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**HEARING ON
“EXPANDING CLIMATE SERVICES AT THE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA):
DEVELOPING THE NATIONAL CLIMATE SERVICE”**

**BEFORE THE
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
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Introduction

Chairman Baird, Ranking Member Inglis, and other members of the Subcommittee, I am pleased to speak with you today regarding the need for a National Climate Service and I am honored to be here as the Under Secretary of Commerce for Oceans and Atmosphere and the Administrator of the National Oceanic and Atmospheric Administration (NOAA), one of the nation’s premiere science and stewardship agencies, to discuss NOAA’s capabilities in supporting this evolving national need.

The climate challenge before us is real. Through sustained federal and extramural partnerships and collaboration, the nation has made significant progress in our understanding of climate change. One example of federal agency accomplishments realized through such collaborations is the climate change research efforts of the U.S. Global Change Research Program and the U.S. Climate Change Science Program. The sustained partnerships and collaborations established through this intergovernmental body resulted in the publication of 21 synthesis and assessment products, and the forthcoming report on *Global Climate Change Impacts in the United States*. This report will provide a comprehensive survey of the state of knowledge about climate change impacts in the United States, and will highlight for the American public just how far we have come in our understanding of climate change. We are proud of this achievement.

More work is needed, however, to understand users’ needs and deliver climate-relevant information to inform decision-making. In 2007, The National Academy of Sciences released *Evaluating Progress of the U.S. Climate Change Science Program: Methods and Preliminary Results*, which highlighted existing gaps in federal programs to provide climate change information. This report recognized that good progress has been made to determine many aspects of climate change however, “progress in synthesizing research results or supporting decision-making and risk management has been inadequate.”

Just as the nation's climate research efforts require and benefit from interagency and academic partnerships, so too will the communication of climate information to users. No single agency is capable of providing all of the information and services needed to inform decision-making. To be successful, this effort too will require sustained federal agency partnerships and collaboration with climate service providers and end users.

Today, I am here to discuss with you some of the benefits that a National Climate Service could provide as the nation works to adapt to our changing climate. I will also share with you our vision for how NOAA will work with the several other relevant government agencies, the Executive Office of the President, and a diversity of public and private sector partners, to help shape a national effort that builds on existing capabilities and leverage the capabilities of other federal agencies to develop new information, services and delivery mechanisms to realize the potential of such a Service.

THE EARTH'S CLIMATE IS CHANGING

There is unequivocal evidence that the Earth is warming. This warming can be seen in increases in global-average surface air and ocean temperatures, widespread melting of snow and ice, rising sea level, and changes in many other climate-related variables and impacts.¹ Most of the observed increases in global temperatures since the mid-20th century are very likely due to human-induced emissions of greenhouse gases.¹

Under a broad range of non-mitigation scenarios considered by the Intergovernmental Panel on Climate Change, warming over this century is projected to be substantially larger than over the past century. Changes in many other components of the climate system (warming patterns being only one example) are also very likely to be larger than those observed in the present century. The prospects of such climate changes have profound implications for a global society, underscoring the need for scientific information to aid decision-makers in developing and evaluating options for mitigating future anthropogenic climate change as well as alternatives for adapting to a changing climate.

Within the United States, extensive climate-related changes have been documented over the last century. These include increases in continental-average temperatures, rising sea levels in many coastal locations, an increased frequency of extreme heavy rainfall events, lengthening of the growing season, earlier snowmelt, and altered river flow volumes. Water is an issue in every region, but the nature of the potential impact varies. Drought is a serious problem in many regions, especially in the West and Southeast; and floods and water quality problems are likely to be amplified by climate change in most regions.

For example, the amount of rain falling in the heaviest downpours has increased approximately 20 percent on average in the past century, and this trend is very likely to continue, with the largest increases in the wettest places. Many types of extreme weather events, such as heat

¹ IPCC, 2007: *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K. and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

waves and regional droughts, have become more frequent and intense during the past 40 to 50 years.

