 1966 I received the Ph.D. degree in meteorology from MIT, with a specialization in geophysical fluid mechanics. Since that time I have had over 40 years continuous experience in science-based environmental management, including service on the faculty of Harvard University, advisory assignments with national government agencies and international organizations in several regions of the world, extensive private sector environmental assessment and design work, and two appointed positions with the U.S. Federal Government (involving overall management of national acid rain studies from 1988 to 1991, and climate science studies from 2002 to 2006). A resume summarizing my experience follows this testimony.

In response to Chairman Lampson's letter of invitation, my testimony today provides my views about H.R. 906 from the specific perspective of my experience as Director of the U.S. Climate Change Science Program from 2002 to 2006. Also I make recommendations about other, supplementary issues that the Subcommittee may wish to consider during its continuing consideration of H.R. 906.

A. Overall comments:

1. **The Global Change Research Act of 1990 is in need of significant updating.** H.R. 906 is a good start. In its final version it would be helpful for the revised law to reflect the goal of expected significant improvements in the coverage and level of detail available in climate information, and to call for major upgrading of the expected uses of climate information (measurements, analyses and projections) for the development of **climate services,** which will be the principal actions expected to be undertaken by climate information users.

2. **A proper balance should be sought between ongoing climate research on the one hand, and developing assessments and decision support applications on the other hand.** H.R. 906 is on the right track in its emphasis on enhancing the importance of user initiatives and applications studies in the development of overall climate research planning. However, it would be highly dam-

aging to the international efforts to better adapt to, and mitigate the effects of, extreme climate phenomena if the support for exploratory research were deeply diminished prematurely. While an improved consensus about the core question of human-caused climate change has emerged in recent years, very little is currently well understood about many climate phenomena that pose great risks for a large number of human and ecosystem populations around the world. Examples of poorly understood current climate issues include, among others, abrupt climate change, regional variability of climate parameters, climate-ecosystem interactions, and the (new) levels of extreme weather conditions that may occur as a result of changes in global, regional, and local climate patterns.

3. **H.R. 906 appropriately addresses several requirements in the U.S. climate research program that currently need improved resources and activities.** These improvements (compared to the provisions of the 1990 Act, and compared to the practices that have emerged in the 17 years since the adoption of that Act) include (1) a more specific requirement for significant stakeholder engagement in research planning and in the use of the climate information being developed, (2) a clear requirement for sophisticated information management to address the massive amount of new climate data currently being collected, and the further expansion of these data sets that will come on line in the next few years, (3) a clear mandate to develop policy analysis methods capable of making appropriate use of the large investment in climate information.

A. Structure and Resource Comments:

1. **H.R. 906 does not specify a mechanism for funding the expanded program responsibilities envisioned in the bill.** A multiple-agency program is still the most effective approach, but more legislative structure would better clarify individual agency roles. The multiple-agency organization of the program makes sense, although there should be more careful delineation of roles between agencies that are predominantly research oriented (e.g., NSF, NASA, DOE, parts of NOAA) and those that are mission-oriented and thus key user stakeholders. This will streamline certain types of decision-making. A "user council" or similar body should be created and empowered to provide input on directions and also provide funding for user-oriented programs and products.

2. **There is a need to assure the independence of the science while providing for committed overview by the politically appointed management of the collaborating agencies.** The CCSP activities initiated in 2002, including the 10–Year Strategic Plan for CCSP published in July 2003, have provided a highly useful framework for all CCSP studies. It is now timely to reevaluate and update the major elements of the 2002–2003 research plan. Regular ongoing involvement of the National Academy of Sciences should be continued. This continuous review function has been placed under a long-term contract basis between CCSP and the Academy, and should be maintained.

3. **A stronger role for OMB should be mandated in H.R. 906 to facilitate budgetary coordination across the agencies.** CCSP has been reasonably successful in achieving interagency research coordination, but after the passage of five years it would be an appropriate time to assure the independence of the climate research program by providing for a direct role for OMB in the oversight of the multiple agency program.

4. **H.R. 906 should provide the program with two budget lines under the control of the interagency committee of the whole.** One set of resources would be used to fill gaps and generate new research thrusts that are difficult to support through individual agency mechanisms and for which there is a clear need. A second set of resources would be used to support regional or national assessment and decision support activities. These funds could be awarded on a competitive basis but would require a collective decision on the part of the interagency process to be released.

5. **The role of and funding for a coordination office should be explicitly included in the legislation.** This funding should not be taken out of research funding. The current practice of "taxing" research funds to support overall program coordination activities has historically resulted in under provision of resources for the coordination and management function. My experience over the past several years suggests that an adequately funded program coordination office is essential. With a growing emphasis on the coordination of assessments and decision support studies, even more "cross-cut" management will be needed, and the funds for this type of program integration must be assured.

B. Other Important Suggestions

1. **Unreasonable timetables are currently specified by H.R. 906.** The current draft bill calls for five separate reports to be completed within one year of enactment. These include a new strategic plan, a policy review, a vulnerability assessment, a data management plan, and an annual report. Given the need for extensive multiple-agency drafting and review actions, as well as other reviews by user groups and the scientific community, in my view it will be impossible for the program to produce quality documents in all of the specified categories within a one-year time frame. I suggest that the time for delivery of this first set of information be extended over two years or more.
2. **An overall communications strategy should be included in H.R. 906.** Based on my personal experience as Director of the National Acid Rain Assessment Program in the late 1980's and as Director of CCSP for four years recently, I earnestly recommend that responsibilities for communication and education activities be incorporated into H.R. 906. Without a clear mandate for such activities, it is almost impossible to obtain approval for communications and education activities in the President's budget. And without support for communications and education activities, the efficiency of transmitting climate change information to potential users throughout the Nation will be seriously diminished.
3. **The assessment reporting requirements in H.R. 906 should be coordinated with other national and international climate reporting cycles already established.** The IPCC Fourth Assessment is currently being completed, and will likely be followed by a Fifth Assessment six years later (i.e., in 2013). During approximately a two-year period of drafting and review for the IPCC assessment, the U.S. climate science community will be heavily engaged in the IPCC international assessment. I recommend that the summary assessments specified in H.R. 906 be placed on a six-year schedule (at least after the first edition), and the schedule for the U.S. assessments be offset by approximately three years form the delivery dates for the IPCC reports.

I trust my suggestions offered here may be useful to the Subcommittee, and I would be pleased to respond to any questions that you may have. Thank you.

BIOGRAPHY FOR JAMES R. MAHONEY

Education

LeMoyne College, Syracuse, NY: B.S., Physics, *Magna cum Laude,* 1959

MIT, Cambridge, MA: Ph.D., Meteorology, 1966

Professional Experience

2002–2006 (March): Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy Administrator of the National Oceanic and Atmospheric Administration (NOAA). Also served throughout this period as Director of the U.S. Climate Change Science Program, involving the combined work of 13 federal agencies with an annual program budget of approximately $2 billion.

1999–2002 (March): Environmental management consultant serving U.S. and international clients. Topics included insurance recovery for environmental damages, and technical analysis of regional air quality and haze patterns.

1991–1999 (July): Senior Vice President of International Technology Corporation, a $1+ billion international engineering and construction company pursuing a broad technical specialty environmental business, combined with field construction activity dealing with restoration of contaminated soil and ground water. From 1997 to 1999 also served as President of the Consulting and Engineering Division of the corporation, responsible for a $200+ million technical business. Also from 1997 to 1999 served as Chairman of the Board and responsible corporate officer for Landbank, Inc., a wholly owned subsidiary addressing the brownfield market by restoring and redeveloping contaminated commercial property sites.

1988–1991 (January): Director of the National Acid Precipitation Assessment Program (NAPAP) involving six federal agencies with a combined federal budget of approximately $100 million annually. The position was in the Executive Office of the President, during the final year of the Reagan administration and during the first two years of the administration of President George H.W. Bush.

1987–1988 (February): Environmental management consultant serving U.S. and international clients. Topics included environmental management government orga-

nization planning for Saudi Arabia, and environmental permitting issues for large Kraft paper plants.

1984–1987 (February): Manager of the Environmental Industries Center of the Bechtel Group, Inc. The Environmental Industries Center addressed environmental compliance, planning and engineering matters for Bechtel's major domestic and international clients.

1983–1984 (January): Environmental management consultant serving U.S. and international clients. Topics included strategic planning for a large environmental engineering firm, and comparative studies of international environmental regulations.

1968–1983 (September): Co-founder and Senior Vice President of Environmental Research & Technology, Inc. (ERT). ERT began as a start-up in December 1968 and by the late 1970's it had grown to become the largest environmental specialty firm in the United States, with offices and laboratories located throughout the United States combined with a substantial international business operating in several countries in both the developed and developing world. Also served as President of ERT International, Inc., a wholly owned subsidiary responsible for ERT's international business from 1975 until 1983.

1966–1973 (June): Assistant Professor and Associate Professor (from July 1970) in the School of Public Health at Harvard University, specializing in environmental health management. During the period from December 1968 through June 1973 I served in two positions: the faculty position at Harvard and the Senior Vice President position at ERT, Inc. (see above).

1962–1965 (December): Graduate research assistant in the Department of Meteorology at MIT.

1959–1962 (June): Graduate student at MIT, supported by fellowship grants.

1956–1959 (June): Laboratory assistant and lecturer in the Physics Laboratories at LeMoyne College.

Honors

2006: Awarded the U.S. Department of Commerce William C. Redfield Award for outstanding public service, presented by Commerce Secretary Carlos M. Gutierrez.

2002: Confirmed by the U.S. Senate (following nomination by President George W. Bush) to be Assistant Secretary of Commerce.

1990: Elected as a Fellow of the American Meteorological Society.

1990: Awarded the U.S. Department of Commerce Gold Medal for outstanding accomplishments as Director of the National Acid Precipitation Assessment Program, presented by Commerce Secretary Robert A. Mosbacher.

1989: Elected as President of the American Meteorological Society.

1985: Selected as one of a group of four inaugural Bechtel Fellows from a worldwide population of 100,000+ Bechtel employees.

1973–2006: Served as member and co-chair of several committees and boards of the U.S. National Academy of Sciences.

1959: Selected as a Danforth Graduate Fellow in a national competition among college seniors.

1955: Valedictorian of high school graduating class (Christian Brothers Academy of Syracuse, NY).

Ms. GIFFORDS. Thank you, Dr. Mahoney. Mr. Nutter, please.

STATEMENT OF MR. FRANKLIN W. NUTTER, PRESIDENT, THE REINSURANCE ASSOCIATION OF AMERICA; MEMBER OF UCAR'S BOARD OF TRUSTEES

Mr. NUTTER. Madam Chair, Members of the Committee, thank you. It is an honor to appear before you.

Reinsurance is essentially the insurance of insurance companies. Insurance companies traditionally lay off risk, particularly catastrophe risk, notably extreme weather events to the reinsurance market.

No financial services business is more dependent on the vagaries of climate and weather than property and casualty insurers. The industry is at great risk if it does not understand climate change variability, and the severity and frequency of extreme events. Understanding global climate change and integrating that information into the insurance system is an essential part of addressing climate extremes, and conveying information to governments and the public about the economic consequences of human activity in the face of a changing global climate.

We believe that the enactment of H.R. 906, with an increased emphasis on input to government climate research by user communities such as ours, will greatly enhance adaptation and response to the effect of climate and of global change. The industry looks at climate change largely through the prism of the catastrophe losses that it pays. The General Accounting Office just released a report that from 1980 through 2005, private insurers and federal insurers, meaning the National Flood Insurance Program and the Crop Insurance Program, paid $320 billion in claims on weather-related losses. The insurance industry paid two-thirds of those losses. 2005 alone produced a record year. Total global insured catastrophe losses were $83 billion, 80 percent of which were U.S. landfalling hurricanes.

As bad as those numbers, AIR Worldwide estimates that insured losses from natural catastrophes could be expected to double roughly every ten years. With respect to the impact of climate change alone, fixing everything else in place, the Association of British Insurers concludes that the average annual losses from three major storm types affecting insurance markets, that is U.S. hurricanes, Japanese typhoons, and European windstorms, could increase by two-thirds by the 2080s. Climate change could increase wind-related insured losses from extreme U.S. hurricanes by about three quarters, the equivalent of two to three Hurricane Andrews annually. The ABI advises that these loss estimates do not include likely increases in society's exposure to extreme storms due to growing wealthier populations and increasing assets at risk. These are their assessments based upon the impact of climate change.

The catastrophe modeling firm Risk Management Solutions advises that financial losses from weather-related catastrophes have increased by an average of two percent per year since the 1970s, with climate change as a major factor, even when inflation, changes in wealth and population, are taken into account.

It is quite clear that there are several factors affecting the losses associated with extreme events, including population growth in high risk areas, certainly people moving to those areas, the dramatic increases in insured coastal values, the insurance industry's own expansion of coverage, climate change, and the incidence of more intense extreme events.

We believe that H.R. 906, with greater emphasis on basic climate research, coordination among sponsoring government agencies, improved integration of user needs into the research agenda, and access to climate data will enhance risk assessment, and lead to improved insurance markets.

In this regard, our sector needs science-based business intelligence. A key component of the Global Climate Change Research

Program is observation technologies. It will be critical to our ability to provide insurance markets that climate and weather data through observation capabilities be maintained.

Perhaps the most relevant aspect of the insurance industry, with respect to science assessment and extreme events, is the use of catastrophe models. These models incorporate scientific assumptions about climate trends and the probability of future events, then produce estimates of prospective costs associated with these events.

In the context of the Global Climate Change Research Program and its reauthorization pursuant to H.R. 906, our industry would benefit from enhanced research on historical extreme events, particularly those which predate satellite technology. Climate research which addresses the effect of climate change on the frequency and intensity of extreme events would be of great value. Additionally, the consequences of climate change on extreme weather regionally would improve insurer adaptation strategies.

A key component of this agenda, again, are observation capabilities. Our industry is taking steps to adjust to climate change, even though there is no insurance policy that covers climate change. It is our belief that H.R. 906 will be of great value in improving our capability. Insurers are in the business of assessing risk, pricing it, and providing financing or risk transfer. Its long-term strategy, however, does not include bearing the costs of climate change without a commitment on the part of society to pursue a mitigation strategy addressing both the causes and consequences of climate change.

H.R. 906 is to be commended as placing greater weight on basic research, that emphasizes user needs, and maintains or enhances observation capabilities, the coordination of research with the global research community, as well as private sector resources.

Thank you very much.

[The prepared statement of Mr. Nutter follows:]

PREPARED STATEMENT OF FRANKLIN W. NUTTER

Chairman Lampson, Ranking Member Bartlett and Members of the Subcommittee on Energy and Environment:

My name is Frank Nutter and I am President of the Reinsurance Association of America (RAA). It is an honor to appear before you on behalf of the RAA. The RAA is a national trade association representing property and casualty organizations that specialize in assuming reinsurance. Together, RAA members and affiliates write over 70 percent of the reinsurance coverage provided by U.S. property and casualty reinsurers and affiliates.

No financial services business is more dependent on the vagaries of climate and weather than property and casualty insurers. The industry is at great risk if it does not understand global climate variability and the severity and frequency of extreme events. It must be more than a pass-through mechanism for the costs associated with natural disasters. Understanding global climate change and integrating that information into the insurance system is an essential part of addressing climate extremes and conveying information to governments and the public about the economic consequences of human activity in the face of changing global climate.

We believe that the enactment of H.R. 906, the *Global Climate Change Research Data and Management Act of 2007,* with an increased emphasis on input to government climate research by user communities will greatly enhance adaptation and response to the effects of global change.

Climate and Catastrophes

The General Accounting Office reports that from 1980 through 2005 private and federal insurers paid $320 billion in claims on weather related losses. The insurance industry paid two-thirds of those losses. The number of insured natural catas-

trophes has doubled since 1990; the insured losses in this decade already exceed the decade of the 1990s. The year 2005 alone produced a record: total global insurer catastrophe claims were $83 billion, 80 percent of which were from U.S. land-falling hurricanes. Even 2006, thought of as a benign catastrophe year, produced 43 insured loss catastrophes in North America out of a global total of 349. Although some of these catastrophes are earthquake related, over 90 percent of events causing damage to people and property originated in the atmosphere. Almost 12,000 people lost their lives to storms and floods in 2006. AIR Worldwide estimates that insured losses from natural catastrophes should be expected to double roughly every ten years due to increases in construction costs, increases in the number of structures and changes in their characteristics.

