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WEATHERING CHANGE: NEED FOR CONTINUED INNOVATION IN FORECASTING AND PREDICTION

HEARING

BEFORE THE

SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES, AND COAST GUARD

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

NOVEMBER 16, 2011

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ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

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CONTENTS

	Page
Hearing held on November 16, 2011	1
Statement of Senator Begich	1
Statement of Senator Snowe	3
Statement of Senator Boozman	31

WITNESSES

Hon. Mary M. Glackin, Deputy Under Secretary for Operations, National Oceanic and Atmospheric Administration, U.S. Department of Commerce	5
Prepared statement	7
Hon. Todd J. Zinser, Inspector General, U.S. Department of Commerce	14
Prepared statement	15
David C. Trimble, Director, Natural Resources and Environment, U.S. Government Accountability Office	19
Prepared statement	20
Rear Admiral Cari B. Thomas, Director of Response Policy, United States Coast Guard	25
Tom Iseman, Program Director, Water and Climate Adaptation, Western Governors' Association	37
Prepared statement	39
Dr. Peter P. Neilley, Vice President, Global Forecasting Services, The Weather Channel Companies	44
Prepared statement	46
Robert S. Marshall, Founder and CEO, Earth Networks, Inc.	49
Prepared statement	50

APPENDIX

John D. Rockefeller IV, U.S. Senator, West Virginia, prepared statement	63
Daniel A. Sobien, President, National Weather Service Employees Organization, prepared statement	63
Response to written questions submitted to Hon. Mary M. Glackin by:	
Hon. John D. Rockefeller IV	66
Hon. Maria Cantwell	71
Hon. Amy Klobuchar	75
Hon. Olympia J. Snowe	77
Hon. Roger F. Wicker	78
Response to written questions submitted by Hon. John D. Rockefeller IV to Hon. Todd J. Zinser	80
Response to written questions submitted to David C. Trimble by:	
Hon. Amy Klobuchar	81
Hon. Olympia J. Snowe	82
Response to written question submitted by Hon. Roger F. Wicker to Rear Admiral Cari B. Thomas	82
Response to written questions submitted by Hon. John D. Rockefeller IV to Tom Iseman	83
Response to written questions submitted by Hon. Roger F. Wicker to:	
Dr. Peter P. Neilley	84
Robert S. Marshall	85

WEATHERING CHANGE: NEED FOR CONTINUED INNOVATION IN FORECASTING AND PREDICTION

WEDNESDAY, NOVEMBER 16, 2011

U.S. SENATE,
SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES, AND COAST GUARD,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:33 a.m. in room SR–253, Russell Senate Office Building, Hon. Mark Begich, Chairman of the Subcommittee, presiding.

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

Senator BEGICH. It's like the beginning of church. Everyone is very quiet. I'm not sure if we're starting or not, but we are. So thank you all very much for being here.

I will call this meeting to order of the Oceans Subcommittee. Thank you again for the panelists to be here this morning. We anticipate one or two additional senators to be here, but I wanted to go ahead and start the meeting. And again, good morning to all of you.

We're here to talk about the weather and the climate, which really is just the same as weather, on a longer time scale. Today's hearing is meant to provide oversight of these two important functions of the National Oceanic and Atmospheric Administration, otherwise known as NOAA.

NOAA's weather programs touch the lives of every American every day. Forecasts help people make informed decisions, whether a family planning their annual trip from their village to Anchorage, or a fisherman trying to stay safe in the Gulf of Maine.

And while the phrase "climate change" is always controversial, we in Alaska are already living the effects. Having solid information about climate trends is critical for good governance and business planning. I'm proud to serve on the Commerce Committee where, for decades, both Republicans and Democratic chairmen have promoted the highest standards of scientific integrity.

I'm a big supporter of efficient and effective government, too. So as I look forward to hearing more today about efforts to better support state and local governments and business decisionmakers through the creation of the Climate Service within NOAA, you

don't have to be a climate scientist to wonder what's going on this year.

2011 has shattered weather and climate records across the country, from record heat and cold, to snow and rain, drought and flooding. Even in Alaska, where we are used to braving many extremes, last week's massive storm was a sobering reminder of the importance of knowing what's coming and being as prepared as possible.

Last week, Alaska was hit by a massive winter storm. Had it hit the lower 48, it would have stretched from Mexico to Canada. With hurricane-force winds and 10-foot tidal surges, it was truly an epic event. Fortunately, NOAA was able to give clear warnings of what was coming. Alaskans are resilient. They hunkered down, and communities implemented their emergency plans. While assessments are still under way, the damage could have been far worse if we did not have the benefit of those warnings from NOAA a few days in advance of the storm.

NOAA weather satellites are key to providing these advanced warnings. I joined several members of this committee this year to fight for funding of the Joint Polar Satellite System. Polar satellites provide critical data for forecasters of severe weather nationwide, and to Alaska in particular, since NOAA's other satellites don't adequately cover our northern state.

I'm pleased to report that the House and Senate conference report on NOAA appropriations supported funding for that expensive yet critical program.

I hope today's hearing will help NOAA and the Committee find ways to continue to promote the highest level of innovation, even as we recognize the tough budget climate we face for the coming years. Our nation cannot afford to overlook the importance of reliable weather information.

Today's hearing is meant to push deeper and promote cost-effective and earlier decisions regarding program management in the deployment of weather and climate services. The last administration ran up a multi-billion price tag due to program delays in the management of the weather satellites, and I want to make sure this administration is a better steward of the taxpayer funding.

For these reasons I am pleased to welcome our witnesses here today, and I want to extend a very special thank you to Deputy Under Secretary Mary Glackin.

Ms. Glackin, I understand you are to retire from what has been an exceptional career in public service. You have worked at NOAA for more than three decades, earning seemingly every professional award possible, including twice the Presidential Rank Award.

I am grateful you are here today, particularly given your own expertise and your leadership in improving weather operations by capitalizing on new technology and science. Your retirement is a real loss to NOAA and to the Federal Government, but I wish you every success and fulfillment in your future endeavors, and thank you again for being here.

I'm also pleased to welcome the Honorable Todd Zinser, Department of Commerce Inspector General. Mr. Zinser will testify about the challenges NOAA faces in its efforts to develop and launch the Joint Polar Satellite System, while minimizing the loss of critical weather and climate information.

David Trimble, Director of the Natural Resources and Environment branch of the Government Accountability Office, will assist the Committee in providing recommendations to help advance Federal climate change strategic planning efforts.

And I'm honored to welcome Rear Admiral Cari B. Thomas, Director of Response Policy in the United States Coast Guard. With this year's extreme weather events around the country, including last week's massive Alaskan storm, I welcome your timely perspective regarding the importance of NOAA weather and climate information to the success of the Coast Guard's search and rescue mission.

Panel 2 will include Dr. Peter Neilley, Vice President of Global Forecasting Services for the Weather Channel Companies, which I was happy to participate in recently about the Alaska storm. Doctor, it's amazing they let a senator on the Weather Channel, but we thank you for that.

Dr. Neilley will speak to the relationship between the private sector and NOAA in the development of weather and climate information and outline the priorities for NOAA's services. And I know you're a big fan of the new Coast Guard reality show also, Dr. Neilley.

Tom Iseman of the Western Governors' Association will offer perspective on the significant impacts that severe weather events and long-term climate trends can have on life in the West. He will also speak to the partnership that I believe shows significant promise, the Governors' close coordination with NOAA on the delivery and sharing of objective, credible weather and climate information and services.

Thank you all for willing to be witnesses. I will ask Senator Snowe to say a couple of words but give her a second here.

I will also say, with the Coast Guard's new reality show, I will say that Alaska now has the most reality shows of any state——

[Laughter.]

Senator BEGICH.—anywhere, and we love it because it shows more about Alaska. But it also shows, if you notice, almost every one of those shows has a significant weather component. I don't care if you're flying or out there catching crab or in the Coast Guard, whatever it might be. It is weather that dictates a lot of our activity in Alaska, and literally our weather systems are vast and wide when you think about where we are and how large we are.

So again, thanks to this panel and the panel that will be coming up next.

Let me ask my Ranking Member, Senator Snowe, to say a few words, and then we'll start the discussion.

Senator Snowe?

STATEMENT OF HON. OLYMPIA J. SNOWE, U.S. SENATOR FROM MAINE

Senator SNOWE. Thank you, Mr. Chairman, for holding this hearing on the state of our nation's environmental and weather observation infrastructure and satellite systems. As you know, I've been a long supporter of the Integrated Ocean Observing System, introducing authorizing legislation in each of the last four Congresses.

The IOOS system, which was first piloted in the Gulf of Maine in 1999 and has been collecting data since 2001, has proven to be a highly successful nationwide network of regional coastal and ocean observing systems. It served as a model in the development of innovative applications that makes data readily available to decisionmakers in real time for critical uses ranging from oil spill response in Portland Harbor to a lobsterman checking wave heights offshore.

Certainly, we have witnessed the benefits of this network approach in Maine. Indeed, scientists at the Woods Hole Oceanographic Institute have determined that the Gulf of Maine Observing System has returned six dollars to our region's economy for every one dollar invested in the system.

Now, as we look forward, this hearing is especially timely. We are at the intersection of the previous satellite program, the National Polar-orbiting Operational Environmental Satellite System, or NPOESS, which operated from 1994 to 2010, when it was dismantled by the White House Office of Science and Technology; and the Joint Polar Satellite Program, or the JPSS, currently under development by NOAA and NASA.

On October 28, the only Earth-observing satellite completed under the NPOESS program, the NPOESS Preparatory Project, or NPP—a lot of acronyms—was successfully launched as a bridge to the next generation of the Joint Polar Satellite System. And frankly, there should be no question it is now crucial in order to preserve the continuity of vital data for our long-range weather forecasting climate record that we ensure the $920 million appropriated for the Joint Polar Satellite Program, which represents over one-third of NOAA's Fiscal Year 2012 appropriation, is implemented efficiently and in a timely manner.

The fact of the matter is, according to the Government Accountability Office and the Inspector General, whom we'll hear from today, we could expect to see a gap in the data provided by our polar satellites several years from now due either to the failure of the NPP satellite or delayed launch of its replacement, the JPSS–1. Yet underlying acquisition and management issues that led to the dissolution of the NPOESS in the first place remain unresolved.

Indeed, the GAO has reported that the NPOESS was plagued by cost overruns and delays since 2005. The program's original cost estimate was $6.5 billion, yet by 2010 that estimate had more than doubled to $15 billion. Moreover, the program suffered setbacks to the development of vital new sensors, which delayed the launch of the final NPOESS satellite for 5 years. And now, the most recent reports on the development of the Joint Polar Satellite System Program from the Inspector General, as well as the GAO, regrettably show that cost estimates have not improved, and that sensor and ground system development may delay the launch of the JPSS–1.

Well, we simply cannot afford to repeat the mistakes of the NPOESS program in implementing the Joint Polar Satellite System, nor can we countenance new problems that the GAO is concerned with in terms of a lack of interagency strategy for environmental observations among NOAA, NASA, and the Department of Defense, which could result in loss of economic benefit from a co-

ordinated approach and limit our ability to understand long-term climate change. The stakes are simply far too high for failure.

According to the National Climatic Data Center, the economic costs of severe weather events have exceeded $50 billion this year alone. Our ability to effectively predict and mitigate extensive damage from severe weather events, such as the massive coastal storm that just struck Alaska, relies heavily on the continual data coverage provided by NOAA's geostationary and polar-orbiting satellites. The two- to three-day forecasting capability provided by this data can mean the difference between safe evacuation or lost lives in the case of a hurricane, or provide enough time to take shelter before a tornado strikes.

Given the devastation we have witnessed in the Midwest and the Southeast in April and May, clearly these extra minutes and days matter greatly in the context of saving human lives from the strength of the storm. Indisputably, the long-term investment in the infrastructure that provides this critical information must be a national priority.

In the short term, we must also explore a range of options to ensure data continuity via alternative sources. The private sector is thinking creatively about how to obtain the same forecasting capacity with fewer resources by creating new platforms capable of supporting a range of sensors or using existing ones such as commercial aircraft in different ways.

So I look forward to hearing from each of our panelists today on the innovations and technologies they believe can provide the most accurate, cost-effective information that we rely on in so many aspects of our daily life and commercial activities. So with that, I welcome the panelists, and I thank you, Mr. Chairman, again for convening this hearing.

Senator BEGICH. Thank you very much, Senator Snowe.

Let's first start with the Deputy Under Secretary of Operations, National Oceanic and Atmospheric Administration, Mary Glackin. And again, I can't stress enough your 30 years of service to this country. I know when people retire it really means they're going to be doing more work in some field that they've been wanting to do for a long time, so I wish you the best there. But, please.

STATEMENT OF HON. MARY M. GLACKIN, DEPUTY UNDER SECRETARY FOR OPERATIONS, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Ms. GLACKIN. Thank you, Chairman Begich, and thank you for your kind words about not only myself but NOAA services. And, Ranking Member Snowe, we appreciate all of the support from this committee, and also the opportunity to testify in front of you today about the need for, and NOAA's role in, supporting innovations to improve weather and climate services.

NOAA has a leading role in understanding changes in weather and climate extremes, including trends in severe local storms and extremes in precipitation, whether it's too little or too much, too often or too infrequent. This year we have seen an unprecedented number of natural disasters, from the heart-wrenching tornado outbreaks in Alabama and neighboring states in April, and in Joplin,

Missouri in May, to the record flooding in the upper Plains and the Northeast, to the extreme drought that is continuing across the Southwest.

We have seen at least 10 disasters, each costing $1 billion or more this year. In the face of these challenges, NOAA has been able to provide accurate forecasts because of its continued investments in mission-focused research and development that drive innovation. There is much more to be done if we are to achieve new, life-saving advancements for the future, and NOAA is committed to working with its partners in the climate and weather enterprise to continue to spur innovation and build upon this record of success.

Our scientists have been at the forefront of weather and climate science, forecasting and public preparedness for decades. Our science helps save lives and livelihoods. I want to briefly discuss two timely examples, weather radar and environmental satellites.

In recent years, NOAA has developed a new weather radar upgrade called Dual Polarization Radar Technology. This capability is being installed this Fiscal Year and will assist forecasters in the warning and forecast process, leading to, among other things, better estimates of precipitation for water management, more accurate flood warnings, better identification of rain to snow transitions, and more precise severe thunderstorm warnings.

Now, to turn to polar satellites, which have been highlighted here today, they have supported weather forecast models for over 30 years. NOAA is working toward the launch of the next polar satellites, the Joint Polar Satellite System, JPSS. We thank the Committee and the Senate as a whole for their recognition of this national priority, and their support in the Senate's Fiscal Year 2012 appropriations bill for NOAA.

Nonetheless, NOAA is expecting a data gap beginning as early as late 2016, when the current satellites reach the end of their life expectancies. Within available resources, NOAA is preparing to mitigate this gap to the greatest extent possible.