As a nation, our economic and social well-being is intricately tied to weather and climate; this relationship produces significant social and economic benefits and costs. Some examples include:

- Coral reefs world wide are among the ecosystems of highest risk of extreme degradation due to climate change. In 2002, Hawaii's coral reefs, when combining recreational, amenity, fishery, and biodiversity values, were estimated to have direct economic benefits of \$360 million/year.²
- Drought is estimated to result in average annual losses to all sectors of the economy of between \$6-8 billion.^{3,4}
- Average annual damage from tornadoes, hurricanes, and floods is \$11.4 billion, of which:
 - hurricanes average \$5.1 billion and 20 deaths per year;
 - floods account for \$5.2 billion, and average over 80 deaths per year, and
 - tornadoes cause \$1.1 billion in damages.⁵

These examples of current weather and climate impacts are why the future effects of climate change matter.

HOW COULD THE NATION BENEFIT FROM A NATIONAL CLIMATE SERVICE (NCS)?

The impacts of our changing climate are regionally diverse and relevant across numerous sectors, including water, energy, transportation, forestry, coasts, fisheries, agriculture, ecosystems, and human health. These impacts are anticipated to grow in response to projected future climate change.

Until now, the systems and infrastructure that we as a nation have developed as the foundation of our water, energy, transportation, agriculture, and other sectors have been designed and built based on what we know about local environmental conditions, and our understanding of the past. In the same way, our approaches to the management and conservation of ecosystems and species have largely relied upon our scientific, historical understanding of those systems.

For example, water planning and management have been based on historical fluctuations in records of stream flows, lake levels, precipitation, temperature, and water demands. All aspects of water management including reservoir sizing, reservoir flood operations, maximum urban stormwater runoff amounts, and projected water demands have been based on these records.

² Cesar, H., P. van Beukering, S. Pintz, and J. Dierking, 2002: *Economic valuation of Hawaiian reefs*. Cesar Environment Economics Consulting, Arnham, The Netherlands, 123 pp.

³ *Economic Impacts of Drought and the Benefits of NOAA's Drought Forecasting Services*, NOAA Magazine, September 17, 2002.

⁴ Interagency Working Group on Earth Observations, National Science and Technology Council Committee on Environment and Natural Resources. (2005) *Strategic Plan for the U.S. Integrated Earth Observation System*.

⁵ National Center for Atmospheric Research (NCAR), Environmental and Societal Impacts Group, and the Atmospheric Policy Program of the American Meteorological Society. (2001) *Extreme Weather Sourcebook 2001: Economic and Other Societal Impacts Related to Hurricanes, Floods, Tornadoes, Lightning, and Other U.S. Weather Phenomena*, National Center for Atmospheric Research, Boulder, Colo. Available only online at <http://sciencepolicy.colorado.edu/sourcebook/data.html>.

Because climate change will significantly modify aspects of the water cycle, the assumption of an unchanging climate is no longer appropriate for many aspects of water planning. To appropriately prepare their communities, decision-makers will need to be supported with access to the best climate information science can provide, and tools to apply that data to guide their decisions.

Meeting the climate challenge will require an unprecedented level of coordination among federal agencies, along with our nongovernmental partners, to pull together our collective expertise to accomplish the goal of providing high quality climate information and services that are user-friendly, responsive, and relevant. A broad range of capabilities for providing climate information currently exists in federal agencies, and various other organizations. As we move forward we must find ways to maximize use of these capabilities, by integrating efforts to provide climate information and services that most effectively and efficiently respond to user needs.

The nation's need for user-driven climate services is increasing and the federal government recognizes the importance of responding to these increasing demands. In order to ensure climate information and services are available to meet current and anticipated demands, many scientific agencies, including NOAA, the Department of Energy (DOE), the Department of the Interior (DOI), the Environmental Protection Agency (EPA), the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA), will continue climate research activities to provide the valuable data required to understand how our climate is changing. The contributions of these agencies are coordinated by the National Science and Technology Council through its Subgroup on Global Change Research.

At a hearing this Committee held in May 2007, the Western Governors Association stated that "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 that they can plan and respond accordingly."