With respect to the impact of climate change, the Association of British Insurers concludes as follows:

- Average annual losses from the three major storm types affecting insurance markets (U.S. hurricanes, Japanese typhoons and European windstorms) could increase by two-thirds by the 2080s.
- Focusing on the most extreme storms (losses with a probability of occurring once every 100 to 250 years), by the 2080s climate change could:
  - — Increase wind-related insured losses from extreme U.S. hurricanes by around three-quarters (the equivalent of two to three Hurricane Andrews annually).
  - — Increase wind-related insured losses from extreme Japanese typhoons by around two-thirds. The increase alone would be more than twice the cost of the 2004 typhoon season, the costliest in the last 100 years.
  - — Increase wind-related insured losses from extreme European storms by at least five percent.
  - — Increase the annual costs of flooding in the UK almost 15-fold.
- Under high emissions scenarios, insurers' capital requirements could increase by over 90 percent for U.S. hurricanes, and by 80 percent for Japanese typhoons. Higher capital costs combined with greater annual losses from windstorms alone could result in premium increases of around 60 percent in these markets.

The ABI advises that these loss estimates do not include likely increases in society's exposure to extreme storms, due to growing, wealthier populations, and increasing assets at risk.

Financial losses from weather-related catastrophes have increased by an average of two percent per year since the 1970s, with climate change a major contributing factor, according to the chief researcher of catastrophe modeler Risk Management Solutions, Inc. The rate of loss increase holds true even when inflation, changes in wealth and population growth are taken into account. In its latest climate change report, Rapid Climate Change, Lloyd's of London warns that waiting on "definitive scientific pronouncements" on the impact of climate change "seems like an increasingly risky strategy."

The causes behind the dramatic rise in insured catastrophe losses are several:

- Population growth in high-risk areas. Dramatic increases in high risk coastal areas suggest people and local governments have placed too little emphasis on exposure to weather risk in a changing climate environment.
- Dramatic increases in insured coastal values. Florida now has nearly $2 trillion of insured coastal properties. New York has $2 trillion, Louisiana $209 billion and South Carolina $149 billion.
- The insurance industry's own expansion of coverage which had the effect of increasing potential insured damage; deductibles were lowered and full replacement cost added to homeowners' policies in the period 1970–1990. Government policy, which either endorsed weak building codes or failed to enforce existing building codes and which has facilitated development in high risk areas. Recent State government initiatives are encouraging however.
- Climate change and the incidence of more intense extreme events. Munich Re's Geo-Science Department has concluded that the proportion of severe storms has risen and that of moderate storms has fallen. Three of the ten most intense storms ever recorded in North America were in 2005.

The Insurance Industry's Financial Interest

The insurance industry's financial interest is inter-dependent with climate and weather. It is the risk of natural events which drives the demand for insurance coverage and yet, if not properly managed, can threaten the viability of an insurer if it is over-exposed in high risk areas. An insurance company thrives or dies on its ability to make estimates of the economic consequences of future events.

We believe pursuant to H.R. 906, greater emphasis on basic climate research, coordination among sponsoring government agencies, improved integration of user needs into the research agenda, and access to climate data will enhance risk assessment by insurers and lead to improved insurance markets.

Insurance and Science

Although a number of European insurers and reinsurers have shown greater interest in understanding the causes of climate change, including the impact of global warming, U.S. insurers have been more focused on the effect of natural disasters. Thus, the U.S. industry has been more attentive to approaches to mitigate the consequences of natural catastrophes and other extreme events. Some European insurers have called upon their governments to reduce the human factors they believe contribute to global warming. In the U.S., the industry's agenda includes the evaluation of building codes and building code enforcement in every community in the country. Additionally, through the Institute for Business & Home Safety, the U.S. industry has greatly enhanced its support for hazard mitigation by conducting research on building design and building materials. Improved research on the likely impact of climate change on extreme weather and the built environment will improve society's hazard mitigation adaptation.

The initiative most related to science and scientific assessment of global climate change is the use of catastrophe computer models to integrate scientific knowledge about climate into the actuarial sciences. These catastrophe models incorporate scientific assumptions about climate trends and the probability of future extreme events and then produce estimated prospective costs associated with natural catastrophes. They assist an insurer with an analysis of its potential exposure and are used to support rates filed for approval with insurance departments. It is the classic example of using insurance to translate scientific analysis and data into the economic consequences of people's behavior, i.e., where they live and the value and potential loss of properties in those areas. The pure result of the use of catastrophe models is the application of risk-based premiums and the understanding of aggregate exposure for insured property.

In the context of the Global Climate Change Research Program and its reauthorization pursuant to H.R. 906, the industry would benefit from enhanced research on historical extreme events; particularly those which pre-date satellite technology. Climate research which addresses the effect of climate change on the frequency and intensity of extreme weather would be of great value. Additionally, the consequences of climate change on extreme weather regionally would improve insurer adaptation strategies.

Insurance Related Adaptive Product Strategies

Although insurance often covers damages from climate related events, there is no insurance policy with specific coverage related to climate change. Insurers and brokers have however announced the development of several climate related financial products:

- Carbon emissions credit delivery guarantees providing coverage for non-delivery of credits due to project insolvency, political and investment risk, operational problems (Marsh)
- Insurance for one-third of waste to energy plants and one-quarter of wind farms (Lloyd's of London)
- A risk financing product that facilitates trade by companies that participate in global trading of emissions credits (an options contract) (Swiss Re)
- A financial product that provides a buyer for carbon credits in the secondary market if the primary buyer fails to deliver (Munich Re)
- Directors and officers liability coverage for failure to address corporate compliance with government regulations (Swiss Re)
- New risk transfer products for weather related damages: "Cat Bonds" ($5 billion were issued in 2006, $30 billion since 1996); weather derivatives ($45 billion in notional value in 2005–6)
- Exchange traded weather securities (Chicago Mercantile Exchange and the New York Mercantile Exchange with Gallagher Re (2007))

Industry observers also note that, as an adaptive strategy, insurers should focus research on energy efficient technologies that have the potential to reduce ordinary insured losses. They also encourage the development of insurance products with premium discounts that reward safety enhancing energy efficiency. In addition, the industry has been encouraged to increase in its investment portfolio energy efficiency oriented investments.

In a world where "reducing carbon dioxide emissions from a high to a low scenario would reduce the impact on losses and insurers' capital requirement for extreme windstorms by 80 percent" (Association of British Insurers), the industry is showing signs of initiative to address carbon related climate concerns. AIG recently (April 2007) joined as the first insurer in the U.S. Climate Action Partnership (CAP), whose goal is a U.S. cap and trade system. Prudential Financial and Hartford Financial Services have agreed to disclose to shareholders the potential financial risk they face from climate change (April 2007). Swiss Re set a target of being greenhouse neutral in its business operations by 2013.

Conclusion

Insurers are in the business of assessing risk, pricing it and providing risk financing or transfer. The insurance industry's long-term strategy, however, does not include bearing the cost of climate change without a commitment on the part of society to pursue a mitigation strategy—addressing the causes and consequences of climate change. H.R. 906 is to be commended as placing greater weight on basic research that emphasizes user needs and priorities and the coordination of research with the global research community, including public, academic and private resources.

BIOGRAPHY FOR FRANKLIN W. NUTTER

Frank Nutter has been President of the Reinsurance Association of America (RAA) since May of 1991. He held the same position with the RAA from 1981–1984.

In the interim, he was President of the Alliance of American Insurers and the Property Loss Research Bureau, which have now merged to be part of the PCI (Property Casualty Insurance Association of America).

Mr. Nutter currently serves on the Board of Trustees of the Bermuda Biological Station for Research; the Board of the International Hurricane Center; the Advisory Board of the Center for Health and the Global Environment, an adjunct to the Harvard University Medical School; and the Board of the University Center for Atmospheric Research, a consortium of universities funded primarily by the National Science Foundation. He currently serves on the Advisory Board of the OECD's International Network for the Financial Management of Large Scale Disasters.

Mr. Nutter has a Juris Doctorate from the Georgetown University Law Center and a Bachelor's degree in economics.

Ms. GIFFORDS. Thank you, Mr. Nutter. Gentleman, I think probably the best plan would be to go to Dr. Mote. We have 15 minutes to get to the Floor to vote, and if we can keep your testimony, again, to five minutes, then we will recess, and hopefully, see you all back after—we have a series of votes, so we can't split the group up, and have half go, and half come back.

So, Dr. Mote, we will go to you, and then, we will recess, and come back afterwards.

STATEMENT OF DR. PHILIP W. MOTE, CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON; OFFICE OF WASHINGTON STATE CLIMATOLOGIST AND AFFILIATE PROFESSOR AT THE UNIVERSITY OF WASHINGTON

Dr. MOTE. Thank you, Madam Chair and Members of the Committee, for your interest in climate monitoring research and applications. I am Philip Mote, and I am a research scientist.

I am involved in the Pacific Northwest Climate Impacts Group which, since 1995, has been articulating how climate influences natural resources, not just climate change, but climate variability. And we have also made great strides in discussing these findings

with natural resource managers, getting their perspective, what they need, and what information they need from us. So, I have been on both sides of, you know, doing basic science research, and also, more applied science. The Climate Impacts Group is one of eight regionally funded teams funded by NOAA's Regional Integrated Sciences and Assessments Program. Unfortunately, the whole country is not covered or served by RISA programs.

As the science of climate variability and change has advanced tremendously since 1990, so too have the societal demands for information about climate and what it means locally. Some examples of how climate has advanced: climate models now consist of elaborate components that simulate the ocean and sea ice, land surface, biosphere, carbon cycle, as well as the atmosphere, and our regional models are now capable of simulating climate in great deal regionally. And there is, in fact, a program underway called NARCCAP, the North American Regional Climate Change Assessment Program, which is combining regional climate modeling for the whole country, coordinated by the National Center for Atmospheric Research.

There have also been tremendous advances in paleoclimate, our ability to use tree rings and other so-called proxies to understand climate over timescales of hundreds to thousands of years, that provide the context for understanding our current climate and possible future climate.

Let me give you some examples of information that stakeholders have sought from the Climate Impacts Group or from the Office of Washington State Climatologists. Water utilities around the Northwest are factoring in climate change to long range plans, so they want to know what are the probable changes in temperature, precipitation, snowmelt, streamflow, so that they can incorporate that, as well as population and demand changes, into their plans and their policies.

The Northwest Power and Conservation Council wanted very detailed streamflow estimates for future decades, so that they could calculate changes in hydropower production from the Columbia River basin, and the hydropower dams there. The U.S. Army Corps of Engineers is starting to think about what does it mean to change flood control rule curves that govern reservoirs, given that there has already been an observed shift of two weeks in the spring snowmelt. There is no policy that currently would allow them to make that move, but for starters, they need good, detailed information. A natural gas utility wanted help demonstrating to the state Utilities and Transportation Commission that warming trends have rendered obsolete the old assumption of constant climate by which their rates are set.

So, a regional and State level focus is very valuable for connecting with these stakeholder needs, and providing climate services. In a number of respects, a national level effort, a National Climate Service, is needed, that would take the basic research that is provided by modeling centers and analysis, and translate into stakeholder needs.

National level expertise in climate science can provide the highest quality, most comprehensive information about patterns of climate variation and change, both from the past and from future

modeling. Such expertise can be brought to bear on problems that may be too difficult for a single regional group to solve. For example, to properly construct probabilistic scenarios of future climate change at a given location would ideally involve evaluating scenarios from tens of climate models against the observed record of the 20th Century, and then weighting their projects of future change according to how well they did with the past. This is a task that is both computationally and conceptually probably too challenging for a regional team like ours to undertake.

Another challenge would be the construction of sea level rise scenarios, factoring in not just global sea level rise, but local relative land movements, obviously of great concern in the tourist-friendly beaches of South Carolina, which I had the good fortunes to visit a year or two ago. All of these things, all these types of information are needed on very fine local scales, and can be provided by a comprehensive national effort.

Finally, a word about the unglamorous topic of monitoring the climate, which H.R. 906 rightly addresses. As numerous reports by the National Research Council and others have documented, the Nation's various observing networks and, notably, the cooperative observer network that forms the backbone of long-term weather observations, and the streamgauge network of the U.S. Geological Survey, are slowly dwindling in coverage and, in some cases, quality. A vigorous effort is urgently needed to preserve these networks as our primary source of information for documenting the changes in our environment and our climate over the 20th Century and into the 21st Century, in order to understand how best to cope with these changes. The American Association of State Climatologists calls on the 110th Congress to rescue these networks from decline.

Finally, a National Climate Service, with high level buy-in from the Administration and the various agencies would serve the needs for climate information of a wide spectrum of private and public sector entities, and H.R. 906 points us in that direction.

[The prepared statement of Dr. Mote follows:]

PREPARED STATEMENT OF PHILIP W. MOTE

Summary

As the science of climate variability and change has advanced and as public awareness of its implications for natural resource management and economic activity has grown, demands for climate information have rapidly exceeded the capacity of experts. Significant federal investment is needed in a National Climate Service to match these growing needs. H.R. 906 aims in that direction by calling for improved direction of federally funded climate research.

Regional focus

For several reasons, a regional focus on research and delivery of climate information is appropriate. First, economic and natural resources emphases differ starkly from region to region, and in some cases are organized regionally (for example, the Northwest Power and Conservation Council). Second, a regional focus matches regional decision-makers and regional scientists whose very proximity permits sustained interactions, understanding, and trust to develop.

NOAA's Climate Program Office meets some needs for climate information by leading and funding efforts such as the Regional Integrated Sciences and Assessments (RISA) program. RISA projects point the way toward a new paradigm of stakeholder-driven climate sciences that directly address society's needs and concerns.

The RISA program began with university-based efforts in regions of the United States where recent advances in integrated climate sciences held the greatest promise to assist decision-making. Much of the first-generation RISA success built on

breakthroughs in predicting variability, change, and impacts of climate processes occurring in the tropical Pacific Ocean. This is the area where El Niño and La Niña conditions, which affect much of the western and southern United States, as well as Mexico, originate.

RISA scientists provide information that decision-makers can use to cope with drought, understand climatic influences on wildfire, and assess climate impacts on the transportation sector, coastal communities and human health. Stakeholders can use such information to evaluate potential climate change impacts on water supplies and hydroelectric power and support disaster management planning. RISAs are helping farmers, ranchers, and fishermen use climate information to produce the Nation's foods and fibers, and Pacific Islanders to figure out how to weave climate information into their quest for sustainability.

With each passing year, the impacts of climate variability and change on water availability, wildfire regimes, public health, agriculture, energy issues, and coastal communities become more acute. At the same time, climate sciences are making great strides in producing knowledge that could aid decision-makers dealing with these issues.

University of Washington's Climate Impacts Group (CIG) was the first project funded by RISA's predecessor, in 1995, and there are now a total of eight regional projects. CIG has developed close connections with the public, private, and North American tribal groups and agencies responsible for managing the region's water, forest, fishery, and coastal resources in order to ensure that our research results in information and products that are not only useful, but also used to shape decisions in the PNW. As a result of this interaction, CIG has gained a clear picture of the current use and perceived value of climate forecasts by natural resource managers, insight into their decision calendars, and an understanding of institutional barriers to adaptability. Stakeholders benefit from the development of improved tools and information for planning, such as resource forecasts and regional- and resource-specific interpretations of global climate change. Members of CIG's stakeholder community are listed in Appendix A. A sustained regional focus over the course of more than a decade has allowed deep two-way interactions to develop, with scientists learning from natural resource managers and vice versa toward a shared goal of improving resilience to climate variations and change.

In addition to regional focus, the Nation's State Climatologists serve their respective states. While the primary focus of most State climatologists is delivering weather and climate data, many also develop higher-level products in response to stakeholder needs, for example, specialized tools for drought monitoring.

National expertise, sectoral focus

While regional- and State-level focus is a critical part of climate services, in a number of respects a national-level effort is also needed. National-level expertise in climate science can provide the highest-quality, most comprehensive information about patterns of climate variation and change. Such expertise can be brought to bear on problems that may be too difficult for a single regional group to solve. For example, to properly construct probabilistic scenarios of future climate at a given location would ideally involve evaluating tens of scenarios from global climate models and weighting them appropriately according to their fidelity at simulating past climate, a task that is both computationally and conceptually challenging. Another example would be the construction of probabilistic sea level rise scenarios accounting for global sea level change, local relative land motions, possible contributions from changes in atmospheric circulation, etc. Finally, as the Federal Emergency Management Agency undertakes the redrawing of food plain maps nationwide, a thorough probabilistic assessment of the possible changes in food risk associated with climate change could best be accomplished by a national-scale effort.

Preserving observation networks

As numerous reports by the National Research Council and others have documented, the Nation's various observing networks and notably the Cooperative Observer Network are slowly dwindling in coverage and quality. An urgent effort is needed to preserve these networks as a legacy for future generations and as our primary source of information for documenting the changes in our environment and our climate, whether these changes be natural or man-made. See also the attached letter from the American Association of State Climatologists.