NOAA is continuing working to improve the science and practice of forecasting and prediction. It's not enough, however, to provide longer lead times for droughts, seasonal flooding, heavy rainfall events, and heat waves. We must also ensure that people hear these warnings and take informed and appropriate action to protect their own safety.

The mixture of technology and social science advancements is a new approach to building a weather-ready nation, one that we expect to provide huge returns measured in avoided economic losses and lives saved. In all its efforts to support innovation, NOAA works in close partnership with the broader weather and climate enterprise that includes other Federal agencies, the private sector weather and climate industry, academic institutions and consortia, state and local governments, and other non-government organizations. My written testimony provides several examples of these ongoing partnerships, and I'm pleased that you'll hear testimony from several key partners at this hearing today.

So in conclusion, the investments made by Congress and the administration in NOAA's weather prediction and warning capabilities directly saves lives in the United States during these disasters. NOAA is continuing to innovate to improve preparedness, detec-

tion, modeling, and forecasting efforts necessary for improved decisionmaking and to save lives and property. Although nothing can eliminate the physical threat that severe weather and natural hazards pose, NOAA has demonstrated success in better predicting them, reducing their impact, and helping vulnerable communities become more resilient to their devastating effects, and will work to continuously improve its products and services to the Nation.

I'll be happy to take any questions from the Committee.

[The prepared statement of Ms. Glackin follows:]

PREPARED STATEMENT OF HON. MARY M. GLACKIN, DEPUTY UNDER SECRETARY FOR OPERATIONS, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Good morning Chairman Begich, Ranking Member Snowe, and Members of the Subcommittee. My name is Mary Glackin and I am the Deputy Under Secretary for Operations at the National Oceanic and Atmospheric Administration (NOAA). Thank you for the opportunity to testify today about the need for, and NOAA's role in, supporting innovation to improve weather and climate services.

NOAA, since its beginnings, has relied on mission-focused research and innovation as a means of improving services to the Nation. NOAA has the sole responsibility of issuing severe weather warnings to communities across the country. NOAA-led weather innovations such as the national Doppler RADAR network and weather modeling improvements continue to provide our Nation with increases in advanced warnings that protect lives and property from tornadoes and other severe weather events. This year we have seen an unprecedented number of natural disasters, from the heart wrenching tornado outbreaks in Alabama and neighboring states in April, Joplin, Missouri in May, to record flooding in the upper Plains and the Northeast. In the face of these challenges, NOAA has been able to provide advanced and accurate forecasts because of its continued investment in the long-term research and development that drive innovation. There is much more to be done if we are to achieve new life saving advancements in the future, and NOAA is committed to working with its academic, private sector, and other partners in the broader climate and weather enterprise to continue this record of success.

NOAA scientists have been at the forefront of weather and climate science, forecasting and public preparedness for decades—our science helps save lives and livelihoods. NOAA has a leading role in understanding changes in weather and climate extremes, such as trends in severe local storms and extremes in precipitation—too little or too much, too often or too infrequent. Extreme weather and associated societal impacts have increased in recent years, and with our changing climate, the Nation can expect more frequent extreme weather events in the future. To combat this increased vulnerability, communities across the country must become more resilient to extreme events, with smarter land use planning, more widespread use of emergency action plans, and numerous other actions.

Our nation's environmental predictive capabilities are supported by four foundational pillars: observations, computer modeling (including High Performance Computing), scientific research, and our people, who provide forecasts, warnings, and decision support services to key decisionmakers. By strengthening the pillars—through improved satellite and in-situ observations, computational capacity, and coupled atmosphere, ocean, land models, and necessary research—we can revolutionize the forecast process across the entire spectrum, from relatively small-scale, short range applications to long range weather and climate predictions.

Yet, the success of NOAA's mission should not only be measured by the accuracy of its information, but by the effectiveness of its application. As such, NOAA is pursuing a number of innovative approaches to not only to provide significantly more lead time for forecasts, but to also ensure that people hear these warnings and take informed and appropriate actions to protect their own safety. This mixture of technological and social science advancements is a new approach to building a "Weather-Ready Nation" and one that we expect to provide huge returns—measured in avoided economic losses and lives saved.

A Historic Year in the Making

Despite NOAA's quality forecasts and outlooks, severe weather events in 2011 have demonstrated the need for continued investment in scientific innovation to improve environmental intelligence. 2011 has already established itself in the record books as a historic year for weather-related disasters, and it is not over. We have

already seen ten $1-billion-plus disasters. Total damages from weather- and water-related events since January for the United States are well over $45 billion and climbing. 2011 is now the fourth deadliest tornado year for the United States since 1875, and the deadliest since 1936, with 548 people killed as of November 6. April 2011 ranks as the most active tornado month on record with 875 tornadoes, breaking the previous record of 542 set in 2003. More tornadoes occurred on April 27 of this year than any other day in the past 61 years. On May 22, a large portion of Joplin, Missouri was devastated by an EF–5 (winds greater than 200 mph) tornado, resulting in over 150 fatalities and over 1,000 persons injured. The Joplin tornado was the deadliest this year and is ranked 7th among the deadliest tornadoes in U.S. history.

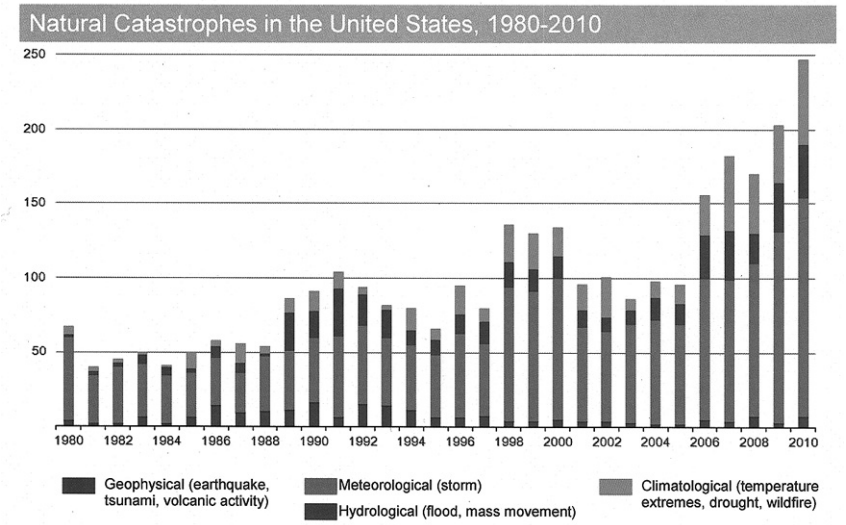
Fueled by record-setting precipitation totals, historic flooding has hit the Midwest and Ohio Valley, from the smallest streams to the largest rivers. The Ohio Valley region had its wettest April on record, and the record goes back to 1895 for some states. Record breaking heavy rains across Montana and the Dakotas, combined with runoff from record winter snowpack, caused tremendous flooding across those states, with Minot, North Dakota, being among the hardest hit.

This year the United States has also experienced severe impacts due to decadal-scale changes in our climate. Across the U.S. Southwest extreme drought continues—stretching from New Mexico through Texas and Oklahoma across the Gulf States and Florida. According to the State of Texas, the past twelve months—from October 2010 through September 2011—have been the driest in state history since 1895. Nearly two-thirds of Texas is currently experiencing drought categorized as "exceptional"—the most severe type. Texas has responded to more than 24,000 fires in approximately the same period, which have burned more than 3.8 million acres and destroyed over 7,000 businesses and homes. The Texas Agrilife Extension Service has calculated that Texas' agriculture sector alone experienced losses of roughly $5.2 billion through August.

Prime wildfire conditions continue across large portions of the Southern Plains and Southwestern States. More than 8.2 million acres have burned nationwide—nearly 120 percent of the 10-year average by this time of year.

What it Means

Nearly 90 percent of all Presidentially declared disasters are weather- and water-related, and our vulnerability to the impacts is increasing as our population grows. As shown in the chart below, the number of natural catastrophes resulting in property damage and/or bodily injury in the United States is trending upward, with 2011's numbers on track to surpass last year's record as of July.



Source: Munich Re NatCat*SERVICE* (statistics and chart).

Over the past thirty-plus years, the United States has seen a total of 107 weather- and climate-related disasters each totaling over $1 billion dollars in dam-

age. Total standardized losses since 1980 exceed $750 billion (inflation-adjusted to 2011 dollars using the Consumer Price Index).

Demographic trends and population growth and an increased reliance on technology have made our society more vulnerable to high impact events at a time when we are seeing an increasing trend in extreme weather events. As a result, many agricultural, business, and urban planners are looking for ways to increase community resilience now. For example, the City of Chicago is taking steps to prepare for the likelihood of intense storms striking more often, of rainfall events causing more flooding, and of warmer temperatures. Local climate studies, along with recent trends such as an increase in the frequency of heavy rainfall events, have led them to conclude that proactive steps are needed to mitigate the cost and impact of these events. New York City is also engaged in adaptation planning, with particular focus on the risk of flooding from rising sea level. The Navy's Task Force on Climate Change has advised that the Navy should prepare to police the equivalent of an extra sea as the Arctic ice melts. These cities and organizations, among many others, recognize the need to understand changes and trends in weather patterns, and to apply this to planning that may reduce vulnerability to high-impact weather and water events. Their recognition of the need to reduce their vulnerability to weather and water extremes is an important first step. However, there is much more that needs to be done in other sectors of our economy and with the general public to increase our resiliency to the impacts of these events.

NOAA Science Spurs Innovation to Better Meet Societal Needs

NOAA's science spurs innovation within the agency. NOAA science includes discoveries and ever new understanding of the oceans and atmosphere, and the application of this understanding to such issues as the causes and consequences of climate change, the physical dynamics of high-impact weather events, the dynamics of complex ecosystems and biodiversity, and the ability to model and predict the future states of these systems. NOAA is supported in these efforts by key pieces of legislation, such as the Global Change Research Act and America COMPETES Act, the latter of which this Committee reauthorized in 2010.

NOAA conducts and supports innovative research in order to provide the public with information, products, and services that enable stakeholders to make the best decisions possible to advance economic growth while promoting a healthy environment. NOAA is not alone in these endeavors and works in close partnership with the broader weather and climate enterprise that includes other Federal agencies, the private sector weather and climate industry, academic institutions and consortia, state and local governments, and other organizations. NOAA supports research at partner institutions such as Cooperative Institutes, its Sea Grant college network, Regional Integrated Science and Assessments program, and other mechanisms.

Often, NOAA-supported advances are conducted in partnership with the private sector, such as through the NOAA Small Business Innovation Research program, and foster additional opportunities for economic growth in the private sector. Many innovative weather and climate technology advances spurred by NOAA investments in its own and partner institutions have been commercialized by the private sector and are now sold by the private sector around the world as the gold standard, such as NOAA's Argo floats, which are state-of-the-art profiling floats that are providing realtime pressure, and ocean temperature and salinity for climate, weather, and other service applications and research efforts.

Research, Observations and Prediction

Longer lead-time forecasts for droughts, seasonal flooding, heavy rainfall events, heat waves and cold spells provide tremendous economic value for the Nation through overall reductions in loss of life and in physical and economic damage. NOAA provides a spectrum of critical information across a range of time and space scales, which is used by government, business, emergency managers, planners, and the public. The value of that information increases when businesses, farmers, energy producers and utilities, as well as the general public, are prepared and have effective plans of action to mitigate impacts.

Returning to NOAA's four pillars, future investments in innovation will be focused on: observations, computer modeling (including High Performance Computing), foundational scientific research, and our people, who will be better positioned to advise key decisionmakers during extreme events. For example, on the larger scale, coupled environmental models provide improved simulations of the interaction between the ocean and atmosphere, resulting in more accurate predictions of tropical cyclone behavior. On smaller scales, higher resolution observations and models can provide the type of short-term severe weather predictions that will 1 day allow us

to know up to 60 minutes ahead of time where a tornado will touch down, and to provide warning to the public based on these forecasts.

An example of scientific innovation in observations is NOAA's deployment of Dual Polarization radar technology. Developed in NOAA, "Dual Pol" is the latest weather radar upgrade, providing both horizontal and now vertical components to what NEXRAD Doppler radar is seeing. It will add fourteen new products to the suite of data already available to NOAA weather forecasters and our partners who receive radar data. These new tools will assist forecasters in the warning and forecast process. With Dual-Pol radar, forecasters can better glean information such as the size, shape, and type of precipitation particles. This information will lead to better estimation of total precipitation for water management and flood forecasting; accurate identification of the snow levels in higher terrain; improved ability to identify areas of heavy rainfall, including flash flooding potential; identification of rain-to-snow transitions, to alert travelers and road crews; and more precise severe thunderstorm warnings, especially for those containing hail. The full benefit of Dual-Pol radar, however, will not be fully realized until weather forecasters and research meteorologists develop new ways to utilize the data specific to their geographic areas and gain experience.

One of NOAA's very promising technologies toward improving higher resolution observation that supports weather predictive capabilities is called Multi-Function Phased Array Radar (MPAR)—the potential future generation replacement of weather radars. These new prototype radars build off existing military technology with a unique antenna that collects the same weather information as existing weather radar, but in about one-sixth the time. MPAR could not only expand the current weather surveillance network, but also has the potential to meet air traffic surveillance, homeland security and defense requirements for identifying and tracking non-cooperative aircraft over the United States. The decision to determine the feasibility of MPAR deployment is still several years out and will require significant research and collaboration with academic and industry partners. Steps for finalization include research, prototype development, testing and evaluation, and, if the technology proves feasible, eventual deployment of new systems.

We anticipate numerous enhanced weather and climate service benefits from MPAR. MPAR's adaptive sensing capability has the potential to support continued improvements to the severe weather warning system for tracking tornadoes, strong wind gusts, hail and locally heavy rains responsible for flash floods and mudslides. In addition, MPAR will provide observations that allow for more precise information about hazardous weather that affect flight safety and airspace capacity, in turn providing economic efficiency to domestic aviation and surface transportation systems. Finally, more detailed atmospheric observations, such as would flow from MPAR, are anticipated to improve air quality real-time advisories and forecasts, climate variability monitoring and forecasting, and wildfire monitoring and prediction.

We know that shifts in weather patterns are often regional in nature, and have variable time spans. For example, El Niño and La Niña, which have become household words, are generally predictable over fairly definable areas and time spans. During the 1997–1998 El Niño and 1998–1999 La Niña, the U.S. agricultural sector experienced damages of $2.4–2.8 billion and $3.6–10.7 billion (in 2010 dollars), respectively. We are coming to understand many of these larger scale phenomena, such as the North Atlantic Oscillation, which is a change in the water temperature in the North Atlantic that is strongly correlated with heavy snowfall events in the Mid-Atlantic and Northeast states. These patterns, observed in-situ by NOAA's Tropical Atmosphere-Ocean (TAO) buoy array in the equatorial Pacific Ocean, strongly influence and can help inform NOAA's seasonal forecasts, including the recently published 2011–2012 Winter Outlook. NOAA has successfully transitioned numerous research innovations such as the TAO array into operations, turning wise investments into critical operational tools for accurate environmental prediction.