Specific examples of requests for climate services include the following:

- The wind power industry has identified a need for baseline data and future projections of wind measurements that would aid them in long term planning for wind energy development to ensure a return on their investment.
- Corn growers have requested regional and long term climate forecasts that would help them in making decisions about when and what they should grow.
- Federal agencies with land and water management mandates, such as the Bureau of Reclamation and the U.S. Army Corp of Engineers, have requested scientific information and technical training on climate change impacts.

Around the country, decision-makers at all levels of government are considering options for how to best prepare their communities for the impacts of a changing climate. As we move forward with efforts to mitigate and adapt to our changing climate, we will need to draw from the expertise of all federal agencies engaged in climate change science to support the development of climate services to enable decision-making. The nation needs an objective, authoritative, and

consistent source of consolidated, reliable, and timely climate information to support decision-making.

As I mentioned during my confirmation hearing, I believe our country must address the impacts of the changing climate head-on. In my work on the Pew Ocean Commission, I heard first-hand from businesses and state and local governments in communities all across this country about the need for reliable information and predictions about the impacts of climate change. From concerns about droughts and sea level rise to changes in the chemistry of the ocean, there is a real hunger for more and better information. NOAA is equipped, and ready to work with its partners, to provide this information.

KEY COMPONENTS OF A NATIONAL CLIMATE SERVICE

Unlike climate services, weather services are familiar to most citizens. Weather services focus on the description, analysis, and atmospheric forecasting on very short time scales, from minutes extending up to a period of one week to ten days. The objective is to provide forecasts of continually changing weather conditions and warnings of severe weather events to protect life and property. The benefits of this service are measured in lives saved, injuries avoided, and reduction in property damage.⁶ For example, through NOAA's hurricane research to operations efforts, NOAA has improved wind speed estimates by 15 percent since 2004 and reduced track forecast error by 50 percent since 1990. These hurricane forecast improvements are estimated to save taxpayers \$640,000 per non-evacuated mile.

In contrast to weather, climate refers to the longer-term statistical properties of the atmosphere—ocean—ice-land system. Climate variability and change are products of: (1) external factors, such as the sun; (2) complex interactions involving the different components of the earth system; and (3) human-induced changes to the earth system. Climate services encompass a variety of types of activities in order to address the range of short to long term variations and changes in climate, including those that are natural and human induced. Such activities are often associated with different types of users or decision-makers and with different types of needs and products.⁶ Improving development and targeting delivery of climate information through a National Climate Service offers untold economic, public health and safety, and national security benefits.

NOAA has a vision of a National Climate Service as a partnership that would be established with other federal agencies, various levels of government, and the private sector. The National Climate Service would provide credible and authoritative climate information and services to assist the nation, and by extension the world. This would include policy-relevant information for decisions related to climate change mitigation and adaptation. This concept of developing a National Climate Service as a single point of accountability for providing climate information and services to the nation has been studied by NOAA, the National Academy of Sciences,⁷ external advisory groups, and by Members of this Committee. Each of these studies has raised important issues that will need to be addressed. NOAA's current vision for a National Climate

⁶ Board on Atmospheric Sciences and Climate, National Research Council (2001) *A Climate Services Vision: First Steps Toward the Future*.

⁷ National Research Council, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on Human Dimensions of Global Change (2009) *Informing Decision in a Changing Climate*.

Service has evolved as a direct result of these studies, as well as input and feedback from public and private sector partners and constituents around the nation.

The overarching goal of a National Climate Service would be to provide the essential climate change information needed for effective decision-making. As such, a National Climate Service must enable decision-makers, including resource managers, and the public to better anticipate, plan, and respond to impacts of changing climate conditions. A National Climate Service must also remain engaged in climate change science to maintain credibility, awareness, and flexibility, and to avoid insularity. In similar fashion, the National Climate Service must engage with a diversity of users to fully understand the needs and provide salient and useable information, tools, and expertise.