Why undertake a new National Assessment

In the roughly ten years since the first National Assessment was begun, the science of climate change has advanced immensely. Atmospheric general circulation models (AGCMs) have been replaced by climate system models that simulate also the ocean, land surface processes, sea ice, and even components of the biosphere and

carbon cycle in tremendous detail. Hundreds of simulations have been performed with these models describing the evolution of the climate from 1900 to 2100, allowing comparisons with past climate and projections of future climate. Attribution of climate change to human activity can now be performed not just for globally averaged temperature but for sub-continental temperature changes and also for changes in other, more societally-relevant climate variables. Paleoclimate research has dramatically improved our understanding of past climate variability and change. Finally, regional climate modeling has also advanced, permitting much higher resolution simulations and better information over complex terrain such as the mountainous West. A comprehensive effort at regional modeling is underway, called North American Regional Climate Change Assessment Program (NARCCAP), coordinated by the National Center for Atmospheric Research.

In addition to significant advances in the science, a second reason to undertake a new National Assessment is that attitudes toward climate have advanced. Officials with federal, State, regional, local agencies, private companies, consultants, and others, are wondering how to incorporate the best information about climate change into plans, policies, and reports. Members of RISA teams, like the Climate Impacts Group, are straining to meet the demands for information. These requests come to CIG in the form of specific questions, requests for academic papers, requests for data including detailed probabilistic climate scenarios, in-person presentations at the rate of about 150/year, media interviews, analysis of climate variables, explanations of or comments on controversial points, and requests to review reports, web sites, and the like. These questions can be answered in limited fashion by the existing network of RISA programs and State climatologists.

Far better would be to match national capabilities in science research with regional and sectoral needs for climate information, especially if a national assessment led to creation of a National Climate Service that included additional regional teams covering areas of the country not currently served by the RISA program. These capabilities were suggested in the President's Climate Change Science Program, in which one of the goals was Decision Support, but few resources were devoted to making decision support a reality.

Tasks to create a National Assessment and National Climate Service

Creating new regional teams and strong sectoral assessment capabilities would require significant agency investment not just in dollars but in effort and time. A thorough assessment would require tens of millions of dollars per year, scaling up the funds that support the existing eight regional assessment teams in the RISA program to a comparable effort that would serve the entire Nation geographically and in addition would create sectorally based assessment efforts. As was learned in the first national assessment, substantial effort is required to get federal agencies to work together for a common purpose. Finally, the timeline should be at least three years from the availability of funding to the delivery of a report. This amount of time is required to constitute new teams, forge partnerships between key stakeholders and scientists, and write and peer-review a set of reports.

Beyond the production of a report, the National Assessment should catalyze the creation of networks for delivering useful climate information and reducing societal vulnerability to climate variation and change. A useful prototype of such a network is the National Integrated Drought Information System, which seeks to combine the skills and resources of federal agencies in producing timely drought analysis and warnings, and in finding ways to reduce societal vulnerability to drought.

Appendix A

Stakeholders of UW's Climate Impacts Group

Local level

City of Tualatin, Oregon
King County, Washington
Local watershed planning units
Portland Water Bureau
Puget Sound Clean Air Agency
Seattle City Council
Seattle City Light
Seattle Public Utilities
Tacoma Power and Light
Thurston County, Washington

State Level

Alaska Department of Fish and Game
California Department of Water Resources
Idaho Department of Water Resources
Oregon Department of Agriculture
Oregon Department of Land Conservation and Development
Oregon Department of Water Resources State Governor's Offices (Washington, Oregon, Idaho)
State Legislatures (Washington, Oregon, Idaho)
Washington Department of Agriculture
Washington Department of Ecology
Washington Department of Fish and Wildlife
Washington Department of Health
Washington Department of Natural Resources
Washington Division of Emergency Management
Washington State Office of Financial Management

Regional or Federal Level

Bonneville Power Administration
International Pacific Halibut Commission
National Marine Fisheries Service [Northwest Fisheries Science Center and the Alaska Fisheries Science Center]
National Oceanic and Atmospheric Administration, River Forecast Center
National Park Service
U.S. Army Corps of Engineers
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Congress, PNW delegation
U.S. Department of Agriculture, Natural Resource Conservation Service
U.S. Department of Energy, Pacific Northwest National Laboratory
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geologic Survey

Tribal

Columbia River Inter-Tribal Fish Commission
Northwest Indian Fisheries Commission

Other

BC Hydro (British Columbia, Canada)
Idaho Power Company
National Wildlife Federation
North Pacific Fisheries Management Council
Northwest Power and Conservation Council
Oregon State University, Coastal Impacts
PNW news media (print and broadcast)
Puget Sound Energy
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An approach to designing a national climate service

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Climate variability and change are considerably important for a wide range of human activities and natural ecosystems. Climate science has made major advances during the last two decades, yet climate information is neither routinely useful for nor used in planning. What is needed is a mechanism, a national climate service (NCS), to connect climate science to decision-relevant questions and support building capacity to anticipate, plan for, and adapt to climate fluctuations. This article contributes to the national debate for an NCS by describing the rationale for building an NCS, the functions and services it would provide, and how it should be designed and evaluated. The NCS is most effectively achieved as a federal interagency partnership with critically important participation by regional climate centers, state climatologists, the emerging National Integrated Drought Information System, and the National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences Assessment (RISA) teams in a sustained relationship with a wide variety of stakeholders. Because the NCS is a service, and because evidence indicates that the regional spatial scale is most important for delivering climate services, given subnational geographical/geophysical complexity, attention is focused on lessons learned from the University of Washington Climate Impacts Group's 10 years of experience, the first of the NOAA RISA teams.

Pacific Northwest climate | regional integrated sciences and assessments

The last 20 years have seen exciting advancements in climate science, from seasonal forecasting to understanding anthropogenic climate change. Equally exciting is the growing awareness in scientific and resource management communities of the opportunities and challenges presented by these scientific advancements. Capturing the full potential of this increasing synergism between the producers and users of climate information, however, requires more than can be provided by existing institutional arrangements. What is needed is a sustained mechanism for promoting science to support decision-relevant questions, translating new climate information into relevant decision environments, and building regional and national capacity to anticipate, plan for, and adapt to climate variability and change. What is needed is a national climate service (NCS).

An NCS identifies, produces, and delivers authoritative and timely information about climate variations and trends and their impacts on built and natural systems on regional, national, and global space scales. This information informs and is informed by decision making, risk management, and resource management concerns for a wide variety of public and private users acting on regional, national, and international scales. Such a service does not yet exist in the United States despite the need having been recognized more than 20 years ago [informal discussions within the National Oceanic and Atmospheric Administration (NOAA) about creating a national climate service began in the early 1980s]. However, designing and implementing a climate service can no longer be debated casually. Natural climate variations bring increasingly costly impacts, and research repeatedly indicates that it is cheaper to prepare for climate events that have negative consequences than to react to the consequences of those events (1).

This article enhances the national discussion on an NCS by posing and answering five questions. (*i*) Why build an NCS? (*ii*) What is an NCS? (*iii*) What functions and services should an NCS provide? (*iv*) How should an NCS be designed? (*v*) How should an NCS be evaluated? The article uses the decade-long (1995–2005) experience of the Climate Impacts Group (CIG) at the University of Washington to provide insight into the design and function of an NCS and to highlight the effectiveness of regionally based production and delivery of climate information. In this article, "climate information" includes statistical descriptions of climate; "climate forecasts" are forecasts of the future state of the atmosphere and oceans (derived primarily from the evolving state of the tropical Pacific); and "climate scenarios" are long-term (multidecadal) projections of future climate based on predictions of greenhouse gas concentrations. "Climate variability" refers to natural seasonal to decadal variations in climate, whereas "climate change" refers to human-induced changes in climate as a result of increasing greenhouse gas concentrations.

Why Build an NCS? Weather and climate are clearly important for human activities and natural ecosystems. Between 1980 and 2005, the United States saw 66 extreme weather and climate events costing at least $1 billion each, with total inflation adjusted losses of >$500 billion.[†] The trend in actual damages has been increasing steeply, largely because of increasing human exposure, with a single storm, Hurricane Katrina (2005), causing >$100 billion in costs/damages and >1,200 fatalities (2, †).

Climate forecasts create opportunities for society to prepare, potentially reducing the costs of climate-related events. The impacts of the 1997–1998 El Niño on the U.S., predicted with 6 months' notice as a result of improved climate observations and other forecasting advances, cost the U.S. an estimated $4.2–4.5 billion (1998 dollars) and 189 lives. An estimated 850 lives were saved and $19.6–19.9 billion in economic gains realized, however. Although many factors contributed to these benefits (e.g., a milder winter, record construction levels), the lead time provided by the forecast is credited for reducing El Niño-related losses in California, where major steps were taken to prepare for an increased risk of flooding, and reducing heating costs to consumers as utilities used the forecasts to delay purchase of natural gas and heating oil rather than sign higher-priced early-season contracts (1).

Despite the increasing predictability of climate, information on predicted climate and climate impacts is not typically used well. Every empirical study conducted to date has shown that climate forecasts are not used to their full potential (3–7). Similarly, few entities are preparing for projected impacts of climate change. To

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Abbreviations: NCS, national climate service; NOAA, National Oceanic and Atmospheric Administration; RISA, Regional Integrated Sciences and Assessments; CIG, Climate Impacts Group; NWS, National Weather Service; ENSO, El Niño/Southern Oscillation; PDO, Pacific Decadal Oscillation; NIDIS, National Integrated Drought Information System; RCC, Regional Climate Center; PNW, Pacific Northwest.

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be sure, progress remains to be made with respect to understanding the earth's climate system, predicting climate variations, and projecting climate change. However, increasing societal resilience to climate variability and change is not just about increasing information; it is also about building capacity, overcoming institutional barriers, and stimulating social learning at the level of managerial and operating agencies. In short, increasing societal resilience to climate impacts requires: (*i*) understanding climate trends and variations as well as possible, (*ii*) understanding the impacts of climate on human and non-human systems, (*iii*) providing decision-relevant tools based on that information, and (*iv*) increasing society's capacity to act on that information. The institution that would provide these services is an NCS.

What is an NCS, and Why Do We Need One? An NCS identifies, produces, and delivers authoritative and timely information about climate variations and trends and their impacts on built and natural systems on regional, national, and global space scales. This information informs and is informed by decision-making, risk management, and resource management concerns for a variety of public and private users acting on regional, national, and international scales. The stakeholders (and the constituency for an NCS) include public and private individuals and organizations at federal, state, and local levels within the U.S. with sensitivity to and need for climate-related information.

A climate service should be national foremost, because every part of the country is affected by climate variability and change, although the type and intensity of impacts often vary regionally. An NCS, therefore, exists to serve national needs related to enhancing economic growth, managing risk and protecting life and property, and promoting environmental stewardship, *inter alia* (8). Over time, as has occurred after the establishment and maturation of the NOAA's National Weather Service (NWS), we can expect opportunities for the private sector to use government data and products to craft a wide range of products that meet the special needs of private-sector users. Secondly, an NCS is needed to provide an overarching and coordinated approach for managing climate observation systems and producing and disseminating information on climate impacts to stakeholders at the federal, state, and local levels.

Not all aspects of a climate service must be national in scale, however. The true strength of the NCS concept is the regional focus of the service. Experience has shown that connections between climate scientists and stakeholders are most effective at the local, regional, statewide, and multistate scales at which the stakeholders operate (5, 9–11). It is also clear, as is shown in *Evolution of the CIG as a Regional Resource in the PNW*, that partnerships between long-lasting regional research and assessment teams such as the NOAA's RISA teams and groups of stakeholders lead to increased utility of decision tools and climate forecasts.

Functional Elements of an NCS. Conceptually, an NCS is a three-legged stool consisting of observations, modeling, and research nested in global, national, and regional scales with a user-centric orientation (Fig. 1). The first leg is a climate observing system adequate for documenting, understanding, and predicting changes in the global climate system (atmosphere, ocean, land, and cryosphere). Although some components of the global observing system exist, the current system is considered "seriously deficient" with respect to the spatial coverage and data quality needed to manage the impacts of climate change.[5] Furthermore, because the global observing system is the sum total of national systems that contribute

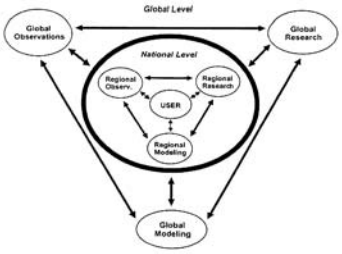

Fig. 1. Functional elements and relationships of an NCS.

to it, its maintenance and operation depends on widely divergent levels of funding. The global climate-observing system must not only satisfy the principles of climate observation laid out by the Global Climate Observing System[5] in support of the overall regime for monitoring long-term climate trends, as defined by the Framework Convention on Climate Change, but also monitor for assessing and predicting seasonal to interannual variability [e.g., the El Niño/Southern Oscillation (ENSO)] and decoding decadal variability [e.g., the Pacific Decadal Oscillation (PDO)], which are functions currently not included in the Framework Convention on Climate Change scope.

Current U.S. observational capacity, which is primarily national and administered by federal agencies, is highly fragmented, with different systems having been established at different times by different organizations for different reasons, all without cross-calibration. This fragmentation leads to gaps in observations in space and time as well as in parameters measured (12). Major observing systems include the NOAA's NWS cooperative network for weather observations, the Federal Aviation Administration's Automated Surface Observing System, the U.S. Geological Survey's Stream Gauge Network, and the U.S. Department of Agriculture's Snowpack Telemetry and Remote Automated Weather Stations networks. No structure exists to shape the development of a comprehensive, cohesive whole from these disparate parts. An NCS would provide the overarching structure to address these deficiencies, enhance the effectiveness of the global observing system, and expand the limits of what we can currently know and forecast about climate. The observations are by far the most expensive component of the NCS, yet are essential.

The second leg of an NCS is modeling to support routine global climate analysis and regional modeling on the spatial scales needed by stakeholders and climate impacts researchers. Global coupled climate models are needed to assimilate disparate global climate data and produce a routine (at least monthly) global analysis of the climate system; this forms the data and model basis for global predictions, the basis for a consistent and orderly growth of the climate record, and for the large-scale boundary conditions for modeling downscaled information. Decision makers typically need quantitative information for a specific location or area (13). For example, the CIG has often been asked to provide analysis to support decisions made at the spatial scale of a county or smaller, which is significantly less than the resolution of global models. This

[5]Global Climate Observing System (2003) *The Second Report on the Adequacy of the Global Observing Systems for Climate in support of the UNFCCC* (World Meteorological Organization TD No. 1143).

[5]Global Climate Observing System (2004) *Implementation plan for the Global Observing System for Climate in Support of the UNFCCC* (World Meteorological Organization TD No. 1219).

discrepancy is important for the regional component of an NCS, which must downscale global/national observations and modeling to address problems faced at and by the regional spatial scale.

The third leg of an NCS is research. On the global scale, research is needed to improve the models and the data assimilation schemes used in global and regional modeling. Research should also represent an optimal melding of what stakeholders need for managing resources and what scientists view as necessary for developing a deeper understanding of the coupled climate/resource systems. However, national- or global-scale research is often difficult for a stakeholder to apply directly to location-specific decisions. The research component of an NCS would allow stakeholders to work more actively with climate scientists on decision-relevant research; consequently, the NCS should have the authority and the funds required to issue requests for proposals for the research needed to succeed in its mission.

Fig. 1 reflects the structural and organizational imperatives of an NCS. The purpose of the system is to provide useful information and products to society by combining observations, models and modeling, research, forecasts, and a wide variety of decision tools on the indicated space scales to build understanding and capacity and to increase resilience to climate variability and change. To accomplish this, an NCS must have a user-centric orientation in which stakeholders are seen as a continuously involved constituency. Salient and authoritative information must flow to the user from observations, modeling, and research on the space and time scales determined by user needs. It should be emphasized that every specific user need that requires climate information will require all of the elements indicated in Fig. 1.