Our tornado warnings have improved significantly over the past two decades primarily because of past research efforts. More research would help us better understand the rapid evolution of severe thunderstorms and why some produce tornadoes and others do not. We face a similar challenge with our understanding of hurricanes. While our track forecasts have improved greatly—our forecast location for 5 days out is now as accurate as the forecast location for 3 days out was 15 years ago—we still do not understand what causes some tropical systems to jump two intensity categories in less than 24 hours, while others do not. NOAA's goal—through an innovative research-to-operations test-bed called the Hurricane Forecast Improvement Project (or HFIP)—is to demonstrate a 20 percent reduction to the average errors of hurricane track and intensity forecasts by the end of Fiscal Year and operationalize that improvement over the next few years. This will improve the accuracy and reliability of hurricane forecasts; extend lead time for hurricane forecasts

with increased certainty; and increase confidence in hurricane forecasts. The desired outcome is to ultimately reduce the Nation's risk to hurricane impacts by delivering improved forecasts and tools for community planners and other decisionmakers. The anticipated societal benefits will reduce deaths, injuries and property damage, and reduce the other costs associated with hurricanes by enabling decisionmakers to better identify at-risk populations and property, and by raising the confidence levels to initiate mitigation measures further in advance of approaching hurricanes.

NOAA is making investments in key research and development areas that address a key information gap today between instruments on Earth's surface and on satellites. One area of NOAA investment that could help bridge that gap is in Unmanned Aerial Systems (UAS). Operated by remote pilots and ranging in wingspan from less than six feet to more than 115 feet, UAS collect data from dangerous or remote areas. UAS have the potential to improve NOAA's ability to monitor and understand the global environment by collecting data from areas that are currently inaccessible. In partnership with NASA NOAA spent 6 weeks in the fall of 2010 studying hurricane formation and development in the Gulf of Mexico and the western Atlantic Ocean. Researchers sent the Global Hawk, equipped with a suite of instruments, over hurricanes Earl, Karl, and other storms in the region. The UAS flew multiple times over hurricane eyes, soared above one storm (a record for a unmanned aircraft system), and collected high-resolution data on the storms' wind and cloud structures, particles in the air, lightning strikes and other meteorological variables. NOAA is partnering with other Federal agencies, academia, and private companies to test a variety of UAS. UAS may also have significant benefits beyond hurricanes, including new observational support for improving: the accuracy of other storm, flood, and drought forecasts, benefiting emergency managers and diverse private industries; our understanding of climate change; assessments of changes in Arctic sea ice and effects on ecosystems and coasts; and fire weather forecasts to increase safety and success in fighting wildfires that threaten people and property.

NOAA also fosters innovation through partnerships. Water management decisionmakers require a new generation of water information, forecasts, and decision support. NOAA is working with its Federal partners USGS, USACE and others to implement Integrated Water Resources Science and Services, creating an integrated, high-resolution common operating picture for water information, supporting timely and critical water management decision in full coordination and collaboration with forecasting and decision support services.

And finally, advances in data assimilation, computer modeling, and atmospheric observations through high-tech polar orbiting satellites and geostationary satellites have led to substantial improvements in NOAA's model forecasts. For example, leading up to the "Snowmageddon" event of February 2010, NOAA was able to detect the storm threat seven-plus days in advance and begin alerting the East Coast up to 5 days in advance of the storm. This allowed states to implement contingency and continuity of operations plans, airlines to rearrange flights, and the retail industry to pre-stock their shelves. As a result, there was minimal impact to national and local airline and highway transportation. This long lead time was made possible in large part by observations obtained by NOAA's polar-orbiting satellite and numerical weather prediction models.

Polar-orbiting satellites are the backbone of *all model* forecasts for 3 days and beyond; however, future innovation in our observations and improvements in our forecasting are at risk. The launch of the next generation of NOAA's polar-orbiting satellites, the Joint Polar Satellite System (JPSS), has been further delayed by funding shortfalls in Fiscal Year 2011. As a result, NOAA is faced with a nearly 100 percent chance of a data gap in the U.S. civilian polar orbit, on which both civilian and military users rely, by late 2016 to early 2017 when the current polar satellites reach the end of their life expectancy. JPSS is a critical part of NOAA's future infrastructure needed to continue our path of forecast improvement—and to maintain what we have built over the last 30 years. NOAA thanks the Committee, and the Senate as a whole, for their recognition of this crucial need and their support in the Senate's Fiscal Year appropriations bill for NOAA.

Uninterrupted flow of data from NOAA satellites is required to support two Department of Commerce Primary Mission Essential Functions (PMEF),[1] which have

[1] *PMEF DOC–2:* Collect and provide the Nation with critical intelligence data, imagery, and other essential information for predictive environmental and atmospheric modeling systems and space-based distress alert systems by operating NOAA-controlled satellites, communications equipment, and associated systems.

PMEF DOC–3: Provide the Nation with environmental forecasts, warnings, data, and expertise critical to public safety, disaster preparedness, all-hazards response and recovery, the na-

Continued

been approved by the National Continuity Coordinator, thus making NOAA satellites not just NOAA priorities but also national priorities. NOAA is investing now to ensure that the Nation can continue to rely on these critical observations in the future. These observations and the derived products and services allow the Nation to prepare effectively for and deal with severe weather and other environmental phenomena.

Getting the Word Out

As the Federal Government's sole official voice for issuing warnings during life-threatening weather events, and as an established, reliable, and trusted source, NOAA provides the Nation's first line of defense against severe weather. NOAA operates the Nation's geostationary and polar orbiting satellites, a nationwide network of Doppler weather radars and surface observing stations. Scientists develop computational models that combine these observations with equations describing the physics of our atmosphere and ocean, and our forecasters interpret and deliver critical information. Alerts and warnings for severe weather and other near term hazards (tornadoes, hurricanes, severe thunderstorms, winter storms, most floods, chemical spills, volcanic ash, tsunami, space weather, etc.,) are delivered through multiple redundant mechanisms, including: NOAA Weather Radio, which triggers the Emergency Alert System; NWSChat, which focuses on real-time coordination with local core customers in the broadcast media and emergency management; the Internet; and, through our private sector partners, commercial television and radio, which communicate critical information to much larger audiences and effectively inform those in harm's way to take appropriate action.

Preparedness

Our prospects for achieving our vision of resilient communities lie in our unique enterprise capabilities. The goal of disaster resilience is to enhance the capacity of a community exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. The preparedness challenge remains essentially the same across both short-term and long-term weather and water events: public awareness, education, and plans of action to mitigate impacts on the personal, community, and regional scales provide the best protection against potential disasters. NOAA has long-held and strongly established ties to the emergency management community, through state, local, and tribal officials, which help ensure appropriate action is taken to prepare communities for weather and water events. NOAA and its partners, such as the National Sea Grant network, use integrated research, training, and technical assistance to enhance the ability of communities to prepare for, respond to, and rebuild after disasters strike. For example, we are developing a Coastal Resilience Index that provides a tangible way for communities to identify gaps and examine how prepared they are for storms and storm recovery, and provide guidance on how to increase resilience through measures including strengthening infrastructure or adopting stricter building codes.

The historic floods, which spanned from Montana across the Dakotas, into northern and central plains and southern Mississippi Valley earlier this year, are an excellent example of why we need to prepare for catastrophic events. The NOAA spring flood outlook highlighted those particular areas as having the likelihood of major flooding. Our River Forecast Centers and local Weather Forecast Offices worked with Federal, state and local emergency managers and planners to help prepare for and plan to mitigate the impact of the flooding. Based on our forecasts, communities took extensive actions to limit the impact of the flooding, including massive levee reinforcements and eventual evacuations to prevent loss of life. FEMA prepositioned relief assets, and the USGS ensured their river gauges were operational—all of the agencies worked together to help mitigate the potential impact.

Unfortunately, in spite of our best efforts, severe weather events still cause loss of life and significant damage. More of this could be mitigated with more timely, accurate and focused warnings. The impacts and lives lost from the disasters mentioned above would have been far worse without critical data input of observations from satellites and in-situ observations, and the extensive work of NOAA and our Federal, non-Federal, state, and local partners to improve the Nation's preparedness for these events through education and outreach. However, as evidenced by the tragic loss of life in a number of these events, there is a long way to go to truly achieve a Weather-Ready Nation.

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tional transportation system, safe navigation, and the protection of the Nation's critical infrastructure and natural resources.

Achieving a Weather- and Water-Ready Nation

With the high death toll and impacts we've seen this year, we take little solace in knowing that outcomes could have been worse without the extensive work of NOAA and our Federal, non-Federal, state, and local partners. There is much more that needs to be done to improve the Nation's resilience for these events. Research, education, and outreach are the essential ingredients to improving preparedness and via improved forecast and warning accuracy and lead times. Realizing a Weather-Ready Nation, where society is prepared for and responds to weather dependent events, is vital.

NOAA has started a national dialog with the Nation's top experts in broadcast meteorology, emergency management, and the weather industry to examine what is happening with severe weather and what can be done in the short-and long-term to improve the Nation's severe weather forecasts and warnings, and community preparedness. Included in this effort are social sciences, innovative technologies, and social media to improve our effectiveness in reaching those in harm's way and provoking appropriate response, whether to the urgency of a tornado or tsunami warning, or to the longer-term likelihoods of flooding or drought. For example, most NWS offices have established Facebook pages, providing an additional medium for conducting outreach and education, as well as highlighting information about ongoing or upcoming weather events. Additionally, NOAA uses NWSChat to give private sector partners an invaluable opportunity to interact with NWS experts and to refine and enrich their communications to the public. Moreover, more private companies are carrying weather warnings on wireless networks, providing real-time alerts to your cell phone or e-mail.

Sustaining our commitment to existing services, while continuing to innovate to improve our capacity to meet the Nation's weather and water needs, requires targeted investments to shore up aging infrastructure, improve scientific understanding, and implement enhanced services to reduce risk to the Nation caused by weather and water. NOAA must increase our capacity to collect and assimilate increasing amounts of data to improve model performance, which is achieved through scientific innovation and technological advancements. Future technology improvements include more advanced polar and geostationary satellites, more sophisticated radar coverage, observing systems, and improved computing capabilities. These technology assets are crucial pieces of our national infrastructure.

Additional, innovative projects, such as the Weather and Emergency Manager Decision Support (WxEM) and the HFIP's Socio-Economic Research Recommendations Projects are also integrating social science into NOAA products and information to encourage more resilient behavior that reduces loss of life and property.

Through the Weather and Emergency Manager Decision Support, NOAA is exploring ways to make its information easier to find, easier to understand, and easier to apply in operations by the Emergency Management community. This will result in improved decisionmaking for risk management of life and property. Further, the HFIP Socio-Economic Research project is using social science to help improve tropical cyclone risk communication, including the development of new or reconfigured existing graphics (*e.g.,* the hurricane forecast cone of uncertainty) and visualization techniques, to better communicate tropical cyclone and storm surge risk and promote appropriate public response.

We know that NOAA forecasts, warnings, and community-based preparedness programs are vital in enhancing the economy and saving lives. It all starts with a commitment on improved forecasting and ends with a Weather-Ready Nation in which businesses, governments, and people are prepared to use those forecasts to mitigate impacts.

Summary

To achieve an increase in community resilience and reduce the Nation's vulnerability to weather and water related extreme events, we must continue to improve predictions. Again, our Nation's environmental predictive capabilities are supported by four foundational pillars: observations, computer models, research, and our people. By strengthening the pillars—through continued innovation in improved satellite and in-situ observations, computing capacity, coupled atmosphere, ocean, land models, and necessary research and science improvement—we can revolutionize the forecast process across the entire spectrum from relatively small-scale, short range applications to long range weather and climate predictions.

The dual goals of preparing for and mitigating natural hazards require the continuous commitment and partnership of many individuals and sectors—from Federal, state, tribal, and local to public, private, and academic. The investments made by Congress and the Administration in NOAA's weather prediction and warning capabilities *directly* save lives in the United States during these weather disasters.

NOAA remains committed to leading U.S. efforts to save lives and property through preparedness, detection, modeling, and forecasting efforts necessary for improved decisionmaking. Although nothing can eliminate the physical threat that severe weather and natural hazards pose, NOAA has demonstrated success in better predicting them, reducing their impact, and helping vulnerable communities become more resilient to their devastating effects—and will work to continuously improve its natural hazards products and services to the Nation.

Senator BEGICH. Thank you very much for your comments.

Next we'd like to have Todd Zinser, Inspector General, U.S. Department of Commerce.

STATEMENT OF HON. TODD J. ZINSER, INSPECTOR GENERAL, U.S. DEPARTMENT OF COMMERCE

Mr. ZINSER. Thank you, Mr. Chairman, Ranking Member Snowe. Thank you for the opportunity to testify today, and thank you for your recognition of Mary's service. It's been a privilege of mine to serve with her these past 4 years as Inspector General.

My office has oversight responsibility for NOAA, including NOAA's weather satellite programs. We recently issued an audit report this past September on the Joint Polar Satellite System, known as JPSS. My written testimony summarizes our findings and recommendations, and this morning I would just offer three observations based on our continuing oversight.

First, JPSS is a critically important program for the Nation and its ability to observe weather and provide data for forecast watches and warnings, but it is a program that must overcome years of setbacks experienced by its predecessor program called the National Polar-orbiting Operational Environmental Satellite System, or NPOESS. NPOESS was an early effort dating back to the mid-1990s to reduce duplication and overlap in the polar environmental satellite programs of the Department of Defense, NASA and NOAA. The effort did not succeed, and, in February 2010, after many years of delays and cost overruns, in February 2010 the administration restructured the program. This involved decoupling Defense on the one hand and NOAA and NASA on the other.

NOAA and NASA are now partners on JPSS and my sense is that, despite a difficult transition over the past 21 months, the program officials are continuing to work diligently and are optimistic about continued progress of the program.

My second observation is that there are many challenges ahead for JPSS, and those challenges must now be met against a backdrop of seriously constrained budgets for perhaps the next decade. We have placed these challenges into two groups. Number one, the JPSS program must take steps to prevent a potential near-term coverage gap from the current polar satellite called NOAA–19, and a stop-gap satellite called NPOESS Preparatory Project, or NPP that was successfully launched late last month as part of a contingency plan. NPP was originally intended as a test satellite but has been launched with the intent to use the data it collects to provide continuity of weather observations.

While NPP was successfully launched by NASA and the checkout period for the instruments is progressing well, it is expected to take 18 months or longer before the NPP satellite data is fully operational. That 18-month time-frame coincides with the end of NOAA–19's design life in March 2013, leaving very little room for

contingencies and creating the potential for a near-term coverage gap. The plan to use NPP as a contingency created other challenges identified in our September report.

The second major challenge for the JPSS program is to mitigate a longer-term coverage gap that is expected to occur between the end of design life for the NPP satellite and the operational date for JPSS–1. NPP's projected end of design life is November of 2016. The program plans to launch JPSS–1 in the first quarter of Fiscal Year 2017. That date depends on full funding for JPSS for Fiscal Year 2012 and beyond. There will also be a checkout period for JPSS–1 instruments which could extend from 6 to 18 months after launch. If an extended checkout period is necessary for JPSS–1, the coverage gap for polar satellite data could be as long as 21 months.