The National Climate Service will build on many agencies' strengths and experience. The scientific basis for evaluation of climate change and climate change impacts on a global and regional level will come from existing collaborative efforts underway among NOAA and the other leading climate research agencies, including DOE, DOI, EPA, NASA, and NSF, in the following areas:

- climate observing systems and effective data management and delivery systems;
- problem-focused research and a close coupling with fundamental climate change research that establishes scientific credibility of evolving products;
- climate modeling for predictions and projections; and
- local, regional, national, and international assessments of climate change.

Working with its partners, the National Climate Service will help support the following core climate services:

- ongoing, deliberate dialogue with users to understand evolving needs,
- climate tools and other products at scales relevant to support user decision-making;
- user outreach and capacity building; and
- public understanding.

In order to build and maintain a bridge linking information and users, the Service will provide information to meet the key needs of government and society. Some of these products and services will be relevant for relatively short-term adaptation and mitigation decision support; others will be tailored to be relevant for longer term choices. Some will be operational in nature; others will inform assessments of the state of climate research.

The National Climate Service must have a clear set of principles regarding its products and services to ensure that it remains appropriately focused and managed in an effective way that best serves the nation. NOAA envisions a successful Service guided by the following principles:

- provide balanced, credible, cutting edge scientific and technical information;
- focus on human-caused climate change, but link human-caused climate change and changes in natural variability, such as the frequency and duration of droughts, to meet broad user needs;

- provide and contribute to science-based products and services to minimize climate-related risks;
- provide predictions and projections of climate at scales relevant to decision support;
- strengthen observations, standards, and data stewardship;
- ensure timely assessments;
- improve regional and local projections of climate change;
- inform policy options;
- inform decisions and management options of others; and
- foster climate literacy and workforce development; and
- engage a diversity of users in meaningful ways to ensure their needs are being met.

An effective response to the societal demands of a changing climate is well beyond the scope, authority, or mission of any one federal agency. NOAA commissioned an external review of the challenge of developing a National Climate Service. This external review recommended each federal agency collaboratively define its role and level of commitment in a National Climate Service, but made clear that there must be a lead federal entity. This view is further endorsed by a recent report by the National Research Council,⁸ which stated: "Because successful programs have a leader (NRC, 2005)⁹, the committee recommends that one agency take the lead in developing the climate service, although multiple agencies would have to be involved in its design and implementation." With respect to implementation, a more recent report by the National Research Council¹⁰ notes "...that (the panel) does not recommend centralizing the initiative in a single agency," reflecting on the importance of integrating research and service functions across multiple agencies. NOAA agrees with these recommendations and is ready to meet the challenge of helping lead the development of a National Climate Service and working with our partners in its implementation to provide targeted climate information to the public and private sector to inform decision-making.

An effective National Climate Service will rely upon strong partnerships within and among federal agencies, and across levels of government, academia and the private sector to provide the nation with the science-based and user-responsive climate services it needs. This vision also requires that NOAA integrate its own resources and coordinate efforts with its partners to ensure reliable delivery of climate services and information.

As I've stated earlier, no single agency can address the climate challenge on its own. NOAA is well positioned to provide leadership for a National Climate Service, based on the climate research efforts and experience in providing user-centric services of the collective federal government and nongovernmental partners. NOAA will continue to work with our interagency partners and most especially the agencies that participate with us as part of the U.S. Climate Change Science Program. These agencies will provide much of the data and information that will support the delivery of climate services, and include: the Departments of Agriculture,

⁸ National Research Council (2009) *Restructuring Federal Climate Research to Meet the Challenges of Climate Change*.

⁹ National Research Council (2005) *Thinking Strategically*.

¹⁰ National Research Council, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on Human Dimensions of Global Change (2009) *Informing Decision in a Changing Climate*.

Defense, Energy, Health and Human Services, the Interior, State, and Transportation; together with the Environmental Protection Agency, the National Aeronautics and Space Administration, the National Science Foundation, the Agency for International Development, and the Smithsonian Institution, and overseen by the Office of Science and Technology Policy, the Council on Environmental Quality, the National Economic Council and the Office of Management and Budget.