The arrows in Fig. 1 indicate not only scientific flows between the elements of the global, national, and regional infrastructures, but also the flow of appetite. The user must be able to place reasonable demands on the global, national, and regional infrastructure (either directly or indirectly) and have some means of knowing that this appetite can be satisfied. The climate service is a service, after all. The organizational imperative corresponding to this flow of appetite is crucial to the balanced workings of an NCS. The lines of authority and organization must be such that any imbalance or inadequacy in infrastructure, whether regional or global, that affects the quality or utility of the information demanded by and delivered to the user can be redressed in a reasonable amount of time. This need for direct lines of authority and the need to maintain the complex infrastructure illustrated by Fig. 1 are the bases for our call for a centralized form of management at the national scale, as is described in *What Functions and Services Should an NCS Perform?*

What Functions and Services Should an NCS Perform? The principal functions and services of an NCS are listed in Tables 1 and 2. In this context, "functions" refer to the general operating objectives of the NCS system as a whole. "Services" refer to the general tasks that the national and regional NCS components provide to NCS stakeholders. The first function of an NCS is integrating global, national, and regional observations infrastructure to produce information and assessments useful to stakeholders. The NCS becomes the primary U.S. agency involved in designing and maintaining the global observational system and participating in global-scale assessments. The NCS also negotiates with other governments operating within the Framework Convention on Climate Change regime. At the national scale, the NCS would assist in coordinating the upgrade, expansion, and/or optimization of existing and future observation networks. This point is key: new modeling and analytical techniques permit very sophisticated methods of determining the optimal placement and instrumentation for multiple objectives for a given cost and may permit the retirement of some existing observations and the establishment of much-needed new observations (14, 15).

The second function of an NCS is modeling at all scales with emphasis on regional-scale products that can be used to support stakeholder decisions. This function includes developing forecasting models for hydrologic variables (e.g., runoff, water supply, flood risk, drought risk), fisheries, and forest-fire risk.

The third function consists of performing basic and applied research on climate dynamics and impacts with a focus on understanding and explaining interactions among climate, society, and natural resources; identifying important climate-related vulnerabilities and opportunities; and furthering the development of climate forecasts and regional-scale climate-based resource forecasts. Much of this research, particularly research that is related to projections of future conditions, will be based on modeling driven by the set of applications and potential applications identified by stakeholders and/or researchers. This research differs from traditional stand-alone climate research in that research within the NCS addresses and is motivated by specific user needs. For example, the extensive and persistent drought in the western U.S. has led many water managers to ask why it is happening, how long it will continue, and whether it is related to global warming. All of these questions have motivated very good research.

The fourth function is creating and maintaining an operational delivery system for new products and/or or facilitating transition of new products for delivery by parties outside of the NCS and its partner agencies. These products include climate-change

Table 1. NCS functions

1. Integrate global, national, and regional observations infrastructure to produce information and assessments of use to stakeholders and researchers
2. Develop models for decision support
3. Perform basic and applied research on climate dynamics and impacts relevant to stakeholder interests
4. Create and maintain an operational delivery system and facilitate transition of new climate applications products to NCS member agencies
5. Develop and maintain a dialog among research teams, member agencies, and stakeholders for developing information relevant for planning and decision making
6. Identify climate-related vulnerabilities and build national capacity to increase resilience
7. Represent regional and national climate issues and concerns in regional and national policy arenas and facilitate regional–national communications on NCS needs and performance
8. Outreach to stakeholder groups

Table 2. NCS services at the national and regional level

1. Serve as a clearinghouse and technical access point to stakeholders for regionally and nationally relevant information on climate, climate impacts, and adaptation; developing comprehensive databases of information relevant to specific regional and national stakeholder needs
2. Provide education on climate impacts, vulnerabilities, and application of climate information in decision-making
3. Design decision-support tools that facilitate use of climate information in stakeholders' near-term operations and long-term planning
4. Provide user access to climate and climate impacts experts for technical assistance in use of climate information and to inform the climate forecast community of their information needs
5. Provide researcher, modeler, and observations experts access to users to help guide direction of research, modeling, and observation activities
6. Propose and evaluate adaptation strategies for climate variability and change

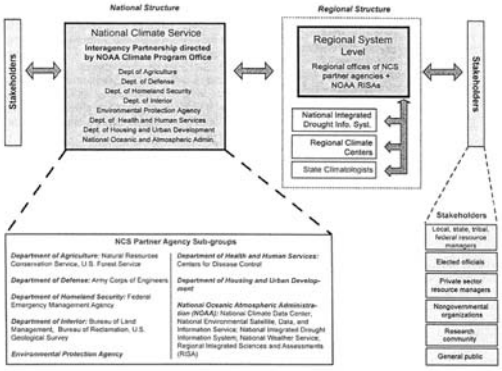

Fig. 2. Representation of an NCS.

scenarios, climate and resource forecasts, decision tools, and planning resources, such as information that identifies shifts in patterns of variability and their implications for water demand and reservoir management or forest-fire management.

The fifth function is developing and maintaining a continuing dialogue among research teams, member agencies, and stakeholders focusing on development and delivery of information useful for planning and decision-making. The sixth function is identifying climate-related vulnerabilities and building national capacity to increase resilience to climate impacts. This function includes providing projections of climate change and drought that are useful to those concerned not only about impacts but also the design of structures, facilities, and other long-term planning objectives. This function also includes preparing national integrated impacts and vulnerability assessments.

The seventh function is representing regional and national climate issues and concerns in policy arenas, such as the development of a national drought policy or changes in Federal policies regarding flood insurance and coastal hazards. The eighth and final function is outreach. Outreach to stakeholder groups provides valuable opportunities for feedback on research products, decision-support products, and other information needs. Outreach also facilitates building relationships with potential NCS service users and enhances learning about climate, climate impacts, and use of climate information by stakeholders.

How Should an NCS Be Designed? The proposed structure is a nationally distributed system with institutional partnerships operating at the national and regional scales (Fig. 2). This structure draws on existing capacity and expertise but configures the components to create a structure that can achieve the integrated objectives of an NCS in a way that no single agency could do alone. The NCS must be implemented as an interagency partnership, given the distribution of interests and capabilities across Federal agencies and the distribution of stakeholders across public and private sectors in the 50 states. This partnership must be authorized and funded by Congress to provide both the authority and incentives needed to facilitate such a partnership at the national and regional levels. Over time, interagency coordination at the federal and regional levels will in turn induce greater degrees of coordination between the partner agencies at the state level.

The principal roles of the national office are to (*i*) combine the observation, research, and modeling activities of multiple agencies into a coherent whole; (*ii*) secure financial resources to support the work of the NCS at national and regional levels; (*iii*) participate in negotiating, designing, and implementing a global observing system and global-scale assessments; and (*iv*) participate in international and bilateral negotiations, coordination arrangements, and consultations on climate matters. The NCS should be directed by the Director of NOAA's Climate Program Office, because many components of the NCS (e.g., observations and research) are currently administered by that office.

The regional level provides the critical regional link to stakeholders for the NCS. Knowledge of regional systems and decision processes combines with expertise in observations, research, and modeling at all scales (global to the regional) to produce climate information and products designed to fit the specific needs of local decision makers. The regional-level is where most of the services are actually delivered. The regional level member agencies, which are partners with NOAA and each other at national and regional scales, work collaboratively with each other, the RISAs, public and private sector stakeholders, and the national offices of the National Environmental Satellite, Data, and Information Services, the NWS Climate Prediction Center, and the forthcoming National Integrated Drought Information System (NIDIS).

The Regional Climate Centers (RCCs) and state climatologists should also play a key role in the NCS. Economies of scale related to data archiving and the existing connection of RCCs to region-specific needs and perspectives would make the RCCs a valuable resource for the observational component of the NCS. State climatologists also have a valued connection to stakeholders that would be useful to the NCS. Formerly part of the NWS, state climatologists are now supported to varying degrees

(mostly at very small levels) by the respective states. They are often faculty members at land-grant universities with ties to the agriculture and water-user communities. Through their close association with state agencies and other stakeholders, state climatologists are historically very responsive to user needs and have developed innovative new services as a result. The South Carolina State Climatology Office, for example, has developed a tool that allows users to obtain drought information over various geographic scales, including county, watershed, or groups of watersheds. State climatologists are also in many cases deeply involved in advising governors and communicating with news media in times of drought. Two RISA programs include state climatologists in a prominent role: the CIG and the Southeast Climate Consortium (with the state climatologists for Washington and Florida, respectively).

Programmatically, the RCCs already have a well defined role and fit easily into an NCS, but systematically entraining the state climatologists across the nation will require some thought and effort. Both the American Association of State Climatologists (AASC) and the NCDC, which currently provides some assistance to state climatologists individually and through the AASC, would need to be involved on behalf of state climatologists in NCS design.

Fig. 2 represents an initial design for an NCS. The system will evolve over time, and the internal organizational subculture of NOAA will likely play a large part in its evolution. We can foresee one path such an evolution would take. The Climate Program Office is a research unit within the NOAA's Office of Oceanic and Atmospheric Research. But it is expected that the NCS will facilitate a steady stream of innovations that will be transferred to operations, which means that the NCS must also be able to control its own operations like the NWS controls theirs. Eventually, therefore, the NCS will have to be spun off from the Office of Oceanic and Atmospheric Research because the latter is not an operational unit.

How Should the NCS Be Evaluated? The system should be periodically evaluated on four criteria. The first criterion judges the degree of collaboration between regional research teams and the regional offices of NCS member agencies, between the regional research teams and the national data centers and observations system, and between the NCS and regional stakeholders. The critical parameter of collaboration is the establishment of partnerships among and between researchers, modelers, and users and how well those partnerships function. The second criterion judges performance on the quality and relevance of regional research efforts to stakeholders and researchers. Judging relevance always involves asking the users. The third criterion judges performance on the relevance and quality of decision support and of decision tools. The fourth criterion calls for periodic detailed and systematic investigations to document evidence of the impact of the system on regional planning and decision-making by user communities.

The NIDIS as a First Step Toward an NCS. An early demonstration of the national-scale concept of an NCS is found in the emerging NIDIS program.[5] NIDIS looks to develop a drought information system, which will help stakeholders assess the impacts and risks of drought, and decision support tools for preparing for and mitigating drought impacts. Major support for NIDIS emerged in the Western Governors' Association (WGA), an organization whose members govern the country's most drought-prone regions (including the West and the Great Plains). The WGA's support for NIDIS was a response to the ad hoc manner in which the U.S. manages drought. This diffuse approach stands in sharp contrast to the clear national system that exists for managing other climate-related events such as floods and hurricanes.[5] The WGA decried the absence of a national drought policy and the lack of a coordinated, integrated drought monitoring and forecasting system. To remedy these deficiencies, the WGA has proposed the following objectives for NIDIS to Congress.

1. Improving and expanding the national drought indicators database by combining physical/hydrological with socioeconomic and environmental impacts data.
2. Facilitating integration and interpretation of data "with easily accessible and understandable tools, which provide timely and useful information to decision makers and the general public."
3. Seeking to establish a "comprehensive national drought policy, including improving drought monitoring and forecasting (NIDIS), coordinating and integrating governmental programs, establishing reliable funding for drought preparedness and response activities, and facilitating state-based drought preparedness and mitigation programs."[5]

The Governors also specifically recommended that NOAA be designated the lead agency for NIDIS.

The emerging NIDIS program is a first step toward demonstrating the national-scale concept of an NCS for several reasons. First, NIDIS is intended to be a fully integrated system linking together observations, modeling, and research for predicting drought events. Second, the integrated system will be matched with specific operational managers (e.g., the Natural Resources Conservation Service), who in turn are linked to a wide range of stakeholders in drought-prone regions of the U.S. Third, the information and decision tools provided by NIDIS will be linked to planning at Federal, regional, and state levels to increase adaptive capacity and resilience to drought. The fundamental design of NIDIS is centered on the nature, type, quality, and utility of information that it must provide. NIDIS is therefore a good example of the need to consider design, implementation, evaluation, and enhancement of observing systems in relation to the function of an information service (E. Shea, personal communication). NIDIS would become a component of the NCS with a specifically defined task and role related only to drought.

Working from the Global to the Regional: The RISA Program and the Experience of the University of Washington's CIG. The case for a regionally distributed design as the basis for the NCS derives from the experiences of the NOAA's Regional Integrated Sciences and Assessments (RISA) teams. The NOAA's RISA program supports research on climate-sensitive sectors (e.g., water resources, fisheries, wildfire, agriculture, human health, and coasts) relevant to the concerns of decision makers and policy planners at a regional level, with the aim of increasing regional resilience to climate fluctuations. The RISA program consists of teams in the following regions: California, the Carolinas, Colorado, New England, the Pacific Northwest (PNW), the Southeast U.S., the Southwest U.S., and the Pacific Islands. A ninth RISA is scheduled to begin in Alaska in 2007. The teams are primarily university-based but may also draw on researchers from government research facilities, nonprofit organizations, and private-sector entities.

A graphical representation of RISA's role in bridging the climate research and resource management communities is shown in Fig. 3. RISAs function as producers and providers of region-specific, climate-based resource forecasts for regional stakeholders. This work is made possible by research on how climate, natural systems, and human socioeconomic systems and institutions interact to determine a region's sensitivity, adaptability, and vulnerability to climate fluctuations. Links to stakeholders are created through a wide variety of outreach activities

Western Governors Association (2004) *Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System* (Western Governors Association, Denver, CO).

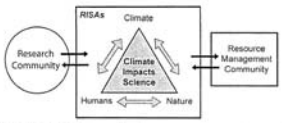

Fig. 3. RISAs bridge the research and resource management communities.

reaching appropriate individuals and authoritative decision makers at all levels.

The experience of RISA shows that each regional team evolves in its own context, in which building trust over time with repeated contacts is critical, as is finding ways to expand stakeholder awareness and understanding of the ways in which regional climate dynamics shape the variation in the resources they manage and the activities in which they engage. There are no general recipes that would work well in all contexts, but there are lessons to be learned from each other that can be adapted and transferred to good effect. Thus, the emphasis is on the evolutionary development of the teams as they are connected to regional stakeholders, and evolution does not occur in a straight line.

The CIG. How then does the regional system work with respect to the NCS functions and services listed in Tables 1 and 2? The answer to this question lies in the origins of the RISA program and the work of the CIG from 1995 to 2005. By the mid-1990s, the NOAA's Office of Global Programs (now the Climate Program Office) was seeking a strong integrative research and assessment role with continuous interaction between researchers and users for the purpose of developing prototype products and interpreting climate forecasts for likely impacts. The Office of Global Programs was the catalyst, providing leadership for the national observation system, research investments within the NOAA National Laboratories and in the universities, and in the design and coordination of regional developments. When it implemented these initiatives in connection with the U.S. Global Change Research Program, the Office of Global Programs emphasized supporting pilot applications and the development of a process for creating a national delivery system for climate information (16).

The CIG was established in July 1995 as the first RISA team. As a pilot, the CIG was designed to be a voyage of discovery with the objective of increasing regional resilience to climate variability and change particularly through development of new seasonal/interannual resource forecast capabilities based on an improved understanding of ENSO dynamics. Research at the CIG focuses geographically on the U.S. PNW (defined as Washington, Oregon, Idaho, and the Columbia River Basin). The region includes several key natural and managed systems with sensitivity to climate. The impacts associated with population growth add to current and future management challenges. Recognizing this, research at the CIG has focused on four climate-sensitive economic sectors: hydrology/water resources, forest ecosystems, the coastal zone, and aquatic ecosystems. Plans for adding human health and irrigated agriculture have not been realized to date because of budget limitations.

We envision our work as an inverted triangle, the base of which is research to support adaptation. The results of this research provide the foundation for the other vertices of the triangle, decision support and outreach. Decision-support tools, listed in Table 3, are designed to facilitate use of climate information in operations and planning. Outreach is designed to develop and maintain ongoing relationships with the stakeholder community. Table 4 shows a list of key stakeholders as of 2005. Investment in outreach should not be overlooked. By educating our stakeholders about ENSO, PDO, paleoclimate, and climate change, we create a demand for information about climate and implications for resource management that previously did not exist. CIG outreach activities include workshops, presentations, an on-line newsletter, web-site development and maintenance, and graduate-level courses at the University of Washington.

The CIG has made several major contributions to regional climate impacts science during the past decade. These include the following.