My third observation, then, Mr. Chairman, is that the senior management at NOAA and the JPSS program must take steps (a) to ensure that there is no additional slippage in the schedule through close management of the program and (b) minimize the potential impact of any coverage gap. Our recent report makes two recommendations in that regard.

First, NOAA needs to finalize a program baseline which includes costs, and scheduling requirements, and keep the Department and Congress informed of the program's performance against that baseline. In doing so, the JPSS program should prioritize all requirements and contingencies in order to maintain the current planned launch date.

Second, NOAA should coordinate across the agency to develop contingencies for a coverage gap. NOAA needs to ensure, for example, that the scientists who work for the National Weather Service are working together with the scientists from the satellite service to develop options for using data from all of its sources to compensate for some of the possible loss of polar satellite data. Our concern is that, at this point, there is no coordinated approach to the problem across NOAA's lines of businesses—and that there should be.

Mr. Chairman, this concludes my statement. I'd be happy to respond to any questions.

[The prepared statement of Mr. Zinser follows:]

PREPARED STATEMENT OF HON. TODD J. ZINSER, INSPECTOR GENERAL, U.S. DEPARTMENT OF COMMERCE

Chairman Begich, Ranking Member Snowe, and Members of the Subcommittee:

I appreciate the opportunity to testify today about the challenges NOAA faces in its efforts to develop and launch its new environmental satellites while minimizing expected data gaps.

For the past 50 years, NOAA, in partnership with the National Aeronautics and Space Administration (NASA), has been responsible for developing and operating polar and geostationary environmental satellite systems. NOAA's environmental satellite operations and weather forecasting are designated primary mission-essential functions of the Department of Commerce because they directly support government functions the President has deemed necessary to lead and sustain the Nation during a catastrophe. But NOAA's current constellation of polar and geostationary operational environmental satellites is aging, and its capabilities will degrade over time. As a result, the risk increases for gaps in critical satellite data.

Between 1995 and early 2010, NOAA partnered with the Department of Defense (DOD) and NASA in the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS), which was at that time the planned replacement system for NOAA's Polar Operational Environmental Satellite System

and DOD's Defense Meteorological Satellite Program. The original NPOESS program was to develop six satellites, with first launch planned for 2009 and an estimated life-cycle cost of $6.5 billion through 2018. By late 2009, however, the program had reduced its scope to four satellites; the first launch was delayed until 2014, while its life-cycle cost estimate had escalated to $14 billion through 2026.

In February 2010, the White House's Office of Science and Technology Policy announced its decision to have NOAA, in partnership with NASA, establish the Joint Polar Satellite System (JPSS) program as part of a NPOESS restructuring due to its long history of cost overruns and schedule delays. At that time, the JPSS program planned to launch two satellites—at an estimated cost of $11.9 billion—to collect data for short-and long-term weather and climate forecasting through 2026. In order to be included in the Fiscal Year President's budget request, NOAA had to develop the JPSS budget estimate so quickly that—while NOAA had existing NPOESS requirements in place—it did not have time to formally approve high-level requirements for JPSS. In September 2011, NOAA notified Congress that it had recently completed its high-level JPSS requirements, was refining its cost estimate, and planned to incorporate updated baselines (cost, schedule, and performance) in the upcoming Fiscal Year budget submission.

The Senate Committee on Appropriations has proposed funding JPSS with $921 million in Fiscal Year while the House of Representatives appropriations bill recommends $901 million. Both bills fall short of the President's $1.07 billion budget request for JPSS, which the program maintains is necessary to ensure the first JPSS satellite's (JPSS–1's) launch date in the first quarter of 2017.

Given its history, this critical program requires strong program management and close oversight to minimize further delays and prevent interruptions in satellite coverage. Our work has identified these near-term priorities for NOAA as it manages JPSS:

- complete the data checkout for the NPOESS Preparatory Project (NPP) and
- strengthen program management and systems engineering to mitigate JPSS coverage gaps.

Preventing Near-Term Coverage Gaps: from NOAA–19 to NPP

JPSS–1 will be preceded in orbit by the NPP satellite, originally a NASA-led risk reduction effort to test NPOESS' new instruments in flight. NOAA will now use NPP to maintain continuity of climate and weather forecast data between NOAA's current polar-orbiting operational environmental satellite (NOAA–19) and JPSS–1. Despite recent efforts by NASA's NPP team (including contractors) to meet the satellite's scheduled launch date, late development of the ground system has compressed the mission schedule—and delayed the schedule for data product availability.

Since we issued our September 30, 2011, report on JPSS, NASA successfully launched NPP on October 28 and reports that satellite checkout activities, such as instrument activation, are proceeding according to schedule. Once checkout completes, NASA will turn the satellite over to the JPSS program to calibrate the instruments and validate the scientific quality of data products; ultimately, the JPSS program will hand over satellite operations to NOAA.

After the launch, NOAA originally planned to make NPP operationally ready in 18 months, which coincides with the end of the design life of NOAA–19 (approximately March 2013). This plan left little room for contingencies. Both NOAA and our office have identified a number of risks that, if not properly mitigated, could cause further delays in NPP operational readiness and degradation of NOAA's weather and climate forecasting capability:

- *Potential coverage gap.* According to the ground system's contractor, Raytheon, the ground system will not be able to support the validation of a significant number of data records until after a system upgrade, planned for March 2012. In addition, NOAA has not finalized coordination between the NPP/JPSS program and NOAA's Center for Satellite Applications and Research (STAR), which is critical to transferring satellite observation into operations. Consequently, NOAA has extended its projection for readiness from 18 to 24 months after launch, which could lead to a gap in operational data between NOAA19 and NPP if NOAA–19 stops functioning properly at the end of its design life.
- *Insufficient number of ground station locations.* Unlike NOAA's existing operational satellite systems, NPP has only a single mission management center for controlling the satellite, and NPP's ground station has the system's only science data downlink (the means to transmit a signal from the satellite to the ground station). NOAA and JPSS program officials have commissioned studies to develop an alternate mission management center and hope to have one ready well

in advance of the JPSS–1 launch. Program officials indicated that the ground station has redundancy in terms of antennas and equipment. However, while there is redundancy, the use of a single ground station in a single geographic location is not consistent with NOAA's existing polar and geostationary operational environmental satellite systems, which use more than one location.

- *Postlaunch ground system development challenges.* NASA conducted two major ground system/NPP satellite compatibility tests in 2011; the first test had been delayed when ground system software builds took longer than expected to produce. Both tests experienced further delays and compressed the remaining work schedule for the NPP launch. NASA has also postponed analysis of some test results and requirements verification. Further, in response to an independent review team's recommendations, the project completed a stress test in late September and early October to evaluate NPP's operational readiness—any system fixes required to mitigate identified concerns would add to the postlaunch data production workload.

In order to reduce the risk of a data gap between NOAA–19 and NPP, NOAA management needs to provide sufficient oversight to enable communication and coordination between the JPSS program and STAR. Further, it must balance instrument calibration and data validation activities (needed to produce operational data) with other ground system development tasks. NOAA should also determine the feasibility of establishing an alternate mission management center and an additional science data downlink for NPP as soon as possible.

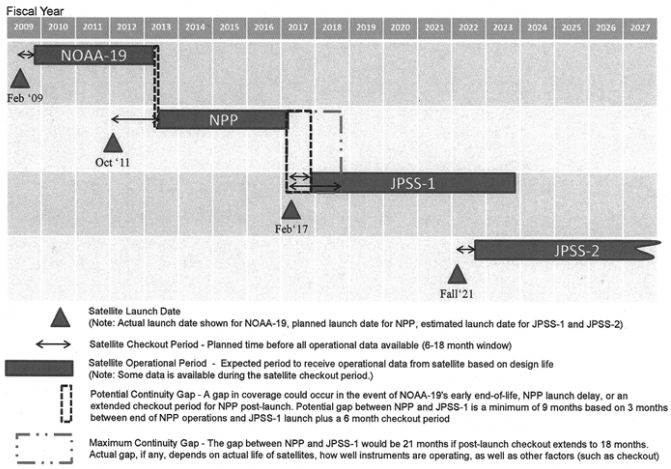
Mitigating Longer-Term Coverage Gaps: from NPP to JPSS–1

NOAA expects a gap in weather and climate observations between NPP's end of design life and the operational date of JPSS–l. NPP's projected end of design life is November 2016, NOAA plans to launch JPSS–1 in the first quarter of 2017,[1] and there is a minimum 6-month checkout period before key data products from JPSS–1 will become operational. We project that, due to continued budget uncertainty and probable Fiscal Year funding somewhat below the President's budget request, the JPSS–1 launch date will be no earlier than February 2017. Based on a February 2017 launch, the gap would last at least 9 months (3 months from November to February, plus the additional 6 months for checkout). Should checkout take 18 months (as NOAA predicts NPP's will), the gap would extend a total of 21 months (see figure 1). NOAA's studies have found that its weather forecasting at 5, 4, and 3 days before an event could be significantly degraded during the coverage gap period.

JPSS–1 will require a checkout period longer than 6 months to achieve full operational capability (versus an interim capability to produce key data products). Full checkout could be prolonged because JPSS–1 instruments will have manufacturing changes from the models flown on NPP—and, in all probability, NPP will no longer be operational when JPSS–1 is on-orbit, thus leaving the JPSS–1 mission without a direct, and more efficient, means for comparison.

[1] NOAA projected a JPSS–1 launch in the first quarter of Fiscal Year 2017, pending (1) the program receiving the full President's budget request for Fiscal Year 2012 ($1.07 billion) and beyond and (2) no Fiscal Year 2012 continuing resolution beyond the first quarter of Fiscal Year 2012.

Figure 1. Potential Continuity Gaps in Afternoon Orbit



Source: OIG analysis of NOAA data, as of August 22, 2011.

We have identified the following areas that require senior management attention to help ensure JPSS–1 operational readiness and minimize the potential impact of the coverage gap:

- *Prioritize all JPSS requirements,*[2] *develop reliable cost estimates to support future funding requests, and systematically communicate planned actions and progress with decisionmakers.* NOAA is currently developing a revised life-cycle cost estimate. Additionally, NOAA tasked NASA with developing contingencies that prioritize some of the most important requirements and maintain a launch readiness date no later than February 2017. We believe the JPSS program should formally prioritize *all* of its requirements, not just the subset in this contingency exercise, so that it can efficiently adjust the program's performance capabilities or launch dates, if needed, in response to year-to-year funding variances. Further, the program should develop a plan to accommodate requirements that may have to be removed or relaxed when annual funding falls short of the program's budget but could be recouped in future appropriations. Finally, due to the importance and complexity of the JPSS program, NOAA must establish a program baseline (cost, schedule, and requirements) as soon as possible—and keep the Department and Congress informed of its planned actions and progress against this baseline to facilitate decisionmaking.
- *Coordinate NOAA response, in case NPP does not live through its 5-year design life.* The NPP spacecraft was designed to last 5 years and carries enough fuel to last 7 years. However, most of its instruments were managed and developed under the NPOESS contract, which received limited government oversight and had a history of technical issues. Additionally, under the NPOESS contract, NASA lacked technical oversight during the instrument development, manufacturing, and testing phases, creating uncertainty about the instruments' ability to operate for the length of the spacecraft's design life. For these reasons, NASA's revised criteria for NPP mission success called for only 3 years of operability. Although NOAA's current analysis assumes that NPP will have a 5-year operational life, NOAA understands that a residual risk of a shorter life expectancy remains due to the lack of oversight during the development of most of NPP's instruments. In order to sufficiently prepare for an expected gap in polar satellite data from the afternoon orbit, NOAA should coordinate efforts from across its line offices to minimize the degradation of weather and climate forecasting during gaps in coverage.

[2] High-level requirements include the number of spacecraft, the instruments needed, the observational data to be provided, the timeliness of data delivery, and data distribution methods, among others.

In conclusion, Mr. Chairman, we have provided (and will continue to provide) our independent assessment of the JPSS program. We look forward to NOAA's action plan to address recommendations in our September 30 audit report. The hope is that, when closing the looming satellite coverage gaps, NOAA finds innovative solutions—and can convey them, in a timely fashion, to Congress and other stakeholders. This concludes my prepared statement, and I will be pleased to respond to any questions you or other Subcommittee members may have.

Senator BEGICH. Thank you very much.

Next we have David Trimble, Director, Natural Resources and Environment, Government Accountability Office.

STATEMENT OF DAVID C. TRIMBLE, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. TRIMBLE. Chairman Begich, Ranking Member Snowe, I'm pleased to be here today to discuss Federal efforts to provide climate data and services to decisionmakers. Recent assessments of the potential impacts of climate change in the United States have found, among other things, that climate-related changes such as rising temperature and sea level will combine with pollution, population growth, urbanization, and other social, economic and environmental stresses to create larger impacts than from any one of these factors alone.

Policymakers are increasingly viewing adaptation, defined as adjustments to natural human systems in response to actual or expected climate change, as a risk management strategy to protect vulnerable sectors and communities that might be affected by changes in the climate. It may be costly to raise river or coastal dikes to protect communities and resources from sea level rise, build higher bridges or improve storm water systems, but there is a growing recognition that the cost of inaction could be greater.

Over the years, GAO has reported on many climate change issues, including recent reports on adaptation and Federal funding for climate change programs and activities. Let me highlight four points from these reports.

First, climate change adaptation has begun to receive more attention and resources because the greenhouse gases already in the atmosphere are expected to continue altering the climate system into the future regardless of efforts to control emissions. Further, there is a growing recognition that past practices for making decisions may no longer be reliable. According to the National Research Council, many decision rules for such things as building bridges or establishing zoning rules assume a continuation of past climate conditions with similar patterns or variation and the same probability of extreme events. According to the NRC, that assumption, fundamental to the way people and organizations make their choices, is no longer valid.

Second, Federal, state and local authorities on the front line of early adaptation efforts face challenges obtaining local or site-specific climate data such as projected temperature and precipitation changes, and translating that data into information they need to make decisions. The lack of such data makes it hard for these officials to understand or quantify the potential impacts of climate change, and difficult to justify the cost of adaptation efforts since projections of future benefits are less certain than current costs.

Third, according to the experts we have surveyed, Federal actions to provide and interpret site-specific information could help address some of these challenges. Our 2009 report on climate change adaptation discusses several potential actions that Federal, state and local officials identified as useful to inform adaptation decisionmaking. These included state and local climate change impact and vulnerability assessments, and the development of processes and tools to access, interpret, and apply climate information.

In that report, we also obtained information regarding the creation of a climate service, a Federal service to consolidate and deliver climate information to decisionmakers to inform their adaptation efforts. While we have not made a recommendation regarding the creation of a climate service within NOAA or any other agency or interagency body, our 2009 report discussed a range of potential strengths and limitations of such a service.