Further design of a National Climate Service must be based on an interactive process that engages federal agencies and individuals from across the spectrum of climate research, service provision, users, partners and stakeholders. This process must be interdisciplinary, user-focused, regionally-representative, and include analysis of strengths and gaps in capacities. A critical design consideration that must be addressed in these processes is the best arrangement for federal agencies to work in partnership to maximize delivery of climate services to the nation. As such, it would be appropriate for the White House Office of Science and Technology Policy (OSTP) to lead an interagency process to analyze capacities and options. This effort would complement the broader interagency effort being led by the Council on Environmental Quality, OSTP and NOAA to prepare a federal adaptation strategy to help the federal government, along with state, local and private actors, increase their resilience to a changing climate.

The public-private partnership that makes today's National Weather Service so successful provides a useful model to emulate. The federal government would not be able to fully provide critical information to the nation without the private sector. We envision the government will develop and maintain an infrastructure of observation and information services on which the public (federal, state, and local governments), private, and academic sectors will rely. The private sector will be able to use data collected by this infrastructure to create unique products and services tailored to the needs of their company or clients. We believe this cooperative relationship will lead to an extensive and flourishing set of climate services that will be of great benefit to the U.S. public and to major sectors of the U.S. economy.

Finally, addressing the evolving climate challenge will require supporting decision-makers not just for a few years, but over many decades. The National Climate Service must be highly-responsive to changing user needs and able to lead based upon expert evaluation of new data and knowledge. The scope and nature of user interactions and partnerships required to support this effort will demand an extraordinary investment in ensuring continuous feedback and adaptive learning among users and providers. Similarly, products and services must be able to evolve, and be initiated rapidly, in response to new scientific information. These complex characteristics and relationships will necessitate ongoing assessments and evaluations of progress, plans, user requirements, and outcomes as a core component of an adaptively-managed National Climate Service.

FROM NOAA'S CURRENT CLIMATE CAPABILITIES TO A NATIONAL CLIMATE SERVICE

There is much work to be done to fully realize a National Climate Service. The development of a National Climate Service will take leadership and sustained efforts across the federal government to work collaboratively. Through its climate research and science, NOAA is currently delivering climate services that generate significant social, economic, and environmental benefits for the nation. These services are outlined below, as requested by the

Committee in my letter of invitation, and represent some of the contributions that NOAA would bring to a National Climate Services.

NOAA's current climate and climate-related capabilities and mandates

NOAA's mission is to understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs. This mission already encompasses the delivery of some climate services. As the lead federal agency responsible for delivering national weather, ocean, fishery, coastal, and environmental data products and services, and among the leaders in climate and satellite information, NOAA provides some of the many scientific underpinnings required for an effective National Climate Service.

The breadth of NOAA's climate and climate-related capabilities includes:

- A long history of building sustained partnerships and interacting with other federal agencies, the private sector, all levels of government (international, national, state, tribal, local), non-governmental organizations, and the public.
- Extensive experience in both weather and climate forecasts and predictions. Weather forecasts, seasonal outlooks, interannual-to-decadal predictions, and climate change projections require observations, models, and scientific understanding of the Earth system. NOAA has established a strong and sustained capability and infrastructure in all of these areas.
- Existing strengths in climate and earth system research and modeling. NOAA maintains a range of capabilities to understand and address key impacts of climate such as coastal hazards, ocean acidification, droughts and floods.
- At an international level, NOAA along with other leading climate research agencies has played a major role in informing policy decisions by contributing to scientific assessments including the World Meteorological Organization/United Nations Environment Programme Scientific Assessments of Ozone Depletion and the Intergovernmental Panel on Climate Change assessment reports. NOAA has served as one of the lead agencies of the U.S. Climate Change Science Program (CCSP) and had a primary role in its predecessor, the U.S. Global Change Research Program. NOAA has led several of the CCSP synthesis and assessment products, including the forthcoming report on *Global Climate Change Impacts in the United States*.
- A unique breadth of mandates and experience in environmental service delivery that provide a strong foundation for a National Climate Service. NOAA's mandated responsibilities include, for example: fisheries, endangered species and marine mammal management, National Marine Sanctuaries, and coastal and estuarine management. With each of these mandates, NOAA managers must account for the effects of climate variability and change on coastal and marine ecosystems, and resources and communities, as well as adapt their management practices accordingly. NOAA and its partners in coastal and marine resource managers are among the vanguard of users of climate information. In addition, the National Weather Service has an established and credible field infrastructure that currently delivers climate products daily at a national, regional, and local level.