Table 3. CIG contributions to decision support in the PNW

Climate variability
Monthly climate outlook
Long-lead (1-year) seasonal streamflow forecasts based on ENSO/PDO
Long-lead (1-year) seasonal marine survival forecasts for Oregon coastal coho salmon
Mid-term (6-month) municipal reservoir forecasts
Near-term (7- to 14-day) extreme weather risk forecasts
Climate change
Climate change temperature, precipitation, snowpack, and streamflow scenarios
Climate change streamflow scenarios for water-supply planning
Client-based research consultancies (e.g., climate-change impacts on municipal water supplies)
Optimization models for evaluating climate-change impacts on streamflow management
Technical assistance to watershed planning

Table 4. Key stakeholders for the CIG

Federal level
Bonneville Power Administration
NOAA Fisheries Service
NOAA River Forecast Center
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation
U.S. Congress
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geologic Survey
USDA Natural Resource Conservation Service
State/tribal level
Alaska Department of Fish and Game
California, Oregon, and Idaho Departments of Water Resources
Washington Department of Ecology
Washington Department of Fish and Wildlife
Washington, Oregon, and Idaho Governor's Offices
Washington, Oregon, and Idaho State Legislatures
Columbia River Inter-Tribal Fish Commission
Northwest Indian Fisheries Commission
Local level
Central Puget Sound Water Suppliers' Forum
City of Tualatin, OR
King County, WA
Washington State watershed planning units
Portland Water Bureau
Puget Sound Clean Air Agency
Seattle City Light
Seattle Public Utilities
BC Hydro (Canada)
National Wildlife Federation
Northwest Power and Conservation Council
News media

- Defining the PDO. The CIG demonstrated a solid connection between interdecadal variations in North Pacific climate and the abundance of salmon and other marine species in the PNW and Alaska, and in so doing named and defined the PDO. The PDO is now recognized internationally as a major climate driver with wide-scale impacts on natural resources in the western U.S., Canada, and eastern Russia (17, 18).
- Identifying ENSO and PDO impacts on the PNW winter climate and key natural resources. The CIG characterized PNW climate variability, including the association of warm-dry and cool-wet winters with warm and cool phases of ENSO and PDO, and the links between several other large-scale climate modes (e.g., Pacific North America pattern and the Arctic Oscillation) and extreme weather events such as windstorms, cold-air outbreaks, and snow. The CIG demonstrated how ENSO, PDO, and other aspects of climate influence key PNW natural resources (including snowpack, streamflow, flooding, and droughts), forest productivity and risk of forest fire, salmon returns, and quality of coastal and near-shore habitat (9, 19–21).
- Identifying 20th century trends in PNW temperature, precipitation, and snowpack. The CIG analyzed 20th century trends in PNW temperature, precipitation, and snow water equivalent (an important indicator for predicting summer water supplies). Annually averaged PNW temperature increased more than the global average during the 20th century, precipitation showed no clear signal, and regional snow water equivalent decreased significantly (up to 60% at some locations) since 1950 (22–25).
- Defining and evaluating the potential impacts of global climate change on PNW climate and resources. CIG research on the impacts of climate change on the PNW projects significant challenges in the decades ahead for the region's water resources, salmon, forests, and coasts as a result of human-caused global warming. These include increased risk of winter flooding and summer drought; salmon mortality in freshwater habitats; forest fires; changes in Puget Sound ecosystem structure and function; and coastal erosion and flooding (9, 26, 27).
- Identifying barriers to the effective use of climate information and characteristics of adaptive institutions. Elite surveys with PNW natural resource managers have revealed that barriers to the use of climate forecasts include lack of knowledge on the part of forecast users, problems with the forecasts themselves, and institutional barriers to use of forecasts (5).

Evolution of the CIG as a Regional Resource in the PNW. Evolutionary development is highly interactive and often serendipitous. At the beginning, the CIG worked to identify and quantify the relationships between global climate phenomena and regional hydrologic processes using the historical record. The results of these analyses were applied to explaining variations on PNW water resources systems. Interaction with stakeholders led the CIG to develop general hydrologic forecasting techniques and specific applications of hydrologic forecasts for PNW water resources management. But the application of these forecasts to operations was not straightforward, given the importance of institutional factors that determine vulnerability to climate variability and barriers to the use of climate forecasts. Only after this work was done was it possible to integrate the understanding of the physical dynamics of climate variability with advances in hydrologic forecasting, modeling of climate change effects, and understanding of the institutional vulnerabilities to climate variability and change in a comprehensive fashion (28).

As time passed, the CIG saw that learning within the stakeholder community develops in an evolutionary way, punctuated by sharp transitions in response to external events. The 1997–1998 El Niño, the strongest of the 20th century, was a high-profile event that we could use to illustrate regional vulnerabilities to climate fluctuations and how climate impacts are amplified when ENSO and PDO are simultaneously in warm or cool phases. We also learned from this event that media coverage could give our activities a significant boost during periods when climate issues were highly salient. The event proved to be a wonderful opportunity to teach and learn about responding to climate variability and to attempt to decrease vulnerability to extreme events.

The emphasis on serving the specific needs of regional stakeholders is a key objective of the RISA program. Serving such needs includes not only publication of peer-reviewed research but development of decision support tools designed to help decision makers apply climate information. The CIG has made many innovative contributions to decision support in the PNW (Table 3). These tools are a direct result of the CIG's growing understanding of the region's sensitivity to climate, the predictability of these impacts, and the expressed needs of stakeholder for managing critical resources.

This brief sketch of how the RISAs operate, as seen through the lens of one of the regional teams, demonstrates that not only the RISAs but the NCS as a whole clearly fit into the category of knowledge–action systems as defined by a workshop of the National Research Council:

> These systems are generally viewed as organized efforts to harness science and technology in support of social goals. In general [such systems] encompass the set of relationships, actors, institutions, and organizations that set priorities, mobilize funds, do the R&D, review publications/promotions, facilitate practical application and reinvention, and provide evaluative feedback on performance. Such systems are not generally designed from scratch, but rather evolve through time as a result of multiple and only partially integrated interventions (29).

Effective systems for linking knowledge and action must produce information that is seen to be salient, credible, and legitimate. Collaborative problem definition is "user driven, but reflect[s] input from the scientific (producer) community on what is feasible" (29).

Conclusions

Developing the institutional capacity to provide climate services is a very large undertaking and is neither quick nor easy. The NCS requires comprehensive and interlinked global, national, and regional observing systems, a comprehensive climate model, and a largely distributed research and application capability. These components create the three-legged stool for the ultimate objective: producing climate-based resource information that is not only useful but also used in planning and decision-making. Achieving this objective also requires developing integrated research and outreach teams at the regional scale for sustained, long-term innovation and communication with a wide variety of stakeholders; defining, in a collaborative process with stakeholders, the types of climate information that are most useful for individual applications; producing specific, mutually defined products; and building trust with stakeholders over time.

The NCS is essential for developing national capacity to understand and manage the impacts of climate variability at a time when observations clearly indicate that human-generated climate change is also under way. The NCS would be achieved most effectively as a Federal interagency partnership with critically important participation by regional climate centers and state climatologists, by NIDIS at the mega-regional level, and by the RISA teams. Collaboration and coordination are essential in this respect. The regional scale is clearly the most effective for integrating research and decision support with stakeholder needs, but because the organization is crafted from existing components that do not now fit together, they can and must be

made to fit. NIDIS may well evolve into more of a broker than the RISAs, operating at the mega-region level. The RCCs can evolve into units that focus primarily on the production of decision tools, to which the RISAs transition their innovations and go on to the invention of others.

All of this we know, but major challenges stand in the way of achieving these objectives. The issue of achieving comprehensive, effective global, national, and regional observing systems is perhaps the greatest difficulty, because it seriously limits what the scientific community can do and is greatly affected by the other challenges. Additional challenges include issues of institutional arrangements affecting agencies, jurisdictions, budgets, and Congressional priorities.

Can we do better at national and regional levels within the U. S. at fusing the bits and pieces of a climate service into a comprehensive whole? Certainly, because we have the technical capacity and the knowledge to do so. So far, either we have not demonstrated the will to do so, or we have not recognized the real need to do so in the face of a changing climate. The challenge lies in changing the existing organizational infrastructure to produce an integrated observing system with an information system catering to research and decision-making interests at the national level and designing a carefully crafted series of regional systems from what currently exists. The stumbling blocks are organizational inertia and the competition for programs, budget, and turf and very low Congressional funding allocation priorities. The latter can be changed given salient prodding by Nature. The former can be changed only if Congress clearly specifies changes in system design, in the authority structure, and in providing the resources to achieve change to act as incentives to change in the desired direction. What we need is a large influx of guided interagency collaboration and integration under effective Congressional oversight. The present article is intended to facilitate a national dialogue leading to recognition of the need to change.

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AN OPEN LETTER TO
MEMBERS OF THE 110th CONGRESS OF THE UNITED STATES

Ensuring the Future of the Nation's Climate Observing Network

A Position Paper Adopted By
The American Association of State Climatologists (AASC)
(http://www.stateclimate.org)
March 2007

The American Association of State Climatologists (AASC) – representing all State Climatologists and Puerto Rico along with Climatologists at the nation's six Regional Climate Centers – urge the 110th Congress to direct and appropriate funds to conduct a comprehensive modernization of the nation's premier surface-based, climate-monitoring network: the Cooperative Observer Network (COOP), operated by the National Weather Service (NWS). Our nation, the most technologically advanced on the planet, is in grave danger of losing significant societal benefits and will face billions of dollars in economic impacts each year if the network collapses.[1, 2, 3 & 4]

Urgency arises from the fact that all federal modernization plans proposed during the last 14 years have floundered from lack of specific funding direction and insufficient funds, in spite of the fact the COOP remains as relevant today as it was when first established in 1890. We ask the Congress to provide direction and the necessary funds because collecting high quality, climate, weather, and water data spanning multiple *decades* is a distinctly federal role. *Even so, the Federal government may not need to own any equipment* — much like the USDOT does not own the Interstate Highway system.

Even as COOP moves toward collapse, it provides one of the few reliable means to confirm (i.e., reduce uncertainties) climate change and variability across North America. To accurately measure and assess climate, weather, and water patterns at the *local* level where impacts of climate change occur, modernized COOP sites spaced every 400 square miles *on average* nationwide are required[1, 3 & 4] (~8000 stations from a coalition of partnerships) to meet standards of the World Meteorological Organization (WMO[3 & 4]).

The slow collapse of this 116-year old network has been documented in numerous professional reports during the past two decades.[1] This network faces extinction because the data still are manually acquired, much like in 1890, by volunteer observers using equipment that is either obsolete or obsolescent. It has proven almost impossible to replace aging observers. Data quality continues to diminish, access to the data (recorded on paper) remains arduous, and the corps of maintenance professionals has been decimated because federal personnel have been shifted to other duties.

Modernizing the NWS COOP network will provide weather and water information that are automatically reported, stored, and made available (i.e., in real time) to improve the accuracy of all forecasts. Given that paper is used now, the instantaneous transfer of new data will create huge societal and economic benefits because countless public/private interests are impacted by the climate, weather, and water. For example:

> To reduce a dependence on foreign oil, we must generate electricity more efficiently. The efficiency of generation can be greatly increased if loads are predicted and generation scheduled in advance. Power usage, and hence demand for generation, is directly tied to temperature variations. The added value of improved fine-scale temperature information is immense – if decision-quality data from carefully selected sites are available in real-time to grid operator and power generating agencies.[2]

Federal financial aid for drought, extreme floods, or record snowfalls is usually tied to Presidential disaster declarations. More than 65 'billion dollar' climate, weather, and water disasters have impacted our economy during the past 25 years. The spatial extent of most disaster declarations has been based on COOP observations of temperature, precipitation and snowfall *at the sub-county level*. Thus, valid requirements exist to modernize a high density, high resolution observing network whose data will impact climate, weather, and water forecasts in a very positive manner. Further, some $40 billion in annual contracts of the weather-risk management community are based solely on NOAA-certified airport temperature and precipitation data. No doubt more contracts would be possible if reliable COOP data were available in real-time. Unfortunately, the availability, reliability, and consistency of COOP data have fallen below acceptable standards.[1] This situation impedes the federal decision process during disasters and severely limits a growing area of economic activity.

Water is a critical natural resource to our economy. Modernization of the COOP network at a spatial resolution of one site per 400 square miles will directly improve local and regional management of this vital resource. In addition, a modernized COOP has been identified as *the* key observational component of the National Integrated Drought Information System, as proposed by the Western Governors' Association[4] and approved by the 109th Congress in HR 5136.

Having near instantaneous access to detailed wind, temperature, and humidity data in populated environments would, if available, help the Nation prepare for and manage chemical and biological threats by increasing the speed and effectiveness of responses to the release of hazardous substances and high-impact weather and water phenomena. But, the observations must be timely, reliable, and consistent through time for computer dispersion models to produce accurate forecasts that protect both first-responders and the public they serve.[3] Such is not the case today.

We, as local and regional providers of climate services and climate change assessments, appreciate th budgetary constraints faced by Congress. Yet, the evidence is compelling that modernization of this network is a cost-effective investment for the nation and our heirs. While the NWS should set standards, many other Federal agencies have a significant stake in the modernization. Even so, the modernization cannot be achieved by one agency with limited resources nor can it be accomplished without partners. Regional, state, and private partners stand ready as important stakeholders at the sub-county level to assist with the modernization, deployment, upgrading, and maintenance.

The American Association of State Climatologists, a national organization of climate scientists, calls upon the 110th Congress to rescue the nation's climate monitoring and observing network. We ask the Congress to provide direction and funding at a level that completes a comprehensive modernization in five years and assures longevity of the network through the 21st century. We are ready to lead a unified effort.

Respectfully Submitted,

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Paul G. Knight, President
American Association of State Climatologists

[1] *Future of the National Weather Service Cooperative Observer Network*, National Research Council, 1998.
[2] Edison Electric Institute, 2002.
[3] *Program Development Plan for COOP Modernization*, Signed by General D. L. Johnson (Director of the National Weather Service) in March 2004 (full modernization remains unfunded).
[4] *Cost and Operational Effectiveness Analysis* for COOP Modernization, prepared in June 2005 for the NWS, 96 pp.

BIOGRAPHY FOR PHILIP W. MOTE

Dr. Philip Mote is a research scientist at the University of Washington, in the Climate Impacts Group (CIG), and an Affiliate Professor in the Department of Atmospheric Sciences. His research interest include Northwest climate and its effects on snowpack, streamflow, and forest fires. A frequent public speaker, he has also written more than 60 scientific articles and edited a book on climate modeling, published in 2000. In 2003 he became the Washington State Climatologist. He served as a lead author of the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* released in 2007.

Ms. GIFFORDS. Thank you, Dr. Mote. The Committee stands in recess.

[Whereupon, at 2:51 p.m., the Subcommittee recessed, to reconvene at 3:22 p.m.]

Mr. UDALL. [Presiding] The hearing will come to order. I want to thank the panelists for your patience. I am going to sit in as Acting Chair for Congresswoman Giffords, who was required to go to the airport and return to her home in Arizona.

We will pick up back with Ms. Bittleman for her five minutes, and then, I would tell the panel we will do all that we can to end at the latest, by 4:00, perhaps five or ten minutes early, but we do want to take advantage of your expertise and your presence.

Ms. Bittleman, the five minutes is yours.

STATEMENT OF MS. SARAH BITTLEMAN, DIRECTOR, WASHINGTON, D.C., OFFICE OF THE GOVERNOR OF OREGON, THEODORE R. KULONGOSKI, ON BEHALF OF THE WESTERN GOVERNORS' ASSOCIATION

Ms. BITTLEMAN. Thank you very much, sir.

Thank you for the opportunity to address the Committee today regarding H.R. 906. My name is Sarah Bittleman. I work for the Governor of Oregon, Governor Kulongoski, here in Washington, D.C. I would like to thank the sponsors, Representative Udall and Representative Inglis especially, for their bipartisan effort on this bill, as well as for their outreach to the Western states in its development. The Western Governors Association, which I am representing here today, appreciates the specific effort to make this bill relevant to and address the needs of the states.

With the efforts occurring in Oregon and in many Western states to address climate change, the Western Governors believe it is not only appropriate, but it is also necessary to reorient and fully fund the U.S. Global Change Research Program to make it more user-driven. The U.S. has spent considerable dollars on understanding the science of climate change. Now is the time to address and adequately fund the issue of adaptation. How will climate change manifest itself in different areas of the country? What impacts can we expect at the State and local levels? How can we prepare for the change in an effort to avoid or mitigate the impacts? How can we most effectively implement adaptation measures, given that many of them need a long lead time?

At the risk of sounding like an advertisement for a summer blockbuster movie, I need to recite some of the very real effects of climate change projected for the American West: smaller snowpacks that lead to water shortages; earlier snowmelt that lead to water shortages; and yet, more extreme floods; more evaporation and dryness; less groundwater; more drought; more wildfires; pest

and disease, more of them affecting our agricultural crops and forests.

I don't think I need to remind the Members of the Committee that there are already substantial stressors on water in the West today. Given global climate change, we expect additional ones. The Western Governors stated in their 2006 report, entitled "Water Needs and Strategies for a Sustainable Future," that Congress and the Administration should fund research that makes it easier to predict and mitigate climate change impacts.

The Governors believe Title I of H.R. 906 would appropriately focus the research of the U.S. Global Change Research Program on improving the understanding of global climate change, responding to the information needs of communities and decision-makers, and providing periodic assessments of the vulnerabilities of the U.S. and other regions to global climate change. In other words, making the program more user-driven and user-friendly.

Some states are already creating their own climate change research centers, including Oregon. In May 2006, Governor Kulongoski created the Climate Change Integration Group to develop a climate change strategy for Oregon that provides long-term sustainability for the environment, protects public health, considers social equity, creates economic opportunity, and expands public awareness. Their main focus has been on adapting to climate change.