Fourth, adaptation will require making policy and management decisions that cut across traditional sectors, issues and jurisdictional boundaries. Many Federal entities, executive offices and organizations manage programs and activities related to climate change. However, getting these entities to work toward a common goal is complicated. In 2009, we recommended the development of a strategic plan to guide the nation's efforts to adapt to a changing climate, including the identification of mechanisms to increase the capacity of Federal, state and local agencies to incorporate information about current and potential climate change impacts into government decisionmaking.

The recent Interagency Climate Change Adaptation Task Force is a positive step, but coordination on climate change issues across the government is still a challenge. Our May 2011 report on climate change funding found that Federal officials do not have a shared understanding of strategic government-wide priorities, including the roles and responsibilities of the key Federal entities. In a period of declining budgets, effective collaboration across all Federal agencies is critical, now more than ever.

That concludes my statement. I will, of course, be happy to answer any questions.

[The prepared statement of Mr. Trimble follows:]

PREPARED STATEMENT OF DAVID C. TRIMBLE, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Chairman Begich, Ranking Member Snowe, and Members of the Subcommittee:

I am pleased to be here today to discuss Federal efforts to provide climate data and services to decision makers. Climate change is a complex, crosscutting issue that poses risks to many existing environmental and economic systems, including agriculture, infrastructure, ecosystems, and human health. A 2009 assessment by the United States Global Change Research Program (USGCRP) found that climate-related changes—such as rising temperature and sea level—will combine with pollution; population growth; urbanization; and other social, economic, and environmental stresses to create larger impacts than from any of these factors alone.[1] According to the National Academies, USGCRP, and others, greenhouse gases already in the atmosphere will continue altering the climate system into the future, regardless of emissions control efforts. Therefore, adaptation—defined as adjustments to

[1] USGCRP coordinates and integrates Federal research on changes in the global environment—including climate change—and their implications for society.

natural or human systems in response to actual or expected climate change—is an important part of the response to climate change.

Many Federal entities manage climate change programs and activities. According to the Office of Management and Budget's June 2010 Federal Climate Change Expenditures Report to Congress, 9 of the 15 cabinet-level departments, along with 7 other Federal agencies, received funding for climate change activities in Fiscal Year 2010.[2] In addition, entities within the Executive Office of the President, such as the Office of Science and Technology Policy, and Federal interagency coordinating bodies, like USGCRP, work together to ensure Federal climate change activities are guided by the latest climate science. A September 2010 report by the National Academy of Public Administration, which was prepared for the National Oceanic and Atmospheric Administration (NOAA) and Congress, referred to this set of Federal activities as the Federal "climate change enterprise."[3]

Federal climate programs are shifting their focus to adaptation and climate services. Our October 2009 report on climate change adaptation found no coordinated national approach to adaptation, but our May 2011 report on climate change funding cited indications that Federal agencies were beginning to respond to climate change more systematically.[4] About the same time as the issuance of our October 2009 report, Executive Order 13514 on Federal Leadership in Environmental, Energy, and Economic Performance called for Federal agencies to participate actively in the Interagency Climate Change Adaptation Task Force.[5] The task force, which began meeting in Spring 2009, is co-chaired by the President's Council on Environmental Quality, NOAA, and the Office of Science and Technology Policy and includes representatives from more than 20 Federal agencies and Executive Branch offices. The task force was formed to develop Federal recommendations for adapting to climate change impacts both domestically and internationally and to recommend key components to include in a national strategy. In addition, USGCRP recently launched a national climate assessment designed to engage stakeholders in a process that builds on science, data, and information to help decision making. Individual agencies are also beginning to consider adaptation actions. For example, in May 2009, the Chief of Naval Operations created Task Force Climate Change to address the naval implications of a changing Arctic and global environment.

My testimony today addresses: (1) the data challenges that federal, state, and local officials face in their efforts to adapt to a changing climate, (2) the actions Federal agencies could take to help address these challenges, and (3) Federal climate change strategic planning efforts. The information in this testimony is based on prior work, largely on our recent reports on climate change adaptation and Federal climate change funding.[6] Our work was based on, among other things, analysis of studies; site visits to areas pursuing adaptation efforts; responses to a web-based questionnaire sent to federal, state, and local officials knowledgeable about adaptation; and interviews with such officials. A detailed description of our scope and methodology is available in each issued product. All of the work on which this statement is based was performed in accordance with generally accepted government auditing standards.

A Lack of Site-Specific Data, Such as Local Projections of Expected Changes, Can Challenge the Ability of Officials to Manage the Effects of Climate Change

As we reported in October 2009, insufficient site-specific data, such as local projections of expected changes, make it hard for federal, state, and local officials to predict the impacts of climate change, and thus hard for these officials to justify the current costs of adaptation efforts for potentially less certain future benefits.[7] Based on the responses by a diverse array of federal, state, and local officials knowledgeable about adaptation to a web-based questionnaire designed for that report, related

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[2] Office of Management and Budget, Federal Climate Change Expenditures Report to Congress (June 2010). See *http://www.whitehouse.gov/sites/default/files/omb/assets/legislative_reports/FY2011_Climate_Change.pdf*.

[3] Panel of the National Academy of Public Administration, *Building Strong for Tomorrow: NOAA Climate Service,* a report prepared for Congress, the Department of Commerce, and NOAA (Sept. 13, 2010).

[4] GAO. *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions,* GAO–10–113, (Washington, D.C.: Oct. 7, 2009), and *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions,* GAO–11–317, (Washington, D.C.: May 20, 2011).

[5] For more information about the Interagency Climate Change Adaptation Task Force, see *http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation*.

[6] GAO–10–113 and GAO–11–317.

[7] GAO–10–113.

challenges generally fit into two main categories: (1) translating climate data—such as projected temperature and precipitation changes—into information that officials need to make decisions and (2) difficulty in justifying the current costs of adaptation with limited information about future benefits.

The process of providing useful information to officials making decisions about adaptation can be summarized by the following:

- First, data from global-scale models must be "downscaled" to provide climate information at a geographic scale relevant to decision makers. About 74 percent (133 of 179) of the officials who responded to our questionnaire rated "availability of climate information at relevant scale (*i.e.,* downscaled regional and local information)" as very or extremely challenging.
- Second, the downscaled climate information must be translated into impacts at the local level, such as increased stream flow. Some respondents and officials interviewed for our October 2009 report said that it is challenging to link predicted temperature and precipitation changes to specific impacts. For example, one Federal official said that "we often lack fundamental information on how ecological systems/species respond to non-climate change related anthropogenic stresses, let alone how they will respond to climate change."
- Third, local impacts must be translated into costs and benefits, since this information is required for many decision making processes. Almost 70 percent (126 of 180) of the respondents to our questionnaire rated "understanding the costs and benefits of adaptation efforts" as very or extremely challenging.[8] As noted by one local government respondent, it is important to understand the costs and benefits of adaptation efforts so they can be evaluated relative to other priorities.
- Fourth, decision makers need baseline monitoring data to evaluate adaptation actions over time. Nearly 62 percent (113 of 181) of the respondents to our questionnaire rated the "lack of baseline monitoring data to enable evaluation of adaptation actions (*i.e.,* inability to detect change)" as very or extremely challenging.

These challenges make it difficult for officials to justify the current costs of adaptation efforts for potentially less certain future benefits. A 2009 report by the National Research Council (NRC) discusses how officials are struggling to make decisions based on future climate scenarios instead of past climate conditions.[9] According to the report, requested by the Environmental Protection Agency and NOAA, usual practices and decision rules (*e.g.,* for building bridges, implementing zoning rules, using private motor vehicles) assume a stationary climate—a continuation of past climate conditions, including similar patterns of variation and the same probabilities of extreme events. According to the NRC report, that assumption, which is fundamental to the ways people and organizations make their choices, is no longer valid.

Federal Actions to Provide and Interpret Site-Specific Information Would Help Officials Understand the Impacts of Climate Change and Available Adaptation Strategies

Federal actions to provide and interpret site-specific information would help address challenges associated with adaptation efforts, based on our analysis of responses to the web-based questionnaire and other materials analyzed for our October 2009 report.[10] The report discussed several potential Federal actions that federal, state, and local officials identified as useful to inform adaptation decision making. These included state and local climate change impact and vulnerability assessments and the development of processes and tools to access, interpret, and apply climate information. In that report, we also obtained information regarding the creation of a climate service—a Federal service to consolidate and deliver climate information to decision makers to inform adaptation efforts.

About 61 percent (107 of 176) of the federal, state, and local officials who responded to the web-based questionnaire developed for our October 2009 adaptation report rated the "creation of a Federal service to consolidate and deliver climate information to decision makers to inform adaptation efforts" as very or extremely use-

[8] The number of respondents varies because some officials did not respond to certain questions.

[9] National Research Council of the National Academies, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, *Informing Decisions in a Changing Climate* (Washington, D.C., 2009).

[10] GAO–10–113.

ful.[11] Respondents offered a range of potential strengths and weaknesses for such a service. Several said that a climate service would help consolidate information and provide a single-information resource for local officials, and others said that it would be an improvement over the current ad hoc system. A climate service would avoid duplication and establish an agreed set of climate information with uniform methodologies, benchmarks, and metrics for decision making, according to some officials. According to one Federal official, consolidating scientific, modeling, and analytical expertise and capacity could increase efficiency. Similarly, some officials noted that with such consolidation of information, individual agencies, states, and local governments would not have to spend money obtaining climate data for their adaptation efforts. Others said that it would be advantageous to work from one source of information instead of different sources of varying quality. Some officials said that a climate service would demonstrate a Federal commitment to adaptation and provide a credible voice and guidance to decision makers. In an announcement on February 8, 2010, the Department of Commerce proposed establishing a NOAA climate service. Though not yet established, information is available on the NOAA climate service website, including draft vision and strategic framework documents.[12] According to NOAA documents, such a climate service would provide a single, reliable, and authoritative source for climate data, information, and decision support services to help individuals, businesses, communities, and governments make smart choices in anticipation of a climate changed future.[13] A September 2010 report by the National Academy of Public Administration discusses the factors needed for a NOAA climate service to succeed—such as the designation of a lead Federal agency to be the day-to-day integrator of the overall Federal effort regarding climate science and services—and makes recommendations on how to achieve those factors.[14]

Other respondents to our questionnaire, however, were less enthusiastic about the creation of a climate service. Some voiced skepticism about whether it was feasible to consolidate climate information, and others said that such a system would be too rigid and may get bogged down in lengthy review processes. Furthermore, certain officials stated that building such capacity may not be the most effective place to focus Federal efforts because the information needs of decision makers vary so much by jurisdiction. Several officials noted that climate change is an issue that requires a multidisciplinary response, and a single Federal service may not be able to supply all of the necessary expertise. For example, one Federal official stated that the information needs of Bureau of Reclamation water managers are quite different from the needs of Bureau of Land Management rangeland managers, which are different from the needs of all other resource management agencies and programs. The official stated that it seems highly unlikely that a single Federal service could effectively identify and address the diverse needs of multiple agencies. Several respondents also said that having one preeminent source for climate change information and modeling could stifle contrary ideas and alternative viewpoints. Moreover, several officials who responded to our questionnaire were concerned that a climate service could divert attention and resources from current adaptation efforts by reinventing duplicative processes without making use of existing structures. The 2009 NRC report on informing decisions in a changing climate recommends that the Federal government's adaptation efforts should be undertaken through a new integrated interagency initiative with both service and research elements but that such an initiative should not be centralized in a single agency.[15] Doing so, according to this report, would disrupt existing relationships between agencies and their constituencies and formalize a separation between the emerging science of climate response and fundamental research on climate and the associated biological, social, and economic phenomena. Furthermore, the report states that a climate service located in a single agency and modeled on the weather service would by itself be less than fully effective for meeting the national needs for climate-related decision support. The NRC report also notes that such a climate service would not be user-driven and so would likely fall short in providing needed information, identifying and

[11] GAO–10–113.

[12] For more information about the NOAA Climate Service, see *http://www.noaa.gov/climate.html.* A range of climate information is presented at *www.climate.gov,* NOAA's Climate Services Portal.

[13] The Department of Defense and Full Year Continuing Appropriations Act, 2011 prohibited any funds appropriated in the act to be used to implement, establish, or create a NOAA Climate Service as NOAA had previously described it during Fiscal Year 2011.

[14] Panel of the National Academy of Public Administration, *Building Strong for Tomorrow: NOAA Climate Service,* a report prepared for Congress, the Department of Commerce, and NOAA (Sept. 13, 2010).

[15] USGCRP's September 30, 2011 Draft Strategic Plan reflects elements of these NRC recommendations.

meeting critical decision support research needs, and adapting adequately to changing information needs.

We have not made recommendations regarding the creation of a climate service within NOAA or any other agency or interagency body, although the provision of climate data and services will be an important consideration in future government-wide strategic planning efforts, particularly in an era of declining budgets.

Federal Climate Change Strategic Planning Efforts Could Be Improved

Federal strategic planning efforts could be improved for many aspects of the climate change enterprise. Our October 2009 report on climate change adaptation concluded that, to be effective, related Federal efforts must be coordinated and directed toward a common goal.[16] This report recommended the development of a strategic plan to guide the Nation's efforts to adapt to a changing climate, including the identification of mechanisms to increase the capacity of federal, state, and local agencies to incorporate information about current and potential climate change impacts into government decision making. Some actions have subsequently been taken to improve Federal adaptation efforts, but our May 2011 report on climate change funding found that Federal officials do not have a shared understanding of strategic governmentwide priorities.[17] This report recommended, among other things, the clear establishment of Federal strategic climate change priorities, including the roles and responsibilities of the key Federal entities, taking into consideration the full range of activities within the Federal climate change enterprise. In other reports, we also noted the need for improved coordination of climate-related activities. For example, our April 2010 report on environmental satellites concluded that gaps in satellite coverage, which could occur as soon as 2015, are expected to affect the continuity of important climate and space weather measurements.[18] In that report, we stated that, despite repeated calls for interagency strategies for the long-term provision of environmental data from satellites (both for climate and space weather purposes), our Nation still lacks such plans.

Of particular importance in adaptation are planning decisions involving physical infrastructure projects, which require large capital investments and which, by virtue of their anticipated lifespan, will have to be resilient to changes in climate for many decades. The long lead time and long life of large infrastructure investments require such decisions to be made well before climate change effects are discernible. Our ongoing work for the Senate Committee on Environment and Public Works Subcommittee on Oversight and Subcommittee on Transportation and Infrastructure will explore this issue by reviewing the extent to which federal, state, and local authorities consider the potential effects of climate change when making infrastructure investment decisions.

Chairman Begich, Ranking Member Snowe, and Members of the Subcommittee, this concludes my prepared statement. I would be happy to respond to any questions that you or other Members of the Subcommittee may have.