- NOAA contributes to sustained climate observing networks comprised of a suite of operational satellites and *in situ* networks for integrated atmospheric and oceanic observations, including measurements of air and ocean temperatures, greenhouse gases, aerosols, and ozone. NOAA also maintains several of the nation's permanent archives of weather, climate, and oceanographic data through its data centers. NOAA, along with the other leading climate research agencies, provides analyses of the observed records, including the nation's climate statistics and reanalysis of observations for initial conditions for climate prediction. With its wealth of observational data, NOAA makes major contributions to the process studies required to attribute the causes of climate change.

Transitioning to a National Climate Service

Through our existing statutory responsibilities under the *National Climate Program Act of 1978* (15 U.S.C. §§ 2901-2908), NOAA has a long history of producing climate information, delivering products and services, and building the capacity of others through established networks and partnerships at all levels.

We expect that development of a National Climate Service will stimulate advancements of similar stature as those generated through NOAA's integrated weather services. For example, NOAA's 'end to end' weather services have increased annual average lead times for tornados from less than 4 minutes in 1987 to almost 15 minutes today, and flash floods from less than 10 minutes in 1987 to better than 50 minutes today. Such advancements are estimated to have contributed to NOAA's weather services preventing over 330 fatalities and 7800 injuries from tornadoes, and to have resulted in health and welfare benefits that we estimate to be of over \$3 billion between 1992 and 2004.

Development of a National Climate Service can benefit from NOAA's existing expertise, infrastructure, and capabilities in climate science; its extensive experience in service delivery; its relationships with other federal, state, and local partners; and must leverage the extensive experience of the other leading climate research agencies. NOAA's existing climate products and services include climate data services, climate predictions and climate change projections, assessments, and decision support information.

Existing networks include interagency and other partnerships that comprise the National Integrated Drought Information System (NIDIS), National Weather Service Forecast Offices and River Forecast Centers, National Data Centers, Regional Integrated Science and Assessment projects at universities, Regional Climate Centers, State Climatologists, Sea Grant, the Coastal Services Center, international climate research institutes, NOAA Cooperative Institutes, and extension agents.

Two examples illustrate NOAA's experience as a leading source of climate information and provide a strong indication of the agency's foundation for the development of climate services: (1) NOAA's partnership with the National Association of Home Builders and Department of Housing and Urban Development, and (2) its leadership of NIDIS.

Partnership with the National Association of Home Builders and the Department of Housing and Urban Development (HUD) – NOAA performed a decade of research to develop an Air Freezing

Index, which has now translated into operational use by the construction industry. Home builders can now construct a frost protected shallow foundation as a practical alternative to deeper, more-costly foundations in cold regions with seasonal ground freezing and the potential for frost heave. Construction of a frost protected shallow foundation can be informed by NOAA's Air Freezing Index, and incorporates strategically placed insulation to raise the frost depth around a building. NOAA's air freezing research is estimated to provide an annual savings benefit to U.S. homeowners of \$300 million saved in new construction costs and energy savings of 586,000 megawatt-hours.

National Integrated Drought Information System (NIDIS) – The growing impacts of drought on society led to a call by our state governors for drought preparedness information. NOAA's implementation of the *NIDIS Act of 2006* is being achieved through the coordination and collaboration of federal, state, tribal, academic, and local representatives on issues including water resources, agriculture, ecosystem impacts, energy and coastal environments. NIDIS is working to provide dynamic and easily accessible drought information for the nation by serving as an integrated knowledge center by identifying, collecting, and disseminating existing innovations at the national, regional, watershed, state, county, and private sector levels. NIDIS provides data to help decision-makers assess the risk of having too little water and to prepare for and mitigate the effects of drought (such as farmers making decisions about crops, forestry professionals planning ahead for the next fire season, and urban water managers preparing for high-demand seasons). Still in its initial phases, NIDIS is continually developing more robust services and regional decision support resources.