It is important that the program created under H.R. 906 integrates and supports the State efforts that are already in existence, like the one in Oregon and across the West, as well as regional climate research and application centers. This includes the State climatologists' offices, agricultural extensions, State and local governments, and resource management agencies.

Additionally, Western Governors stated in their 2006 report that the federal agencies must continue to fund and expand funding for data collection networks and activities necessary for monitoring, as Dr. Mote mentioned, assessing and predicting future water supplies. To the degree that Title II of the bill would lead to such improvements in data management, the Governors certainly believe it is appropriate and supported.

One recommendation that we would make for the bill is to amend it to address the need for a National Climate Information Service in the context of the U.S. Global Change Research Program. A National Climate Service, as again, Dr. Mote mentioned, such a Service would be the focal point for coordination of climate activities across the Federal Government, and could be the organization charged with such responsibilities as making sustained climate observations and assessments about the state of the climate, and providing climate outlooks and projects, similar to an early warning system. Additionally, the NCIS could provide routine assessments of climate impacts and vulnerabilities, and develop relevant products and services for decision and policy-makers.

The National Integrated Drought Information System that this committee authorized last year would thus become an important component of a larger climate information system. The Western states see all of this as very much connected. Decision-makers at all levels of government and in the private sector need reliable and

timely information to understand the possible impacts of the response, and respond to the effects of climate change.

The Western Governors Association supports H.R. 906 as an effort to move the Nation's climate change research program in this direction, and I welcome any questions you might have.

[The prepared statement of Ms. Bittleman follows:]

PREPARED STATEMENT OF SARAH BITTLEMAN

Chairman Gordon and Members of the Committee, my name is Sarah Bittleman, and I am the Director of Oregon Governor Theodore Kulongoski's Washington, D.C. Office.

Thank you for the opportunity to address the Committee today regarding H.R. 906, the *Global Climate Change Research Data and Management Act of 2007*. I appear before you on behalf of the Western Governor's Association (WGA)—an independent, nonprofit organization representing the governors of 19 Western States, American Samoa, Guam and the Northern Mariana Islands. Through their Association, the Western governors identify and address key policy and governance issues in natural resources, the environment, human services, economic development, international relations and public management.

Before making specific comments about the U.S. Global Change Research Program and the legislation before you today, I would like to thank the sponsors of H.R.906, Representative Udall and Representative Inglis, for both their bipartisan effort on this bill, and their outreach to the Western States in its development.

Last year, WGA worked closely with this Committee on the development and passage of legislation authorizing the *National Integrated Drought Information System Act of 2006* (NIDIS). There was a high degree of bipartisan cooperation on this Committee, and in particular among the sponsors of the NIDIS bill—Mr. Udall and then-Chairman Hall—and this cooperation undoubtedly led to the successful passage of that bill. The Governors are very pleased to see this spirit of cooperation from the Committee continuing with your efforts on H.R. 906.

Additionally, the Governors want to thank Mr. Udall and Mr. Inglis for their outreach to the Western States in soliciting input into the development of H.R. 906. WGA appreciates the specific effort to make this bill relevant to, and address the needs of, the States.

Mr. Chairman, with the efforts occurring in Oregon and many western states to address climate change, the Western Governors believe it is not only appropriate, but also is necessary to reorient and fully fund the U.S. Global Change Research Program to make it more user-driven. Since the time the USGCRP was enacted in 1990, the debate on climate change in this country has largely focused on whether the world is warming and whether humans are the cause of that warming. The current science indicates that the Earth is warming and that concentrations of atmospheric CO_2 have increased significantly. In a 2005 statement, the United States National Academies of Science concluded, "the scientific understanding of climate change is now sufficiently clear to justify taking prompt action." Eleven National Academies of Science from the major nations of the world, including the United States, the United Kingdom, Japan, China, Russia, and others, have agreed that science supports the fact that climate change is occurring, is influenced by human activity, and presents risks that should be addressed through changed practices and preparation for changed conditions.

The U.S. has spent considerable dollars on understanding the science of climate change, and we must now look to addressing and adequately funding the issue of adaptation. The focus of the USGCRP research must now move with greater focus to help states, tribes and local governments understand what that means: How will climate change manifest itself in different areas of the country? What impacts can we expect at the State and local levels? How can we prepare for the change in an effort to avoid or mitigate the impacts? How can we most effectively implement adaptation measures given that many of them will require a long lead-time?

Impacts from warming that have been projected for the West include the following:

- **Smaller snowpacks—**winter precipitation could fall as rain instead of snow; periods of snowpack accumulation could be shorter; and snowpacks could be smaller, which has serious implications for reservoir storage.
- **Earlier snowmelt—**warming earlier in the year could melt snowpacks sooner, further increasing the length of time between peak water flows and peak

water demands from cities, farmers, utilities, etc., requiring more reservoir storage to capture the earlier runoff.

- **Rainfall—**it is expected that precipitation will come more in the form of rain than snow, but it is not understood whether overall precipitation will increase or decrease, or what the temporal and spatial changes of precipitation will be.
- **Flood-control releases—**water managers may be forced to make changes in reservoir operations and rule curves.
- **More extreme flood events—**extreme events could be more common, causing more frequent and larger floods. In some cases, existing flood control 'rule curves' should be reformulated.
- **Floodplain management—**extensive efforts will be needed to better map and define floodplains, and interaction with local governments will be required to shape the direction of future development in floodplains.
- **Receding glaciers—**some scientists have suggested Glacier National Park could be void of glaciers by 2030 as a result of warming.
- **More evaporation and dryness—**higher temperatures could increase evaporation from streams and reservoirs, soil dryness, and the need for supplemental water for crops and other plants.
- **Less groundwater—**less availability of surface water supplies may lead to increased pumping from groundwater aquifers, further stressing groundwater supplies and hydraulically connected surface water supplies.
- **More droughts—**more intense, frequent, and longer-lasting droughts could result.
- **More wildfires—**there could be an increase in the number and severity of wildfires and an extended wildfire season.
- **More pests and disease—**there could be an increase in the types of disease and pests that exist and proliferate which would adversely impact human public health as well as forest and agriculture health.
- **Water quality challenges—**diminished streamflows during drought could result in less dilution of discharges; sediment loading from storm events that follow wildfires; saltwater intrusion along the coast resulting from rising sea levels; and warmer lake temperatures leading to algae blooms could follow.
- **Sea level rise—**investments in infrastructure to adapt to rising sea levels will be necessary.
- **Hydroelectric generation—**climate changes that alter overall water availability and timing could reduce the productivity of hydropower facilities; changes in the timing of hydroelectric generation can affect the value of the energy produced.
- **Water-borne shipping—**decreases in river flows could reduce the periods when navigation is possible; increase transportation costs; and increase conflicts over water allocated for other purposes.
- **Ecosystems—**natural ecosystems and wildlife have limited ability to adapt or cope with climate changes that occur over a relatively short time frame, which could lead to irreversible impacts, such as additional species extinctions.
- **Recreation impacts—**due to lower lake and stream flow levels, recreation opportunities and economies could be significantly reduced.

Given the existence of a number of variables, it is not currently possible to predict or model with any precision if, how and when a particular area within the region may be impacted. More flexible institutional arrangements are needed in order to adapt to changing conditions related to climate change and other existing stresses as well.

It must be recognized that there is already substantial stress on the water sector today even in the absence of climate change. There are many watersheds that are already fully-appropriated, and new stresses are coming from population growth, land use changes, and water needs for in-stream uses, including those necessary to meet federal laws such as the *Endangered Species Act* and the *Clean Water Act.* In some areas, the new demands may cause major shifts in water supply and water

rights. Climate change may pose additional stresses and could result in thresholds being reached much earlier than currently anticipated.

The Western Governors stated in their 2006 report, *Water Needs and Strategies for a Sustainable Future,* that Congress and the Administration should fund research for improving the predictive capabilities for climate change, and assessment and mitigation of its impacts. Additionally, given the complex climatology in the West, it is important that climate change modeling be conducted at a much finer resolution, e.g., watersheds and sub-watersheds. It is also important that the federal government implement research funding recommendations associated with Goals 4 and 5 of the 2003 CCSP Strategic Plan, including the area of increased partnerships with existing user support institutions, such as State climatologists or climate centers, regional climate centers, agricultural extension services, resource management agencies, and State and local governments.

Consistent with their report, the governors believe Title I of H.R. 906 would appropriately focus the research of the U.S. Global Change Research Program on improving the understanding of global climate change, responding to the information needs of communities and decision-makers, and providing periodic assessments of the vulnerabilities of the U.S. and other regions to global climate change. Some states are creating their own climate change research centers, including Oregon. It is important that the program created under H.R. 906 integrates and supports the efforts of State and regional climate research centers.

Additionally, Western Governors stated in their report that the federal agencies must continue and expand funding for data collection networks and activities necessary for monitoring, assessing, and predicting future water supplies. To the degree Title II of the bill will lead to such improvements to data management, the governors believe it is appropriate.

One recommendation that we would make for the bill is to amend it to address the need for a National Climate Information Service in the context of USGCRP. Such a service could be the focal point for coordination of climate activities across the Federal Government, and could be the organization charged with such responsibilities as making sustained climate observations and assessments about the state of the climate and providing climate outlooks and projections (similar to an early warning system). Additionally, the NCIS could provide routine assessments of climate impacts and vulnerabilities and develop relevant products and services for decision- and policy-makers. The National Integrated Drought Information System (NIDIS) that you authorized the last year would thus become an important component of this larger climate information system.

On May 4 of last year, the Western Governors' Association testified before your committee in support of the NIDIS bill stating:

> *No systematic collection and analysis of social, environmental and economic data focused on the impacts of drought within the United States exists today. Understanding these impacts of drought will empower users and expand the comprehension of the full magnitude of drought losses. By so doing, it will encourage local, State and federal officials to increase efforts in drought planning, preparation, and mitigation. . .. The National Integrated Drought Information System will allow policy-makers and water managers at all levels of the private and public sectors to make more informed and timely decisions about water resources in order to mitigate or avoid the impacts from droughts.*

These same statements could also be applied to the broader needs of climate data and research. Decision-makers at all levels of government and in the private sector need reliable and timely information to understand the possible impacts and corresponding vulnerabilities that are posed by climate change so they can plan and respond accordingly. The Western Governors' Association supports H.R. 906 as an effort to move the Nation's climate change research program in this direction.

DISCUSSION

THE USGCRP BUDGET PROCESS

Mr. UDALL. Thank you, Ms. Bittleman. Thank you, Members of the panel, for your excellent testimony.

At this point, we will open our first round of questions, and I will recognize myself for five minutes. And I want to start with a constituent, a Coloradan, Dr. Fellows.

As you well know from your experience at the Office of Management and Budget, in coordinating agency budgets for the USGCRP, the budget process for interagency programs is always a challenge, shall we say. Would you elaborate on your recommendation that the USGCRP Interagency Committee have "a clear budget process linking tasks to agency and program budgets?"

Are you saying that the Director of the USGCRP must have budget authority over the agencies of the USGCRP? Would the Director of OSTP, for example, be a good candidate for this function?

Dr. FELLOWS. Well, there are a lot of options here, you know, ranging from the current one, where all the agencies retain their budgets, to a completely centralized budget process, and I am not sure that either end of the spectrum is the right way to go.

I do think there is an argument to be made for the Director of the U.S. Global Change Research Program to be close enough to political power to have the clout to make the kind of decisions and tradeoffs that you would across an agency, and probably, to have some level of budget authority that he can use to help encourage, or provide incentives for people to make investments in the highest priority areas of the program.

We used to, when I was in OMB, have an annual budget review process, where we actually called all the agencies in. They got a chance to present their programs, every relevant budget examiner and representative of OSTP had a chance to hear their programs, got to see the links between the programs, and I thought that that was a pretty effective mechanism to try to make the kind of tradeoffs. But we never had the real clout to actually be able to say we need to move in one particular area. We had to rely on the goodwill between all the agencies to do that, so I think that budget authority could help the Director.

Mr. UDALL. Anyone else want to comment on that particular question, given Dr. Fellows' expertise, but others have also faced this same dilemma?

Dr. MAHONEY. Exactly. Mr. Udall, just a brief comment that perhaps it is trying to think pragmatically about what might work. I had somewhat of a hybrid position, because I was a Senate confirmed subcabinet officer, so I had, for better or for worse, political standing over these recent years in managing the program, and I had access to the very top of OMB, OSTP, and exercised those, and to all of the relevant Cabinet officers frequently enough. Still, what I recommend is close to what Dr. Fellows has just said, but I would treat it a little bit differently.

I think that there should be a definite recognized management and coordination function, because that is where, as little as it is, some very important things are done now in the communications area, and in getting all these reports out, and they are tremendously under-resourced, the people in that office work very hard to get it done. But it is also a major source of delay, because they are just overwhelmed.

I think if we took that same office, and I wouldn't want to give any climate program head budget authority over a Cabinet department. I don't think that makes sense. But if that function were placed in one of the departments, but clearly, its role was to be subject to the review by the others, and it had a very small budget

itself in that department, one part for its own manpower, for example, which wouldn't be much, and I actually have in my statement a recommendation about two other functions, close to what Dr. Fellows was talking about. One, that would provide a small kitty of developmental and bright idea and filling the gaps funds that it could administer on a transfer basis or whatever else, and the other one, to provide some seed money for some assessment work.

And to my experience of working in the last several years on this, anyway, having that capability, with an element of budget, which would flow through that department's own budget, but which would be clearly identified as funds to support this programmatic activity, would be a way to maintain the normal purity of the departments being responsible for their own budgets, while having a relatively small budget that could be, it could reach around some.

And that is an area where I would think that some direction by the Congress about its desire to see a more efficient and effective process, given the complexity of our government, would be a positive step.

Mr. UDALL. Thank you, and I see that my time has expired, and Doctor, I will come back to you, and I want to, at this point, I want to recognize my friend and coauthor of this legislation, I want to thank Congressman Inglis again for his joining me in this important endeavor, and Mr. Inglis, you are recognized for five minutes.

ASSESSMENT TIMELINE

Mr. INGLIS. Thank you, Mr. Udall, and I am interested in the timeline that, for updating the ten year Global Change Research Plan. The bill calls for it being updated every four years, and I wonder if you all might want to comment on whether you think that is a sufficient schedule for updates, or will it become stale within that four year period, or do you have any thoughts about that?

Dr. MACCRACKEN. Well, the first one was developed in about 1990, and had a theme that was very disciplinary. It had what were called seven disciplinary areas, so, ecology and things. We actually did develop an alternative approach in the mid-'90s, to try and cut it a different way, to focus on the stratospheric ozone issue, on seasonal to inter-annual, on climate change, and on, I think, land cover, and things. There wasn't a formal plan put out, although there was, in one of these Our Changing Planets a set of objectives and a whole bunch of sort of activities that are not a whole lot different than what came out in the plan later.

I think it is useful every, I am not sure four years is the right number, but you do need to sort of take a different perspective. This is a very complex issue, and there is no optimal way to cut it into pieces, and so, I think it helps to take different looks at different times, and get different perspectives.

We wanted to do that also on the National Assessment, come at it not the second time for climate change, because in four years, that wouldn't have changed so much, but come at it, for example, on well, what are all the factors affecting land cover that we have? Think about global change very broadly. What are the things that are affecting land cover? And so that partly is climate change and

partly variability, and partly atmospheric chemistry changes, and a whole bunch of other things. So, cut it differently, try and get some new insights.

So, requiring something in an update, and some re-looking, I think, is useful. It can be a hard process, but it is useful.

Mr. INGLIS. And Dr. Fellows.

Dr. FELLOWS. I was just going to mention that the world climate science community every five years takes a look, it essentially takes a temperature of the new science in the climate arena, so I think four or five years is probably pretty reasonable.

In the bill, and Dr. Mahoney touched on this, it actually talks about a ten year research plan, an annual plan, a vulnerability plan, a policy plan, and they are all due the first year. It would be interesting to actually look at how that plan might change, if you did the vulnerability and the policy assessment first. So, there is even some sequencing of how you would do these various reports, but a five year cycle, a four or five year cycle is probably good for the program plan itself.

Mr. INGLIS. Some people might say to us about this bill that you know, you can collect information, but is it going to help us that much? And I am thinking of the mountain trout, I believe it is, in the streams of North Carolina and a little bit of South Carolina, in the mountains. Apparently, 1 degree Fahrenheit, I believe it is, temperature change, and we have no more trout. It warms up 1 degree, and they are gone from our rivers.

And I guess, the question is: is it helpful to know? I think it does build awareness. Is that right, Ms. Bittleman?