Why GAO Did This Study

Climate change is a complex, crosscutting issue that poses risks to many existing environmental and economic systems, including agriculture, infrastructure, ecosystems, and human health. A 2009 assessment by the United States Global Change Research Program (USGCRP) found that climate-related changes-—such as rising temperature and sea level-—will combine with pollution, population growth, urbanization, and other social, economic, and environmental stresses to create larger impacts than from any of these factors alone.

According to the National Academies, USGCRP, and others, greenhouse gases already in the atmosphere will continue altering the climate system into the future, regardless of emissions control efforts. Therefore, adaptation—-defined as adjustments to natural or human systems in response to actual or expected climate change—-is an important part of the response to climate change.

This testimony addresses (1) the data challenges that Federal, state, and local officials face in their efforts to adapt to a changing climate, (2) the actions Federal agencies could take to help address these challenges, and (3) Federal climate change strategic planning efforts. The information in this testimony is based on prior work, largely on GAO's recent reports on climate change adaptation (GAO–10–113) and

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[16] GAO–10–113.

[17] GAO–11–317.

[18] GAO. *Environmental Satellites: Strategy Needed to Sustain Critical Climate and Space Weather Measurements,* GAO–10–456, (Washington, D.C.: Apr. 27, 2010). For another example of the need for improved strategic planning, see *Climate Change: A Coordinated Strategy Could Focus Federal Geoengineering Research and Inform Governance Efforts,* GAO–10–903, (Washington, D.C.: Sept. 23, 2010).

Federal climate change funding (GAO–11–317). These reports are based on, among other things, analysis of studies, site visits to areas pursuing adaptation efforts, and responses to a web-based questionnaire sent to Federal, state, and local officials.

What GAO Found

As GAO reported in October 2009, challenges from insufficient site-specific data—such as local projections—make it hard for Federal, state, and local officials to predict the impacts of climate change, and thus hard to justify the current costs of adaptation efforts for potentially less certain future benefits. Based on responses from a diverse array of Federal, state, and local officials knowledgeable about adaptation, related challenges generally fit into two main categories: (1) translating climate data—such as projected temperature and precipitation changes—into information that officials need to make decisions and (2) the difficulty in justifying the current costs of adaptation with limited information about future benefits.

Federal actions to provide and interpret site-specific information would help address data challenges associated with adaptation efforts, based on responses to GAO's web-based questionnaire sent to Federal, state, and local officials and other materials analyzed for its October 2009 report. In addition to several potential Federal actions identified as useful by respondents to GAO's questionnaire, including the development of state and local climate change vulnerability assessments, GAO's 2009 report also contained information about the creation of a Federal climate service. Specifically, about 61 percent (107 of 176) of respondents rated the "creation of a Federal service to consolidate and deliver climate information to decisionmakers to inform adaptation efforts" as very or extremely useful. Respondents offered a range of potential strengths and weaknesses for such a service. For example, several respondents stated that a climate service would help consolidate information and provide a single information resource for local officials. However, some respondents to GAO's questionnaire voiced skepticism about whether it was feasible to consolidate climate information, and others stated that such a service would be too rigid and may get bogged down in lengthy review processes. GAO has not made recommendations regarding the creation of a climate service within the National Oceanic and Atmospheric Administration or any other agency or interagency body.

Federal strategic planning efforts could be improved for many aspects of the climate change enterprise. For example, GAO's October 2009 report on climate change adaptation concluded that, to be effective, related Federal efforts must be coordinated and directed toward a common goal. This report recommended the development of a strategic plan to guide the Nation's efforts to adapt to a changing climate, including the identification of mechanisms to increase the capacity of Federal, state, and local agencies to incorporate information about current and potential climate change impacts into government decisionmaking. Some actions have subsequently been taken to improve Federal adaptation efforts, but GAO's May 2011 report on climate change funding found that Federal officials do not have a shared understanding of strategic governmentwide priorities.

[For an online version of this testimony, go to *http://www.gao.gov/products/GAO–12–238T*].

Senator BEGICH. Thank you very much.

The next person is Admiral Thomas, Director of Response Policy, United States Coast Guard.

STATEMENT OF REAR ADMIRAL CARI B. THOMAS, DIRECTOR OF RESPONSE POLICY, UNITED STATES COAST GUARD

Admiral THOMAS. Good morning, Chairman Begich, Ranking Member Snowe, members of the Committee. I'm pleased to appear before you today to discuss the United States Coast Guard's use of environmental products, satellite distress information provided by the National Oceanic and Atmospheric Administration in support of Coast Guard operations.

The Coast Guard has enjoyed a partnership with NOAA for more than 100 years. This partnership includes providing situational awareness to both professional mariners and recreational boaters on impending weather and dangerous conditions, as well as

NOAA's active participation on the National Search and Rescue Committee, of which I had the honor to chair.

In more than 27 years of conducting Coast Guard operations, I have used any number of NOAA products to help make critical operational decisions. Water temperature, wind and current data, and distress alerting information all assist both the art and the science of saving lives at sea.

Specifically, I'd like to share with you today two situations that demonstrate the critical role that NOAA plays in supporting Coast Guard daily operations.

In the Gulf of Alaska, five people were forced to abandon their fishing vessel into 38-degree water. Tied together and adrift in some of the most dangerous waters in the world, it was only the SARSAT distress beacon, activated by the crew and received by NOAA's weather satellite, that alerted the Coast Guard that they were in distress. That distress notification was transmitted via the NOAA Mission Control Center in Suitland, Maryland, directly to the Coast Guard Rescue Coordination Center in Juneau, Alaska.

In addition, the NOAA weather satellite provided on-scene weather information that crews from three helicopters and one C130 rescue aircraft used to prepare for the rescue mission. At the Juneau Rescue Coordination Center, search and rescue specialists helped develop the comprehensive search plans to locate the source of the distress alert. Our search planning tool uses critical weather, tide, and ocean current information provided by NOAA.

In seconds, this program analyzed the weather and environmental data, along with other critical information, to develop the most effective search plan, allowing for the quickest rescue possible and ultimately minimized risk to our search crews and the mariners in distress. Though only three of the five crew members were saved that day, the three survivors owe their lives in part to NOAA's operation and management of the U.S. SARSAT program and environmental information that weather and climate services provide to the Coast Guard and other partners.

As dramatic as it sounds, it is this type of case that the men and women of the Coast Guard face daily. Last August, and right here along the East Coast, NOAA's environmental data was used in our own mission planning, port readiness, citizen preparedness and infrastructure protection in response to Hurricane Irene. NOAA's forecasting assisted the Coast Guard's advance planning and enabled commercial and recreational vessels alike to seek safety, whether by making preparations to prepare ships in port or get their ships under way to evade the storm at sea.

Coast Guard captains in the port were able to make sound decisions to limit the amount of time that ports were closed during and after the storm. Minimizing the time a U.S. port is closed is critical, especially when taking into account the economic and security impacts of port closures. These critical decisions on port closures during Hurricane Irene by the Coast Guard were based in part on the information received by NOAA's environmental data.

Our own rescue assets, Coast Guard cutters, small boats, aircraft, and most importantly our members and families, all use NOAA's environmental information to determine the safest locations to avoid the storm, and also minimize the time for Coast

Guard units to respond to any distress caused by the storm. The fact that so little damage was sustained in these port areas is a reflection on the amount of preparation performed by the Coast Guard, FEMA, and our other port partners, all leveraging NOAA's environmental data.

These are but two examples of the many situations in which NOAA's environmental data provides invaluable support to the Coast Guard. The Coast Guard capital fleet uses these products to make decisions at sea, but our ships are old and we appreciate Congress' support for its recapitalization. NOAA relies heavily on the weather observations of our ships at sea. It only makes sense that the technology that supports weather prediction and distress beacon transmissions also require updates, and we thank Congress for their support for the JPSS for NOAA.

As I mentioned before, every day the Coast Guard relies on NOAA's environmental products and distress alerting information to ensure the safety of our people, the security of our nation, and the protection of our environment. Thank you, and I look forward to answering any questions you may have.

Senator BEGICH. Thank you again. Thanks to all of you for your testimony. I will start with 5 minutes with some questions here to Secretary Glackin.

Let me ask you, in your testimony you talked about, and you've already heard from the others, too, that the potential gap, especially in 2016–2017, the 100 percent likelihood that there will be some gap of some sort at some level. You've also talked about how NOAA has significant innovation and ideas around advancing technology to improve weather forecasting and predictions.

What are we doing to prepare for the potential gap that we have when we know it's coming? What is NOAA doing to prepare for that, and what innovative steps are you taking to kind of be ready for this potential?

Ms. GLACKIN. Thank you, Senator. As Senator Snowe highlighted in her introductory remark, the projected gap that we're talking about is billed around how long we expect the NPP spacecraft, which we just launched, to be able to last, and when we're able to launch the JPSS–1 spacecraft and have that checked out so it's providing useful data, which is obviously not the day it's launched but some number of months after that.

In regard to addressing what steps to take during that period of expected gap, there are two primary approaches that we've been taking. One is strengthening and trying to look at expanded international partnerships. So, for example, we rely today on the Europeans for a mid-morning orbit, and we need to ensure that that partnership stays strong in this period of time so that we'll have that data available to us so we won't be without any data. And for the Committee's background, that spacecraft does fly instruments that are used currently today in our models and are also what I would say are modern instruments, not ones that were developed 25 years ago.

Senator BEGICH. Could I pause you there for 1 second? The economic troubles that Europe is going through, is there indication of problems with their funding of their continued programs that may affect us that you're partnering with?

Ms. GLACKIN. Well, we can't say that it won't ultimately, but their next spacecraft that's due to be launched is fully funded and ready to go, and they have commitments, or subscriptions they call them, for follow-on efforts in that regard.

Senator BEGICH. OK.

Ms. GLACKIN. So they're well—I think they're well poised, and that's been an excellent partnership for us.

Beyond that partnership, other countries that we look at when we look at who is flying instruments that would be comparable to this, unfortunately there's not a lot there, and one of the prime ones is China in that regard. So we do have a dialogue with China, but we have no plans in place in that regard. We do use some of their data today, is used in opportunistic ways. So that's one——

Senator BEGICH. Do they use—if I can interrupt again. I apologize. Do they use any of our data going the other way?

Ms. GLACKIN. Yes, yes.

Senator BEGICH. OK.

Ms. GLACKIN. Our data is freely available.

Senator BEGICH. OK. So there is—I mean, for our satellite system to continue to operate efficiently and effectively, they have an interest in making sure that occurs, because their system is robust but not like ours.

Ms. GLACKIN. That's right.

Senator BEGICH. Is that fair to say?

Ms. GLACKIN. It's fair to say, and it's also—I could further say that our instruments are of superior quality. They are, of course, putting a lot of money into their program in this regard, and they have a big pipeline coming. So I think that they will get better in capability.

Senator BEGICH. Right. OK.

Ms. GLACKIN. So that's what we're doing on the international front, which is probably the most ready thing to do.

The other is to make sure that we're using all of the available data that we currently have, and this is in-situ data, observations that come from on-ground, as well as other satellite systems that are in this regard. We've really been in the position of doing this because we do this anyway. So there has not been a lot there that we can do in this regard, but we have been looking at that.

And I want to stress to the Committee that using, assimilating satellite data into numerical weather prediction models is a non-trivial process. It takes months and years to get this done, and if you don't do it well, you can actually degrade the model forecast. So that's not a trivial process.

But the staff is looking at that and trying to see, but there's really no substitute for a satellite system, obviously, because it's the way to get the ocean data over the ocean and things like that. So they're the two primary things we've been doing.

Senator BEGICH. Very good. I'm going to ask one quick question to Mr. Zinser here, and then we'll continue to go with 5 minutes for each remaining senator. Then we may do a second quick round depending on how people go and keep to the 5 minutes.

But, Mr. Zinser, let me ask you, do you think NOAA—I mean, I've read your recommendations, and do you think NOAA is pre-

pared, if funding is flat or lack of funding occurs from Congress, to fill that gap?

Mr. ZINSER. Thank you, Senator. I think any kind of flat-lining of resources or a reduction of resources is going to make it more difficult, and what we're recommending is that the satellite data be made part of a larger formula. NOAA plugs the satellite data into a larger model to come up with their observations and predictions, and it needs to make sure that all parts of the agency are contributing to fixing the data gap.

Senator BEGICH. Do you think they are doing that now?

Mr. ZINSER. NOAA is not doing everything that we're recommending. We think NOAA should have a coordinated effort across the lines of business with the studies necessary to determine how the lack of satellite data will degrade the forecast.

Senator BEGICH. Very good. I'll follow up on this on my next round.

Senator Snowe?

Senator SNOWE. Thank you. Just to clarify the issue of the short-term and the long-term data gap, does it depend, Mr. Zinser, on the question of funding only? I understand that's obviously one of the major issues, but is it the only issue with respect to the possibility of having this coverage gap?

Mr. ZINSER. For the potential near-term gap between NOAA–19 and NPP, it's not so much a funding issue as an issue of calibration and validation work that needs to be done with respect to NPP data collecting. Funding is more of an issue for JPSS–1, and if there is a reduction in any kind of funding, that will result in some extension of the gap.

Senator SNOWE. How long would that short-term gap be?

Mr. ZINSER. Potentially it may not exist at all. The issue is how well NOAA can get the ground system and the science behind the data validated and calibrated in order to produce the necessary weather forecast data.

Senator SNOWE. Ms. Glackin, you mentioned the fact, when you were referring to NOAA's response to the report that was issued by the Inspector General, that the Inspector General's report should clarify the budgetary assumptions, and that specifically they should say what request is going to be essential to avoiding or averting this coverage gap. Is that correct?

Ms. GLACKIN. Senator, I believe that you're referring to a comment that we had on the draft report, was the Inspector General was projecting a particular gap.

Senator SNOWE. Right.

Ms. GLACKIN. And we've been trying to be careful in this long period of time, which is going about 18 months now, where we've had various numbers on the table at various times to be consistent about what assumptions go into a gap. So that was the only point that we were making in the Inspector General's report, is that it would be helpful to have the underlying assumptions documented.

Senator SNOWE. What should be the underlying assumption for the budget, then? I guess I'm trying to understand that, because the conference report has it 13 percent less than the administration's request.

Ms. GLACKIN. So let me talk to that directly. First of all, thank you again. It's been fabulous support from this committee for JPSS, and we are extremely pleased at the conference report that came out and look forward to that being signed into law.

Based on that, my expectation is that when the President delivers, my expectation is when the 2013 budget comes out, we'll reflect into that the JPSS program, including the projected launch dates that will also take into account the best we're able to deliver in the time-frame. We have to respond to the Senate language about out-year costs, which was also, at least in part, picked up in the conference report.

So I think that given what looks like some certainty in the funding for 2012 at a level that's not perfect but certainly very good for this program, we'll be in a much better position to inform the Committee about what we expect that to be.

Senator SNOWE. Mr. Zinser, what would be your response? Do you think the administration's request is the minimum that is required in order to keep it on track?

Mr. ZINSER. Thank you, Senator. One issue that NOAA needs to finalize right away is its requirements document. This lays out cost, schedule, and other requirements; it also provides a baseline. They need a baseline. And the current timeline for the launch that NOAA has provided for November 2016 is, as far as I know, based on the President's Fiscal Year 2012 request.