While significant in their own right, these examples are only a snapshot of how, through a National Climate Service, NOAA can apply its current climate capabilities and mandates, and leverage the expertise and strengths of the other leading climate research agencies to address the growing demand for climate services. As NOAA works to define its role in a National Climate Service, we will continue to develop and expand, in partnership with the other leading climate research agencies, the products and services to assist a number of key social, economic, and environmental climate change decisions, particularly those at regional and national levels.

Examples of emerging issues that a National Climate Service could address through collaborative and coordinated effort among federal agencies and other partners include:

Mainstreaming climate change adaptation for critical infrastructure – Current infrastructure design criteria and construction codes may be inadequate for climate change and exacerbate vulnerability to increasing storm intensity and flooding. For example, along the U.S. Gulf Coast, from Houston, Texas to Mobile, Alabama, 27 percent of major roads, 9 percent of rail lines, and 72 percent of ports in the area are built on land at or below 4 feet in elevation; a level within range of projections for relative sea-level rise in this region in this century. A National Climate Service would provide information that would allow the U.S. to relocate and/or secure these installments as well as improve planning for future infrastructure investments.

Delivering regional and decadal climate information – Currently, U.S. climate modeling efforts allow us to provide information at centennial and continental scales. With funds from the *American Reinvestment and Recovery Act of 2009*, NOAA will be able to continue to increase its

computing power so that its climate models can provide information at the decadal and regional scales, which are most relevant to decision-makers. It is important to recognize that the reliability of this information depends on more than just greater model resolution. Critical research efforts will be required to ensure that all essential processes at these new scales are represented in the models in order to produce reliable information. This new information coupled with advances in tools and expertise led by the other leading climate research agencies will open the door to opportunities for a National Climate Service to develop and work with its partners to deliver authoritative products and services to users at scales previously not possible.

National security - Climate change has the potential to affect national security by reducing predictability and stability throughout the world, for example, through disruptions resulting from food and water shortage. The U.S. will also need to anticipate and plan for growing immigration pressures both at home and in other countries. A National Climate Service could help to prepare for and adapt to these changes by providing the observations and forecasts that can be utilized by agencies such as U.S. Agency for International Development and the Department of State to develop policies and action to mitigate these impacts (e.g. new agricultural practices).

Underpinning research - Providing reliable climate information at the fine spatial scales relevant to human activities requires further and rapid progress in scientific understanding and quantitative predictions. NOAA, in partnership with other agencies, will enhance essential climate research programs to shape and inform our fundamental understanding of climate change, its pace, and its consequences. Meeting these new challenges and delivering timely, relevant, and the best scientifically-informed climate information and services to decision-makers will require a coordinated effort that builds upon and expands the nation's observational, research and modeling infrastructure.

CONCLUDING REMARKS

This is a time of rapid change. The pace and nature of changes in the Earth's climate reinforce the need for delivering targeted climate services at appropriate scales. We will need to draw from the expertise of all federal agencies to support the development of science-based and user-driven climate services to enable decision-making. Development of a National Climate Service will take leadership, sustained efforts, and a commitment across the federal government to work collaboratively.

Much work lies ahead of us. NOAA will contribute to this effort by building on its existing capabilities, partnerships and networks to deliver an evolving suite of climate information and services, in collaboration with our partners. We are prepared to provide leadership, in partnership with other federal agencies, to the design and development of a National Climate Service through an interactive dialogue that engages the breadth of climate service interests, including service providers, researchers, and users.

I look forward to working with the Office of Science and Technology Policy, other federal agencies, our partners, and this Committee to further evaluate the merits of this effort.

Thank you very much for the opportunity to testify today. I look forward to answering your questions.