Ms. BITTLEMAN. Yes, Mr. Inglis, I had wanted to add to this, having the assessments reviewed and updated, and the scientific data reviewed and updated periodically, whether it is three years, four years, five years, is all very important. But from a State perspective, I think it is important to realize that the entire process of data collection and adaptation and how climate change is being experienced on the ground is really, to us, what the important aspect of this bill is, which is every year, when data is being collected, at the same time, states like Oregon, and in the Carolinas and Pacific Northwest, the Carolinas, the states are actually acting. We have user groups, we have climate change groups, we have scientists, but we also have economists and businesses that are really reacting to and trying to anticipate how their businesses are going to change.

Salmon fishery is a very good example in the Pacific Northwest. We are looking at salmon populations all the time, in conjunction with NOAA, and the question is, you know, is climate change going to—what are the long-term effects of climate change, and how are we, as an industry, the salmon industry, how are they going to react to that? How can we help them react to that?

So, while—I just would hope that you don't, you know, when there is a year date for a report, I don't think that is as important as the flexibility needed to incorporate all this, all the information, science data, but also, activities that are happening on the ground, including what is happening in the states, and how the states are responding.

Mr. INGLIS. Thank you. My time has expired.

REGIONAL VS. NATIONAL ASSESSMENTS

Mr. UDALL. Thank the gentleman. We will come back around for a second round, if you all can stay. I recognize myself again for five minutes, and I want to start with Ms. Bittleman, but I would alert the panel that I would like you all to think about weighing in once she has had a chance to answer.

And I want to just talk about this regional versus national assessments dynamic that we have. We certainly need regional assessments and regional responses, but each individual region doesn't stand on its own. You get impacts, consequences in other areas. And for this reason, we need also national assessments.

Would you agree, and if so, how do we ensure that the USGCRP will serve both of these information needs?

Ms. BITTLEMAN. Well, since I am here representing a region, I am going to fall on the side of preferring a regional approach, but I think you are absolutely right. We do need national information and a national approach.

Again, I don't see these things as actually separate. In Oregon, and in the Pacific Northwest, we would like to collect climate information on a watershed and sub-watershed level. That is a much more specific level than a region, than a state or a region, and so, what we would like to see is all of this information integrated. So, from a sub-watershed to watershed to State to region to national level, and we see the possibility of integration as the real hope here.

THE INSURANCE INDUSTRY'S PERSPECTIVE

Mr. UDALL. Anyone else like to respond? Mr. Nutter. And Mr. Nutter, by the way, it is always great to have you as part of these hearings, because you bring the economic implications of much of this to the fore, which is crucial to consider, and it is, in fact, why a lot of us have moved, a lot of communities, a lot of industries are moving in the direction. Let us respond now. We have time.

Mr. NUTTER. Well, thank you for the question and the comment.

From the insurance perspective, regional assessments are probably imperative. There is not much point in looking at a national assessment without understanding the subcategories of all that. The effect of climate change on extreme weather events in the Gulf is different than it is for a State like Florida, or East Coast or upper East Coast. The same would be true, the same comment would be true if you are looking at the effect of extreme weather events in the Midwest, the tornados and other extreme events.

So, from our perspective, the regionalization of the assessment is, frankly, the most valuable part.

Mr. UDALL. Very good point. Very useful. Dr. MacCracken.

MORE ON REGIONAL VS. NATIONAL ASSESSMENTS

Dr. MACCRACKEN. I think that is also a very good question. We tried, because there are a number of issues that cut across, to have sector assessments do that, so you wanted to crosscut with that. And so, if you are interested in how the forests are going to do, health-wise, locally, you want to have a regional one. If you want to understand the market for forest products, you have to look

more broadly, certainly across the country. Or if you want to look at agriculture, you can look at what happens to a farmer in a particular place, or you can look at food production more broadly.

So, I think you need both regions, you need sectors, and the area that we didn't get to at all in what we were, realized needed to get done, was how what happens elsewhere in the world affects what happens here, so that can be everything on natural factors, like migratory species, to what happens with our investments. When there was a drought in Indonesia several years ago, there were layoffs on Wall Street. I mean, the world is interconnected with investments. It is certainly interconnected with respect to health, and it is certainly interconnected with respect to environmental refugees.

IPCC looks at some of these, but it sort of does the chapters a little bit separately, and hasn't looked at how one set of countries depends on another, and the various economic connections. So, there are a lot of different cuts that have to be taken, and together, that is how you draw forth the findings for a national level report that would be meaningful to Members of Congress.

Mr. UDALL. There is an interesting school of thought out there when it comes to this challenge we face of responding to global change, and we are having that discussion today, or climate change, or both. If we would figure—I should say when we figure this one out, as the human race, that we will actually create a template to deal with a lot of other challenges and opportunities and problems that we face across the globe.

And that keeps me going every day, given the size of this, and the complexity of what we face.

Dr. MACCRACKEN. The report that we did, that this UN panel recently did for the Commission on Sustainable Development, tried to very much make that point, that climate change is intimately tied to meeting the Millennium Development Goals, and if you don't think about climate change in the context, you are not going to be able to ensure meeting the water needs and the other kinds of things in particular regions, or severe weather, or other kinds of things. So, it is, indeed, all coupled, and has to be done that way, looked at that way.

CLIMATE CHANGE MITIGATION AND ADAPTATION

Mr. UDALL. I know my time has expired, but Mr. Inglis and I have reached an agreement. I think he has asked the questions he would like to ask. I am going to go for a few more minutes, and then, we will begin to bring the hearing to a close, but I did want to turn back to Mr. Nutter, if I might, for a minute, and ask you a question about the large population growth in high risk areas that has exacerbated the impacts of climate change.

Would you comment on how H.R. 906 might provide information to reduce the vulnerability of these already overstressed areas?

Mr. NUTTER. Thank you for the question.

To the extent that the assessments can help not just our industry, the insurance industry, but those who regulate our industry, and those who look at protecting people's property and lives through building codes or other hazard mitigation, we will all learn from the information about increased frequency or severity of storms, and other research products from this program. It would

have enormous public benefit, and obviously, the private benefit to all of us who are engaged in risk assessment or risk mitigation.

So, I see it as a valuable product, as we try to understand the dynamics of a changing climate. My recollection is that 53 percent of the U.S. population lives within 50 miles of a coast. That is a pretty remarkable exposed population. The State of Florida has $2 trillion of insured properties. The State of New York has $2 trillion of insured properties. My recollection, Mr. Inglis, is that your state has something like $150 billion of insured properties.

It is a remarkable exposure, and our ability to deal with the financing of recovery from extreme events, and understand the dynamics, so we can protect property and life from that would be a byproduct of this legislation.

Mr. UDALL. Thank you for that response. Dr. MacCracken, I would turn back to you briefly. You recommend keeping research on climate change science separate from that on energy technologies. I assume you are referring to technology development and research. At some point, however, shouldn't we evaluate new energy technologies, their potential deployment schedules, their costs, and their missions profiles, to see how they will impact atmospheric concentrations of greenhouse gases? And in general, where should this analysis of issues that intersect the science and technology development occur? Easy question, I know.

Dr. MACCRACKEN. You know, I was, in my comment, just trying to keep the, to make sure that the research that goes on about what is going to happen, and the decisions about what technology research you fund, are not so closely intermixed that they bias each other, that you say, well, I mean, I think the fear was in some of the 1990s, that people will use climate change to justify funding fusion research or something, and we really wanted to pursue those kinds of things separately. Certainly, you have to look at what the, what will happen, in terms of technology, and in fact, if I can just go back to comments that Ms. Bittleman and Phil made, when they called for a National Climate Information Service, that is absolutely vital, but there are some other things we need as well, to project into the future that we struggle with, and that includes what is going to happen to the Nation's ecosystems, sort of the land cover projection, what is going to happen in terms of demographics and in economics and technology.

One of the things we struggled with, in trying to put together a useful assessment, was to project well, what is really going to happen? Are there things around the corner that are going to mean that this isn't the problem? How are we going to adapt to it? And one needs to have some sort of perhaps central facility to make that happen, or central, maybe it is a virtual program, or some place where it comes together, but it can't just be Climate Information Service, because as soon as you say, well, I have got the Climate Information Service, then people are going to ask: "Well, what is happening with economic development?" Or "what is happening with demographics and population?" And "where are people choosing to live?" and all these other issues. And that whole social science part of what needs to be in global change isn't really well-funded and doesn't even have much of a constituency or capability for it.

Mr. UDALL. Dr. Mote, I am going to move to you now, if I could.

Dr. MOTE. Sure.

Mr. UDALL. And—if I could ask—you want to comment on that, and then, I will ask you a question?

Dr. MOTE. Yeah, let me just comment on the—another aspect of this sort of separation that Dr. MacCracken talked about is in some instances, mitigating and adapting to climate change do come together. For example, evaluating the resilience of hydropower to a changing climate, or wind power. So, as we design portfolios of future energy, are those portfolios themselves resistant to or resilient to the kinds of changes that may come down in the future.

Mr. UDALL. That is a very, very good point. Some cases, it may work to power needs benefits, in other cases, it may actually work the other way. Hydropower——

Dr. MOTE. Yeah, in the Pacific Northwest is having——

Mr. UDALL. Hydropower——

Dr. MOTE.—warming climates actually helps our hydropower production, because it puts availability of supply more in sync with regional demand. It sort of leaves California in a more difficult position, because then, we don't have spare power to sell in the summer, but——

Mr. UDALL. I am going to not be tempted to comment on that, as a Coloradan, but let me turn to RISA for a minute, and you discussed it as an example of a stakeholder-driven climate sciences venture. How could the climate program be tailored to build upon the work being done by RISA?

Dr. MOTE. Well, the key success of the RISA program has been putting top level scientists directly in touch with top level decision-makers on the regional, State, and local scale. And you know, to some extent, that happens nationally, but these are partnerships that lead to better science, because the science is then driven by a genuine societal need, and it also leads to better management, because the decision-makers are slowly learning more about climate.

Again, it is not just about future climate change, but the patterns of variability that we already experience, paleoclimate, you know, evaluating how robust is the Colorado River Compact, given the 400 year perspective that we get from tree rings, things like that.

Mr. UDALL. Thank you. You had to bring the Colorado River into this.

Dr. MOTE. I drew my first breath 42 years ago today in the high mountain air of Colorado, so——

Mr. UDALL. Today is your birthday?

Dr. MOTE. Yes.

Mr. UDALL. Well, happy birthday. Well, maybe we should——

Dr. MOTE. Thank you.

Mr. UDALL. Well, I think that is a great place to stop at this point.

I did want to yield to Mr. Inglis for a couple of concluding remarks, and then, we will bring the hearing to a close.

Mr. INGLIS. So, I am going to sing. I will spare you, but happy birthday. And I thank Mr. Udall for chairing this part of the hearing, and appreciate his work on this, and it has been very helpful

for me to hear your comments, so thank you for the education you have afforded us today.

Mr. UDALL. Well, let me conclude by thanking you all for appearing before the Subcommittee. It is clear, I hope, to all of you, and those listening, and those participating today, that I take the challenge, as does Congressman Inglis, and many of us here in the House, of addressing global warming, very seriously, and it is one of our highest priorities in the Congress.

Your testimony, as we have said, has been very helpful, and I believe that this legislation will take an important step forward in providing planners with the tools they need to combat climate change.

Under the rules of the Committee, the record will be held open for two weeks for Members to submit additional statements and any additional questions they might have for the witnesses.

At this time, the hearing is now adjourned.

[Whereupon, at 3:52 p.m., the Subcommittee was adjourned.]

Appendix:

Additional Material for the Record

I

110TH CONGRESS
1ST SESSION

H. R. 906

To promote and coordinate global change research, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

FEBRUARY 7, 2007

Mr. UDALL of Colorado (for himself and Mr. INGLIS of South Carolina) introduced the following bill; which was referred to the Committee on Science and Technology, and in addition to the Committee on Foreign Affairs, for a period to be subsequently determined by the Speaker, in each case for consideration of such provisions as fall within the jurisdiction of the committee concerned

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A BILL

To promote and coordinate global change research, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Global Change Research and Data Management Act of 2007".

TITLE I—GLOBAL CHANGE RESEARCH

SEC. 101. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress makes the following findings:

(1) Industrial, agricultural, and other human activities, coupled with an expanding world population, are contributing to processes of global change that are significantly altering the Earth habitat.

(2) Such human-induced changes, in conjunction with natural fluctuations, may lead to significant alterations of world climate patterns. Over the next century, these changes could adversely effect world agricultural and marine production, coastal habitability, biological diversity, human health, global social and political stability, and global economic activity.

(3) Developments in interdisciplinary Earth sciences, global observing systems, and satellite and computing technologies make possible significant scientific understanding of global changes and their effects, and have resulted in the significant expansion of environmental data and information.

(4) Development of effective policies to prevent, mitigate, and adapt to global change will rely on im-

1 provement in scientific understanding of global envi-
2 ronmental processes and on development of informa-
3 tion that is of use to decisionmakers at the local, re-
4 gional, and national levels.

5 (5) Although the United States Global Change
6 Research Program has made significant contribu-
7 tions to understanding Earth's climate and the an-
8 thropogenic influences on Earth's climate and its
9 ecosystems, that Program has not produced suffi-
10 cient information to meet the expressed needs of de-
11 cisionmakers.

12 (6) Predictions of future climate conditions for
13 specific regions have considerable uncertainty and
14 are unlikely to be confirmed in a time period nec-
15 essary to inform decisions on land, water, and re-
16 source management. However, improved under-
17 standing of global change should be used to assist
18 decisionmakers in the development of policies to en-
19 sure that ecological, social, and economic systems
20 are resilient under a variety of plausible climate fu-
21 tures.

22 (7) In order to most effectively meet the needs
23 of decisionmakers, both the research agenda of the
24 United States Global Change Research Program and
25 its implementation must be informed by continuous

1 feedback from documented users of information gen-
2 erated by the Program.
3 (b) PURPOSE.—The purpose of this title is to provide
4 for the continuation and coordination of a comprehensive
5 and integrated United States observation and research
6 program which will assist the Nation and the world to un-
7 derstand, assess, predict, and respond to the effects of
8 human-induced and natural processes of global change.
9 **SEC. 102. DEFINITIONS.**
10 For purposes of this title—
11 (1) the term "global change" means human-in-
12 duced or natural changes in the global environment
13 (including alterations in climate, land productivity,
14 oceans or other water resources, atmospheric chem-
15 istry, biodiversity, and ecological systems) that may
16 alter the capacity of the Earth to sustain life;
17 (2) the term "global change research" means
18 study, monitoring, assessment, prediction, and infor-
19 mation management activities to describe and under-
20 stand—
21 (A) the interactive physical, chemical, and
22 biological processes that regulate the total
23 Earth system;
24 (B) the unique environment that the Earth
25 provides for life;

(C) changes that are occurring in the Earth system; and

(D) the manner in which such system, environment, and changes are influenced by human actions;

(3) the term "interagency committee" means the interagency committee established under section 103;

(4) the term "Plan" means the National Global Change Research Plan developed under section 105; and

(5) the term "Program" means the United States Global Change Research Program established under section 104.

SEC. 103. INTERAGENCY COOPERATION AND COORDINATION.

(a) ESTABLISHMENT.—The President shall establish an interagency committee to ensure cooperation and coordination of all Federal research activities pertaining to processes of global change for the purpose of increasing the overall effectiveness and productivity of Federal global change research efforts. The interagency committee shall include representatives of both agencies conducting global change research and agencies with authority over resources likely to be affected by global change.

1 (b) FUNCTIONS OF THE INTERAGENCY COM-
2 MITTEE.—The interagency committee shall—
3 (1) serve as the forum for developing the Plan
4 and for overseeing its implementation;
5 (2) serve as the forum for developing the vul-
6 nerability assessment under section 107;
7 (3) ensure cooperation among Federal agencies
8 with respect to global change research activities;
9 (4) work with academic, State, industry, and
10 other groups conducting global change research, to
11 provide for periodic public and peer review of the
12 Program;
13 (5) cooperate with the Secretary of State in—
14 (A) providing representation at inter-
15 national meetings and conferences on global
16 change research in which the United States
17 participates; and
18 (B) coordinating the Federal activities of
19 the United States with programs of other na-
20 tions and with international global change re-
21 search activities;
22 (6) work with appropriate Federal, State, re-
23 gional, and local authorities to ensure that the Pro-
24 gram is designed to produce information needed to
25 develop policies to reduce the vulnerability of the

1 United States and other regions to global change;
2 and
3 (7) identify additional decisionmaking groups
4 that may use information generated through the
5 Program.