Our assumptions going in were that funding was going to be somewhat lower than the President's request; and, in fact, it will be. As a result, we've added some time in the timeline and are projecting a launch more in the first quarter of the calendar year (as opposed to the Fiscal Year) in 2017.

Senator SNOWE. I think you make an excellent suggestion about a baseline, for NOAA to draft a baseline with all the specific requirements. I think that's very essential for costs and other requirements to stay on track.

Ms. GLACKIN. If I could just add, that's what I was referring to that would be part of the 2013 budget.

What we're saying is consistent.

Senator SNOWE. That's great.

At a recent hearing, Ms. Glackin, before the House Subcommittee on Investigations and Oversight, Kathryn Sullivan of NOAA, testified that NOAA in collaboration with NASA has fully staffed the JPSS program, that the office was staffed by NOAA and NASA and the Air Force and contract officers. And I gather that is at a staffing level of 819, although that's far short of what NOAA had projected or estimated originally, that it would require 1,600 contract employees.

So what accounts for the discrepancy, and how is that going to affect the program?

Ms. GLACKIN. OK. With the reduced funding that we've had in 2011, we had to limit our priorities and work to getting NPP launched and fully operational, getting an operational data stream, and then maintaining work on some critical satellite instruments that would fly on JPSS–1. We have staff to be able to support those activities.

However, there is more that we need to do and would be, again, why we're so excited about the conference report. We'll now begin to add staff to bring it up to levels that we had projected because we're going to be able to expand efforts into areas that we need to work on; for example, the spacecraft bus for JPSS–1.

Senator SNOWE. So will you be going up to the 1,600?

Ms. GLACKIN. I can't give you an exact number today, but I'd be happy to take that for the record.

Senator SNOWE. I appreciate that. Thank you.

Thank you, Mr. Chairman.

Senator BEGICH. Thank you very much.

Senator Boozman?

STATEMENT OF HON. JOHN BOOZMAN,
U.S. SENATOR FROM ARKANSAS

Senator BOOZMAN. Thank you. Thank you, Mr. Chairman.

Secretary Glackin, in your testimony you talked about the importance of high-performance computing, and you also mentioned earlier that you are working with the Europeans in this area. Are we working with the other departmental agencies to see if they can be of value in utilizing their computing resources? And along these lines, can you comment on the technical developments that they've developed with our other agencies?

Ms. GLACKIN. So the short answer is yes, that we are doing that. We work across the Federal agencies, and in particular with the Department of Defense, the Navy, and the Air Force there, NOAA, and we also work with NASA and DOE on climate issues and things like that. So we work in terms of the numerical weather prediction models that we use. Currently, NOAA is using all of its own high-performance resources to do this. We have back-up, fail-back capabilities there, but we don't actually use them operationally.

Senator BOOZMAN. Mr. Zinser, in your written testimony, could you please clear up something for me? I'm a bit confused. You talk about the NPP satellite and that it's good for 5 years, but the instruments are only good for 3 years in some specific or certain cases. Could you please elaborate on that and tell me a little bit about the problem?

Mr. ZINSER. Yes. The issue is that the instruments being used on NPP have been transferred from the NPOESS program, but because the NPP was originally designed as a test satellite, these instruments were not constructed according to NASA standards. They were constructed according to standards set by the contractor, and there is some concern that since they didn't get much government oversight while they were being developed, they may not last as long as they should. Therefore our conservative estimate is 3 years for the instruments. The 5 years is for the end-of-life design of the satellite itself, but there's enough fuel on the satellite to go for 7 years.

Senator BOOZMAN. And how confident are you with regards to the 3 year versus the 5 year time frame guarantee?

Mr. ZINSER. It's very hard to say based on the limitations that we've identified, but I think 3 years is a conservative estimate.

Senator BOOZMAN. Very good. Thank you, Mr. Chairman.

Senator BEGICH. Thank you very much. We'll do one quick, final round here before we dismiss the panel. We thank you very much.

I just want to follow up if I can on the question I had earlier, Mr. Zinser, in regards to the recommendations and is NOAA prepared, are they doing it, are they coordinating.

Are there things that indicate to you that they are ready and willing to do that, or is it just a process that they're just not geared up yet to have that cross-coordination of all the different agencies to prepare a—I call it kind of a Plan B, but also the baseline. Can you respond to that?

Mr. ZINSER. Yes. I think that NOAA and NASA are working diligently, as I mentioned. They have to overcome many years of setbacks under the NPOESS program. NPP itself is a contingency operation, and they have had to make decisions in that program that haven't eliminated all the risks. For example, we incidated in our report, certain aspects of the ground system had to be deferred until after launch, because their efforts were focused on getting the NPP satellite launched. A lot of the prelaunch work that may have gone on under a normal program ahead of the launch with respect to the ground system has been deferred until now, after the satellite has been launched.

Thus they have had competing demands on their resources and time, but I think that they are looking at different ways to mitigate the gap, and we're going to continue our oversight there.

Senator BEGICH. And from your end of it on the oversight, can I assume that is also probably a role and responsibility we should have to make sure that we're checking in with you on a regular basis to make sure it is happening?

Mr. ZINSER. Yes, sir. We'd be happy to keep your staff informed, and we have a number of audits that we've planned to carry out this year on both the JPSS, and GOES program.

Senator BEGICH. Excellent. And then I thought I heard you say that your analysis of the gap was based on funding but at a little lower amount than what was proposed by the President's budget. Did I hear that right?

Mr. ZINSER. Yes, sir.

Senator BEGICH. OK. And a likelihood I think in your report—and if I'm wrong on this percentage, correct me—was upwards of 80 percent likelihood there will be a gap, even with that funding with a reduced amount, which probably reflects what the conference committee report is now about to produce.

Mr. ZINSER. Yes, sir. One of the difficulties in estimating the JPSS–1 gap is the period of time needed to check out the instruments. Right now, for example, the checkout could be as long as 18 months. As a result, when NOAA comes up with its baseline, the estimate for JPSS–1 instrument checkout will be critical. It could be 6 months, it could be 18 months.

Senator BEGICH. Eighteen months. Got you. Thank you very much.

Let me ask two quick questions to the other two that are here that probably thought you were going to be off the hook with no questions. I know what the feeling is sitting there. You're going, "Please, no questions. I've done my testimony. Let me go sit back in the chair." Not possible here.

[Laughter.]

Senator BEGICH. Let me, Mr. Trimble, let me ask you, and I know GAO did a web-based kind of questionnaire in asking agencies and others should there be a Federal service to consolidate and deliver climate information to decisionmakers, and I think it was 60 percent or somewhere in that area if I remember right, a pretty high percentage said yes.

Can you just elaborate a little more on that, and do you think having a centralized system like that, or a central place for information, will create some restrictive ability for it to be flexible and nimble in this ever-changing information that's flowing? Does that question make sense to you?

Mr. TRIMBLE. Absolutely.

Senator BEGICH. OK.

Mr. TRIMBLE. In our 2009 report, we surveyed knowledgeable climate information users in various branches of government, and you're right, about 61 percent thought that having a single source for climate data would be useful.

There are advantages to that approach, Information users would have a single source, a common methodology, and there is potential to save money. A small minority, it was about 6 percent, didn't think it would be useful. So it's pretty——

Senator BEGICH. Pretty overwhelming.

Mr. TRIMBLE. Pretty overwhelming. The downsides, as you point out, come from comments in an NRC paper from 2009. The National Research Council raised those concerns about being detached from the users who need the information. So I think there's always tension about how much centralization. If you get too centralized, you get away from the people who need the data. So I think what they were pointing out was concerns that if you get too centralized, you are getting away from the people who need climate information it is difficult to be responsive.

In this area in particular, the users of climate-related data are not necessarily traditional NOAA customers, so you don't necessarily have the same longstanding relationship. So I think that was the gist of it.

Senator BEGICH. Is that something that could be mitigated you feel?

Mr. TRIMBLE. You know, we've not done work on that question. I expect it could be. We've not reviewed the details of any plan for this, but I assume that could be tackled.

Senator BEGICH. Very good. Thank you very much.

Admiral Thomas, let me ask you just a quick question. First off, thank you for those couple of examples of how weather information is vital.

In your work that's occurring and continuing to increase really as you look at the Arctic and Alaska and the issues of oil and gas and transportation, all the things that are happening now in the Arctic, when I look at the dates of 2016, 2017, through 2017, beginning of 2018, there's going to be a lot of activity up there, with or without us promoting it, I mean the U.S. I mean, there's shipping already going, there are visitors, what's going on in Russia, all kinds of activity.

Give me your thoughts or maybe just quickly. Do you think that the Coast Guard is fully engaged enough to make sure that NOAA has the necessary information? Because without that weather information, you're going to be at a disadvantage. Is that a fair statement?

Admiral THOMAS. Thank you, Senator. What I'd like to do is just describe a little bit about how we prosecute search and rescue, and how we then apply weather data in order to help provide the very best operational decisions to be able to minimize risk and increase response time.

So search and rescue is a system. And so for us, it requires us to use airplanes, to use ships, to use boats, to use commercial mariners, to use other commercial salvage people in order to prosecute a search and rescue case. Well, it's the same thing as a consumer of weather. So we use NOAA data, we use DOD data, we use NGA data, we use international partner data, observers in airplanes, observers on the sea, NASA, international partners. All help provide data that goes into our search and rescue system.

So then we'll get data on-scene, and then we send out the right asset. We make search planning decisions based on all that information.

Two roles that I play. I sit on FEMA's Emergency Support Functions Leadership Group, and in that capacity is we're preparing for all disasters. We're responding to them. Weather is a critical part of that. Secondarily, I am also the chair of the National Search and Rescue Committee, and NOAA is an important player on that as well, both from the weather perspective as well as the distress beacon perspective.

So minimizing the gap in-between the NPP and the JPSS system will allow us to improve response time, will allow us to minimize the risk to our crews, will allow us to increase our effectiveness on-scene.

Senator BEGICH. Very good. Thank you very much, Admiral.

Senator Snowe?

Senator SNOWE. Thank you, Mr. Chairman.

Admiral Thomas, one of the key components of the JPSS is the Search and Rescue Satellite-Aided Tracking sensor, SARSAT. During his testimony before the Subcommittee on Investigations and Oversight and Environment in the House of Representatives back in September, David Powner of the GAO testified that NOAA had not yet determined how it would accommodate the sensor on the JPSS–1 satellite.

Given the importance of this sensor for search and rescue missions, can you tell the Committee exactly what action the Coast Guard is taking to coordinate with NOAA on this sensor?

Admiral THOMAS. Thank you, Senator. As I understand, the first launch of the first JPSS will not hold a SARSAT system on it, but that said, there are other satellite providers that will allow us to get rescue data, beacon data. One is a geostationary satellite that will continue to be flying. Second, the Coast Guard is partnering with the Air Force to provide a medium Earth orbit satellite that will allow us to get additional information as well.

And so weather prediction and distress beacon is sort of like intelligence, and you wish it to be perfect; it's never perfect. So

through a combination of those technologies, I believe that the Coast Guard will have sufficient capabilities, but minimizing the gap will be important for us.

Senator SNOWE. So, it is yet to be established; is that correct?

Admiral THOMAS. That's correct. I understand the second, the next version of JPSS will then go into SARSAT after that. Yes, ma'am.

Senator SNOWE. Ms. Glackin, do you have any comments on that?

Ms. GLACKIN. Yes, I would like to comment on that. The Admiral is quite correct that it's not going to be on the JPSS–1 satellite. However, it still is included in that timeframe, and NOAA is currently assessing opportunities to launch this, whether it would be in a free-fly or another mission of opportunity. So that's something that we're working through in the coming months.

Senator SNOWE. Admiral Thomas, I noted that there was a strong partnership between NOAA and the Coast Guard during the Deep Water Horizon oil spill, and there was very close cooperation and coordination. Can you tell the Subcommittee how well that worked in terms of determining the currents, the tides, and winds with regard to the movement of the oil?

Admiral THOMAS. Yes, Senator. Thank you. One of the important partnerships that NOAA brought to the table is this program called the Scientific Support Coordinator. So NOAA is a partner of a national response team, of which the Coast Guard and EPA are the co-chairs of that team. And then at the regional level there are regional response teams that also help provide technical information and strategic priorities for regional responses.

So then when it gets down to the local level, the Federal on-scene coordinator needs a suite of folks to help them make the very best operational decisions that they can make, and NOAA's Scientific Support Coordinator, very important partner in that effort, provides principal science advice to the Federal on-scene coordinator, provides trajectory forecasts, provides GIS information, information management. They brought a system called ERMA, which was really crucial to us in making good decisions.

Shoreline clean-up assessments, all part of the Scientific Coordinator's support and really an important part of our response efforts in Deep Water Horizon.

Senator SNOWE. I appreciate that.

Mr. Trimble, you mentioned in a report that was published in May that there needs to be greater coordination between appropriations and our priorities with respect to climate research. Given there hasn't been a clear interagency strategy and coordination when it comes to Earth Observation issues if a climate service was created, how would that help or how would that hurt? Are there risks or benefits involved?

Mr. TRIMBLE. From our most recent report there's a broader need across the Federal Government on the issue of climate change for a more coherent, articulated national strategy. Right now, from our survey of users, there's a different sense of what the priorities are. There's no clear articulation of that. I think a climate service could help focus some of these issues.

But as I alluded to earlier, there are pros and cons when you centralize. You risk over-centralizing. We've not taken a position on the creation of a climate service. Our reports have really just talked about the pros and cons at this point.

Senator SNOWE. Thank you. Can I just make one point? Mr. Zinser, I think you've made an excellent recommendation in your report, suggesting that NOAA should develop a plan or strategy to report to Congress with understandable data, the impact of losing the satellite capacity and what the satellite capacity means for the future, with respect to identifying and anticipating events much sooner. As we know, the JPSS program, is expected to reduce the cone of uncertainty for the landfall of the eye of the storm by estimated 875 miles which is a big difference in allowing communities to be able to evacuate sooner and so on. So it saves lives, and it saves money.

I think that that would be a very useful report for Congress to understand the connection between all of this and the material effect, both in terms of life and property and what it means to this country. That would be very helpful.

I gather, Ms. Glackin, that NOAA is in the process of doing that?

Ms. GLACKIN. Yes. We accepted the Inspector General's recommendations and we'll be moving forward on them.

Senator SNOWE. Thank you. Ms. Glackin, I wish you well. On your three decades of service to this country, thank you.

Senator BEGICH. Can I ask you a quick one on that? When do you think you'll have a report that will be ready to present? If you can't answer that right now, can you get that for the record?

Ms. GLACKIN. Yes, let me come back, because I guess what I'm thinking about is that we need to work through, given the resources we have now, what's the timeframe. I think you would like not only all of the impacts but you'd like to know what's that expected gap and when are we expected to see it.

Senator BEGICH. Yes.