6 **SEC. 104. UNITED STATES GLOBAL CHANGE RESEARCH**
7 **PROGRAM.**

8 The President shall establish an interagency United
9 States Global Change Research Program to improve un-
10 derstanding of global change, to respond to the informa-
11 tion needs of communities and decisionmakers, and to pro-
12 vide periodic assessments of the vulnerability of the United
13 States and other regions to global change. The Program
14 shall be implemented in accordance with the Plan.

15 **SEC. 105. NATIONAL GLOBAL CHANGE RESEARCH PLAN.**

16 (a) IN GENERAL.—The President shall develop a Na-
17 tional Global Change Research Plan for implementation
18 of the Program. The Plan shall contain recommendations
19 for global change research. The President shall submit the
20 Plan to the Congress within 1 year after the date of enact-
21 ment of this Act, and shall submit a revised Plan at least
22 once every 4 years thereafter. In the development of each
23 Plan, the President shall conduct a formal assessment
24 process to determine the needs of appropriate Federal,
25 State, regional, and local authorities and other interested

1 parties regarding the types of information needed by them
2 in developing policies to reduce society's vulnerability to
3 global change and shall utilize these assessments in devel-
4 oping the Plan.

5 (b) CONTENTS OF THE PLAN.—The Plan shall—

6 (1) establish, for the 10-year period beginning
7 in the year the Plan is submitted, the goals and pri-
8 orities for Federal global change research which
9 most effectively advance scientific understanding of
10 global change and provide information of use to
11 Federal, State, regional, and local authorities in the
12 development of policies relating to global change;

13 (2) describe specific activities, including efforts
14 to determine user information needs, research activi-
15 ties, data collection and data analysis requirements,
16 assessment of model predictability, participation in
17 international research efforts, and information man-
18 agement, required to achieve such goals and prior-
19 ities;

20 (3) identify relevant programs and activities of
21 the Federal agencies that contribute to the Program
22 directly and indirectly;

23 (4) set forth the role of each Federal agency in
24 implementing the Plan;

1 (5) consider and utilize, as appropriate, reports
2 and studies conducted by Federal agencies, the Na-
3 tional Research Council, or other entities;
4 (6) make recommendations for the coordination
5 of the global change research activities of the United
6 States with such activities of other nations and
7 international organizations, including—
8 (A) a description of the extent and nature
9 of international cooperative activities;
10 (B) bilateral and multilateral efforts to
11 provide worldwide access to scientific data and
12 information; and
13 (C) improving participation by developing
14 nations in international global change research
15 and environmental data collection;
16 (7) detail budget requirements for Federal glob-
17 al change research activities to be conducted under
18 the Plan;
19 (8) catalog the type of information identified by
20 appropriate Federal, State, regional, and local deci-
21 sionmakers needed to develop policies to reduce soci-
22 ety's vulnerability to global change and indicate how
23 the planned research will meet these decisionmakers'
24 information needs; and

1 (9) identify the observing systems currently em-
2 ployed in collecting data relevant to global change
3 research and prioritize additional observation sys-
4 tems that may be needed to ensure adequate data
5 collection and monitoring of global change.
6 (c) RESEARCH ELEMENTS.—The Plan shall include
7 at a minimum the following research elements:
8 (1) Global measurements, establishing world-
9 wide to regional scale observations prioritized to un-
10 derstand global change and to meet the information
11 needs of decisionmakers on all relevant spatial and
12 time scales.
13 (2) Information on economic and demographic
14 trends that contribute to changes in the Earth sys-
15 tem and that influence society's vulnerability to
16 global change.
17 (3) Development of indicators and baseline
18 databases to document global change, including
19 changes in species distribution and behavior, extent
20 of glaciations, and changes in sea level.
21 (4) Studies of historical changes in the Earth
22 system, using evidence from the geological and fossil
23 record.

1 (5) Assessments of predictability using quan-
2 titative models of the Earth system to simulate glob-
3 al and regional environmental processes and trends.
4 (6) Focused research initiatives to understand
5 the nature of and interaction among physical, chem-
6 ical, biological, and social processes related to global
7 change.
8 (7) Focused research initiatives to determine
9 and then meet the information needs of appropriate
10 Federal, State, and regional decisionmakers.
11 (d) INFORMATION MANAGEMENT.—The Plan shall
12 incorporate, to the extent practicable, the recommenda-
13 tions relating to data acquisition, management, and
14 archiving made by the interagency climate and other glob-
15 al change data management working group established
16 under section 203.
17 (e) NATIONAL ACADEMY OF SCIENCES EVALUA-
18 TION.—The President shall enter into an agreement with
19 the National Academy of Sciences under which the Acad-
20 emy shall—
21 (1) evaluate the scientific content of the Plan;
22 and
23 (2) recommend priorities for future global
24 change research.

1 (f) NATIONAL GOVERNORS ASSOCIATION EVALUA-
2 TION.—The President shall seek to enter into an agree-
3 ment with the National Governors Association Center for
4 Best Practices under which that Center shall—
5 (1) evaluate the utility to State, local, and re-
6 gional decisionmakers of each Plan and of the antici-
7 pated and actual information outputs of the Pro-
8 gram for development of policies to reduce vulner-
9 ability to global change; and
10 (2) recommend priorities for future global
11 change research.
12 (g) PUBLIC PARTICIPATION.—In developing the
13 Plan, the President shall consult with academic, State, in-
14 dustry, and environmental groups and representatives.
15 Not later than 90 days before the President submits the
16 Plan, or any revision thereof, to the Congress, a summary
17 of the proposed Plan shall be published in the Federal
18 Register for a public comment period of not less than 60
19 days.
20 **SEC. 106. BUDGET COORDINATION.**
21 (a) IN GENERAL.—The President shall provide gen-
22 eral guidance to each Federal agency participating in the
23 Program with respect to the preparation of requests for
24 appropriations for activities related to the Program.

1 (b) CONSIDERATION IN PRESIDENT'S BUDGET.—The
2 President shall submit, at the time of his annual budget
3 request to Congress, a description of those items in each
4 agency's annual budget which are elements of the Pro-
5 gram.

6 **SEC. 107. VULNERABILITY ASSESSMENT.**

7 Within 1 year after the date of enactment of this Act,
8 and at least once every 4 years thereafter, the President
9 shall submit to the Congress an assessment which—

10 (1) integrates, evaluates, and interprets the
11 findings of the Program and discusses the scientific
12 uncertainties associated with such findings;

13 (2) based on indicators and baselines developed
14 under section 105(c)(3), as well as other measure-
15 ments, analyzes changes to the natural environment,
16 land and water resources, and biological diversity
17 in—

18 (A) major geographic regions of the United
19 States; and

20 (B) other continents;

21 (3) analyzes the effects of global change, includ-
22 ing the changes described in paragraph (2), on agri-
23 culture, energy production and use, transportation,
24 human health and welfare, and human social and
25 economic systems, including providing information

1 about the differential impacts on specific geographic
2 regions within the United States, on people of dif-
3 ferent income levels within those regions, and for
4 rural and urban areas within those regions;
5 (4) analyzes the vulnerability of different geo-
6 graphic regions of the world to global change, in-
7 cluding analyses of the implications of global change
8 for international assistance, population displacement,
9 and national security; and
10 (5) analyzes the adoption rates of policies and
11 technologies available to reduce the vulnerability of
12 society to global change with an evaluation of the
13 market and policy barriers suppressing their adop-
14 tion in the United States.

15 **SEC. 108. POLICY ASSESSMENT.**

16 Not later than 1 year after the date of enactment
17 of this Act, and at least once every 3 years thereafter,
18 the President shall submit to the Congress a policy assess-
19 ment which—
20 (1) documents current policy options being uti-
21 lized by Federal, State, and local governments to
22 mitigate or adapt to the effects of global change;
23 (2) evaluates the realized and anticipated effec-
24 tiveness of those current policy options in addressing
25 global change; and

1 (3) identifies and evaluates additional policy op-
2 tions for mitigating or adapting to the effects of
3 global change.

4 **SEC. 109. ANNUAL REPORT.**

5 Each year at the time of submission to the Congress
6 of the President's budget request, the President shall sub-
7 mit to the Congress a report on the activities conducted
8 pursuant to this title, including—

9 (1) a summary of the achievements of the Pro-
10 gram during the period covered by the report;

11 (2) an analysis of the progress made toward
12 achieving the goals of the Plan; and

13 (3) a list of the State, local, and regional deci-
14 sionmakers identified as potential users of the infor-
15 mation generated through the Program and a de-
16 scription of the consultations with this community
17 coordinated through the work of the interagency
18 committee.

19 **SEC. 110. RELATION TO OTHER AUTHORITIES.**

20 The President shall ensure that relevant research ac-
21 tivities of the National Climate Program, established by
22 the National Climate Program Act (15 U.S.C. 2901 et
23 seq.), are considered in developing national global change
24 research efforts.

1 **SEC. 111. REPEAL.**

2 The Global Change Research Act of 1990 (15 U.S.C.
3 2921 et seq.) is repealed.

4 TITLE II—CLIMATE AND OTHER
5 GLOBAL CHANGE DATA MAN-
6 AGEMENT

7 **SEC. 201. FINDINGS AND PURPOSES.**

8 (a) FINDINGS.—The Congress makes the following
9 findings:

10 (1) Federal agencies have a primary mission to
11 manage and archive climate and other global change
12 data obtained through their research, development,
13 or operational activities.

14 (2) Maintenance of climate and global change
15 data records is essential to present and future stud-
16 ies of the Earth's atmosphere, biogeochemical cycles,
17 and climate.

18 (3) Federal capabilities for the management
19 and archiving of these data have not kept pace with
20 advances in satellite and other observational tech-
21 nologies that have vastly expanded the type and
22 amount of information that can be collected.

23 (4) Proposals and plans for expansion of global
24 observing networks should include plans for the
25 management of data to be collected and budgets re-

1 flecting the cost of support for management and
2 archiving of data.
3 (b) PURPOSES.—The purposes of this title are to es-
4 tablish climate and other global change data management
5 and archiving as Federal agency missions, and to establish
6 Federal policies for managing and archiving climate and
7 other global change data.
8 **SEC. 202. DEFINITIONS.**
9 For purposes of this title—
10 (1) the term "metadata" means information de-
11 scribing the content, quality, condition, and other
12 characteristics of climate and other global change
13 data, compiled, to the maximum extent possible, con-
14 sistent with the requirements of the "Content Stand-
15 ard for Digital Geospatial Metadata" (FGDC–STD–
16 001–1998) issued by the Federal Geographic Data
17 Committee, or any successor standard approved by
18 the working group; and
19 (2) the term "working group" means the inter-
20 agency climate and other global change data man-
21 agement working group established under section
22 203.

1 **SEC. 203. INTERAGENCY CLIMATE AND OTHER GLOBAL**
2 **CHANGE DATA MANAGEMENT WORKING**
3 **GROUP.**

4 (a) ESTABLISHMENT.—The President shall establish
5 an interagency climate and other global change data man-
6 agement working group to make recommendations for co-
7 ordinating Federal climate and other global change data
8 management and archiving activities.

9 (b) MEMBERSHIP.—The working group shall include
10 the Administrator of the National Aeronautics and Space
11 Administration, the Administrator of the National Oceanic
12 and Atmospheric Administration, the Secretary of Energy,
13 the Secretary of Defense, the Director of the National
14 Science Foundation, the Director of the United States Ge-
15 ological Survey, the Archivist of the United States, the
16 Administrator of the Environmental Protection Agency,
17 the Secretary of the Smithsonian Institution, or their des-
18 ignees, and representatives of any other Federal agencies
19 the President considers appropriate.

20 (c) REPORTS.—Not later than 1 year after the date
21 of enactment of this Act, the working group shall transmit
22 a report to the Congress containing the elements described
23 in subsection (d). Not later than 3 years after the initial
24 report under this subsection, and not later than once every
25 4 years subsequent to that, the working group shall trans-
26 mit reports updating the previous report. In preparing re-

1 ports under this subsection, the working group shall con-
2 sult with expected users of the data collected and archived
3 by the Program.

4 (d) CONTENTS.—The reports and updates required
5 under subsection (c) shall—

6 (1) include recommendations for the establish-
7 ment, maintenance, and accessibility of a catalog
8 identifying all available climate and other global
9 change data sets;

10 (2) identify climate and other global change
11 data collections in danger of being lost and rec-
12 ommend actions to prevent such loss;

13 (3) identify gaps in climate and other global
14 change data and recommend actions to fill those
15 gaps;

16 (4) identify effective and compatible procedures
17 for climate and other global change data collection,
18 management, and retention and make recommenda-
19 tions for ensuring their use by Federal agencies and
20 other appropriate entities;

21 (5) develop and propose a coordinated strategy
22 for funding and allocating responsibilities among
23 Federal agencies for climate and other global change
24 data collection, management, and retention;

(6) make recommendations for ensuring that particular attention is paid to the collection, management, and archiving of metadata;

(7) make recommendations for ensuring a unified and coordinated Federal capital investment strategy with respect to climate and other global change data collection, management, and archiving;

(8) evaluate the data record from each observing system and make recommendations to ensure that delivered data are free from time-dependent biases and random errors before they are transferred to long-term archives; and

(9) evaluate optimal design of observation system components to ensure a cost-effective, adequate set of observations detecting and tracking global change.

TITLE III—INTERNATIONAL COOPERATION IN GLOBAL CHANGE RESEARCH

SEC. 301. FINDINGS AND PURPOSES.

(a) FINDINGS.—The Congress makes the following findings:

(1) Pooling of international resources and scientific capabilities will be essential to a successful international global change program.

1 (2) While international scientific planning is al-
2 ready underway, there is currently no comprehensive
3 intergovernmental mechanism for planning, coordi-
4 nating, or implementing research to understand
5 global change and to mitigate possible adverse ef-
6 fects.
7 (3) An international global change research
8 program will be important in building future con-
9 sensus on methods for reducing global environmental
10 degradation.
11 (4) The United States, as a world leader in en-
12 vironmental and Earth sciences, should help provide
13 leadership in developing and implementing an inter-
14 national global change research program.
15 (b) PURPOSES.—The purposes of this title are to—
16 (1) promote international, intergovernmental
17 cooperation on global change research;
18 (2) involve scientists and policymakers from de-
19 veloping nations in such cooperative global change
20 research programs; and
21 (3) promote international efforts to provide
22 technical and other assistance to developing nations
23 which will facilitate improvements in their domestic
24 standard of living while minimizing damage to the
25 global or regional environment.

1 **SEC. 302. INTERNATIONAL DISCUSSIONS.**

2 (a) GLOBAL CHANGE RESEARCH.—The President
3 shall direct the Secretary of State to initiate discussions
4 with other nations leading toward international protocols
5 and other agreements to coordinate global change research
6 activities. Such discussions should include the following
7 issues:

8 (1) Allocation of costs in global change research
9 programs, especially with respect to major capital
10 projects.

11 (2) Coordination of global change research
12 plans with those developed by international organiza-
13 tions such as the International Council on Scientific
14 Unions, the World Meteorological Organization, and
15 the United Nations Environment Program.

16 (3) Establishment of global change research
17 centers and training programs for scientists, espe-
18 cially those from developing nations.

19 (4) Development of innovative methods for
20 management of international global change research,
21 including the use of new or existing intergovern-
22 mental organizations for the coordination or funding
23 of global change research.

24 (5) Establishment of international offices to
25 disseminate information useful in identifying, pre-

1 venting, mitigating, or adapting to the possible ef-
2 fects of global change.
3 (b) ENERGY RESEARCH.—The President shall direct
4 the Secretary of State (in cooperation with the Secretary
5 of Energy, the Secretary of Commerce, the United States
6 Trade Representative, and other appropriate Federal
7 agents) to initiate discussions with other nations leading
8 toward an international research protocol for cooperation
9 on the development of energy technologies which have
10 minimally adverse effects on the environment. Such dis-
11 cussions should include the following issues:
12 (1) Creation of an international cooperative
13 program to fund research related to energy effi-
14 ciency and conservation, solar and other renewable
15 energy sources, and passively safe and diversion-re-
16 sistant nuclear reactors.
17 (2) Creation of an international cooperative
18 program to develop low-cost energy technologies
19 which are appropriate to the environmental, eco-
20 nomic, and social needs of developing nations.
21 (3) Exchange of information concerning envi-
22 ronmentally safe energy technologies and practices,
23 including those described in paragraphs (1) and (2).

1 **SEC. 303. GLOBAL CHANGE RESEARCH INFORMATION OF-**
2 **FICE.**

3 The President shall establish an Office of Global
4 Change Research Information to disseminate to foreign
5 governments, businesses, and institutions, as well as the
6 citizens of foreign countries, scientific research and other
7 information available in the United States which would be
8 useful in preventing, mitigating, or adapting to the effects
9 of global change.

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