Ms. GLACKIN. So I think we're going to be, again, pretty much consistent with the President's budget coming out, that information.

Senator BEGICH. OK. Well, we look forward to that, if you can get that data, so we can do some additional follow-through on this part of the Committee.

Senator Boozman, do you have some additional?

Senator BOOZMAN. Just a quick question, Mr. Chairman.

Admiral Thomas, you mentioned a number of different tools that you use in weather predicting and forecasting. I guess the only thing I would ask of you, while we've got you here, is how can we make things easier? Are there some specific technical things that you lack that might be helpful, some gaps that you have that you'd like to see done to make your life a little bit easier in being able to carry out your mission?

Admiral THOMAS. Thank you, Senator. As a consumer of weather, we are always looking with our various partners to help improve the quality of the data. Having done many, many assignments around the Coast Guard and watching the weather and making decisions about are we going to go to sea or are we going to have to close a port, all very difficult challenges for us. And as

I mentioned, we use all of our different partners because truly making these kinds of decisions is an art, and there's nothing perfect about it.

And so you take the very, very best information that you have when you're trying to sort out where you're going to search for someone who is lost, how long you're going to search for them, and between things like in the Gulf of Maine has an oceanographic observatory system that provides information to our computer systems. We take information from DOD. We take information from NOAA. We take information—our weather guys are looking at commercial providers as well to be able to provide the best things that we can. So we're consumers.

Senator BOOZMAN. Is there some information out there somewhere that you'd like to collect that's not there but nevertheless would be helpful in your job?

Admiral THOMAS. Right now we've got everything that we need. But, of course, I'd probably defer to NOAA to continue to support continued improvements in that.

Senator BOOZMAN. OK. Thank you very much, Mr. Chairman.

Senator BEGICH. Thank you very much, and I want to thank this panel. I appreciate your time here, again being patient while we asked our second round of questions. Thank you.

We'll now have the next panel come up. And as they get situated, we have three individuals that will present on the next panel. Again, we want to thank everyone for taking the time out of their busy schedules to attend and help give us information to do a better job in forecasting and predicting weather and what we need to do to continue to be innovative in this arena.

The next panel, feel free to go ahead and grab your seats. Thank you again very much for being here, and we'll go from my left to right in the sense of presentation. So again, we thank you.

The first person we have is Mr. Tom Iseman, Program Director, Water Policy and Implementation, Climate Adaptation, Western Governors' Association.

Again, we thank you, and we thank you for kind of the unique partnership that's being developed. So, please.

STATEMENT OF TOM ISEMAN, PROGRAM DIRECTOR, WATER POLICY AND IMPLEMENTATION, CLIMATE ADAPTATION, WESTERN GOVERNORS' ASSOCIATION

Mr. ISEMAN. Thank you, Chairman Begich, Ranking Member Snowe, and members of the Committee. Good morning. I'm Tom Iseman. I'm the Program Director for Water and Climate Adaptation at the Western Governors' Association. WGA is a bipartisan, consensus-based organization that represents the Governors of 19 Western states and three U.S. Flag Pacific Islands.

Western Governors have long recognized the significant impacts that severe weather events, climate extremes, and long-term climate trends can have on life in the West. Whether it is drought, heat waves, severe storms, too little snowpack, or too much river runoff, they affect natural resources, infrastructure, economies, and communities throughout the Western states. That is why WGA has such a strong interest in the weather and climate data and forecasting services of the National Oceanic and Atmospheric Adminis-

tration, and why we appreciate the opportunity to testify here today.

Drought in particular has been a high priority for the Western Governors, and it has been a catalyst for WGA's work with NOAA. We have worked on drought issues for several decades, with many administrations and across party lines.

The National Integrated Drought Information System, or NIDIS, is one of the success stories of our work on drought. The NIDIS Act was passed by Congress in 2006. NIDIS is building an emerging network of regional drought early warning systems. It established a drought portal where information is integrated across agencies, and it's available at one place online, at *drought.gov*.

And most importantly, WGA and the Western states have worked directly with NOAA and the Federal agencies to co-develop this system, making NIDIS a model for the development and delivery of integrated drought and climate information.

While drought can be a widespread and severe phenomenon, the Governors recognize that a variety of climate and weather events affect the West. Building on our work on drought, the Governors adopted a policy resolution in 2009 addressing climate adaptation science in the West. The policy calls for improved predictive capabilities at a regional scale; increased coordination among Federal agencies and with state agencies; and the establishment of a National Climate Service to undertake and communicate research and modeling of climate and its impacts.

Recent events in the West have only underscored the need for enhanced coordination, improved data networks, and advanced predictive models on climate and weather events. For example, the states of the Upper Missouri River Basin have just endured prolonged and widespread flooding, affecting hundreds of homes and communities throughout the basin. Governors from the Upper Missouri states agree on the need for improved forecasting to reduce flood risk.

In recent testimony on the Missouri River Annual Operating Plan, Governor Jack Dalrymple of North Dakota called for significant improvements in predicting snowpack accumulation and annual runoff, and he urged consideration of NOAA's forecast for a recurrence of the La Nina climate pattern in planning reservoir management for 2012.

The same is true of other recent or current events. The American Southwest is in the midst of severe drought. Guam and other islands in the West Pacific are located in Typhoon Alley and experience an array of extreme weather events, or Alaska, which just last week saw its coast buffeted by a severe storm that Chairman Begich described.

These and other weather and climate events are confronting states and local communities every day, and NOAA provides essential information for states to prepare and respond. This is why the Governors and NOAA entered into a Memorandum of Understanding this summer at the Annual Meeting of WGA. The MOU focuses on sharing weather and climate information, with a particular emphasis on disaster risk reduction.

Under the MOU, WGA and NOAA intend to target the most pressing weather and climate issues in specific sub-regions of the

Western states; for example, water resources in the Pacific Northwest, snowpack and river runoff in the Upper Missouri, drought in the Southwest, and coastal management on the West Coast and Pacific Islands.

Over the course of our work with NOAA, several key and consistent themes have emerged. These are not technological innovations but rather innovation in how we develop and apply forecasts to reduce the impact of weather and climate events.

We encourage building state partnerships or partnerships directly between NOAA and the states. We recognize the importance of engaging the private sector in this effort. We urge the design of regionally focused programs. National information is useful, but we really need to get down to the local level to understand impacts and take action. We recognize the need for improving predictive capabilities and models, and also recognizing the uncertainty associated with forecasts. And we want to emphasize the importance of providing basic data, like temperature, precipitation, snowpack, and stream gauging.

And finally, we do agree with the points about the need to coordinate the Federal climate enterprise.

In conclusion, Western Governors are taking a pragmatic approach to weather and climate issues. They recognize the impacts of weather and climate trends, climate extremes and long-term trends, and they seek information to make sound management decisions. NOAA plays an essential role in this effort, and we are pleased to work to strengthen the development and delivery of this critical information.

Thank you.

[The prepared statement of Mr. Iseman follows:]

PREPARED STATEMENT OF TOM ISEMAN, PROGRAM DIRECTOR, WATER AND CLIMATE ADAPTATION, WESTERN GOVERNORS' ASSOCIATION

Thank you, Mr. Chairman, Senators, Ladies and Gentlemen.

Good Morning. I am Tom Iseman, Program Director for Water and Climate Adaptation issues at the Western Governors' Association. I am pleased to participate this morning on behalf of the Western Governors' Association. WGA is a bipartisan, consensus-based organization that represents the Governors of 19 Western states and 3 U.S. Flag Pacific Islands. The Governors work through the WGA to identify and address key policy and governance issues, which include natural resources, the environment, human services, and economic development.

Western Governors have long recognized the significant impacts that severe weather events and long-term climate trends can have on life in the West. Whether it is drought, heat waves, severe storms, too little snowpack or too much river runoff—they all affect the environment, infrastructure, economies and communities throughout the Western states. That is why WGA has such a strong interest in the weather and climate forecasting services of the National Oceanic and Atmospheric Administration, and we appreciate the opportunity to testify here today.

Drought, in particular, has been a high priority for the Western Governors, and it has been a catalyst for WGA's working relationship with NOAA. We have worked on drought issues for several decades, with many administrations and across party lines. You can find many of WGA's reports and resolutions on this topic on our website, and we have provided a brief bibliography in our formal submission.

When the National Drought Policy Commission was convened in 1998, no sitting Western Governors were included. Gov. Brian Schweitzer, prior to being elected Governor of Montana, was one of 15 members of the commission, listed simply as "Montana farmer, rancher and soil scientist." Of course, he later became the Governor of Montana and Chair of the WGA, during which he carried with him a strong commitment to address drought issues.

The National Integrated Drought Information System, or NIDIS, is one of the success stories of our work on drought. The NIDIS Act was passed by Congress in 2006. It established a 'drought portal' where information is integrated across agencies, providing a single entry point for users of drought information online at *www.drought.gov*. NIDIS is also building an emerging network of drought early warning systems, working with local managers to address key regional drought planning needs. Importantly, NIDIS demonstrates a partnership among the Federal agencies and between the Federal agencies and states and other stakeholders. WGA has worked directly with NOAA and the Federal agencies to 'co-develop' this system, making NIDIS a model for the delivery of integrated drought and climate information in partnership between Federal agencies and states.

While drought has been a focal interest, the Governors recognize that a variety of climate and weather events affect the Western economy, public health, and the environment. Building on our work on drought, the Governors adopted a policy resolution (09–2) in 2009 addressing climate adaptation science in the West. This policy calls for improved predictive capabilities at a regional scale; increased coordination among Federal agencies and with state agencies; and the establishment of a "National Climate Service" to undertake and communicate research and modeling of climate and its impacts.

The resolution also established a Climate Adaptation Work Group comprising Western state resource managers across a range of sectors that includes water, wildlife, air quality, and forests. The Work Group partnered with a number of entities, including NOAA and other Federal agencies, to prepare a Scoping Report on climate adaptation priorities for the Western States. This report elaborates on the Western States' priorities for climate science, including both observational data and predictive models, as well as enhanced communication between scientists and decisionmakers.

Recent events in the West have only underscored the importance of coordination, data, and predictive models on climate and weather events. For example, the states of the Upper Missouri River Basin have just endured prolonged and widespread flooding, affecting hundreds of homes and communities throughout the basin. A group of Governors from Nebraska, South Dakota, North Dakota, and Montana has called for improved forecasting of snowpack and runoff in order to reduce flood risk. In recent testimony on the Missouri River Annual Operating Plan, Governor Jack Dalrymple of North Dakota called for "significant improvements in predicting snowpack accumulation and annual runoff,"[1] and he urged consideration of NOAA's forecast for another La Nina climate pattern in planning reservoir management for 2012. As North Dakota's State Water Engineer put it: "this (2011) was an unprecedented year; we need to know if we're likely to see these kinds of events again—and potentially more often—in the future."

Similarly, the American Southwest is in the midst of a severe drought; agricultural losses alone in Texas have been estimated to exceed $5 billion.[2] Information on current and projected conditions, as is being provided by NIDIS, is essential to states and local communities that are affected by drought events. The same is true of fire management and response, species conservation, coastal protection, infrastructure investment, and a variety of other decisions that states and local communities are making every day: they are affected by short-term weather events and long-term climate trends, and NOAA provides essential information for states to prepare and respond.

This is why the Governors and NOAA entered into a Memorandum of Understanding this summer at the Annual Meeting of WGA. The MOU focuses on sharing weather and climate information,[3] with a particular focus on disaster risk reduction in the Western states. As Governor Gregoire, WGA's Chair, said on signing the agreement, "a good working relationship with NOAA in providing science and information services states need will help us all build healthy and resilient communities and economies." Under the MOU, WGA and NOAA intend to target the most pressing weather and climate issues in specific sub-regions of the Western states, for example water management in the Pacific Northwest, snowpack and river runoff in the Upper Missouri, coastal erosion on the West Coast and Pacific Islands and drought in the Southwest.

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[1] Governor Jack Dalrymple, North Dakota, Testimony for the U.S. Army Corps of Engineers Public Scoping Meeting on the Missourit River Annual Operating Plan, Bismark, ND, November 1, 2011.

[2] Travis Miller, et al, Texas A&M AgriLife Extension Service, August 2011.

[3] See WGA *Inventory of Existing NOAA Climate Services and how they are Currently Used,* prepared by WGA for Governor Otter, March 2011.

Over the course of our work with NOAA, several key and consistent themes have emerged:

- *State Partnerships:* NOAA must work directly with states. It is not enough to post forecasts. By working directly with states (and other partners), NOAA can ensure that its climate and weather services are available to decisionmakers and resource managers, and they can tailor future products to respond to user needs
- *Private Sector Engagement:* Governors recognize the important role of the private sector, both as providers and users of climate information. When the MOU was signed, Governor Gregoire and Administrator Lubchenco co-hosted a 'business roundtable' with select industries with a clear nexus to climate and weather. We are pleased to see a private sector panelist today and look forward to continued work with the private sector in this effort.
- *Regional Programs:* Weather and climate events, and our vulnerabilities to them, vary by region. NOAA must respond to regional variability and priorities by tailoring information services to the appropriate climatic and management scale. In NIDIS, we have called these 'Regional Early Warning Systems.' A national map may tell a good story, but users need more tailored information in order to make investment and management decisions.
- *Predictive Capability:* WGA (and an array of other resource managers) consistently call for better forecasts, from seasonal to multi-decadal time scales. That said, we recognize the challenges and inherent uncertainties regarding projections of future climate. Resource managers can make decisions under climate uncertainty, and have done so for decades in the American West; but they need clear acknowledgment and quantification of uncertainty associated with weather and climate forecasts.
- *Basic Data:* Western States continually emphasize the importance of basic data to sound resource management. In addition to temperature and precipitation and other data provided by NOAA, this includes USGS streamgaging and NRCS snowpack monitoring. These basic data may be overlooked in the discussion of global climate models and orbiting satellites, but they are a fundamental tool of day-to-day resource management in the West.
- *Coordination of Federal Agencies:* While NOAA is the undisputed expert in atmospheric sciences, many Federal agencies contribute weather and climate information or, like the states, have management responsibilities that are affected by weather and climate. We urge greater coordination across the Federal enterprise and clearer points of contact for the states, which are often confused and overburdened by the array of Federal initiatives around climate.

In conclusion, Western Governors are taking a pragmatic approach to weather and climate. They recognize the impacts of weather events and climate trends, and they seek information to make sound management decisions. NOAA plays an essential role in this effort, and the Governors are pleased to work to strengthen delivery of this critical information and make it more responsive to state needs. We thank you for the opportunity to be here today.

Thank you, Mr. Chairman, Senators, Ladies and Gentlemen.

WESTERN GOVERNORS' ASSOCIATION
POLICY RESOLUTION 09–2

Supporting the Integration of Climate Change Adaptation Science in the West

A. Background

1. Global warming poses a serious threat to the Western economy, public health and environment. The impacts of climate change are being observed in Western states and are predicted to worsen in the future. The potential adverse consequences include variability of precipitation leading to serious water supply problems, the degradation of air quality, damage to infrastructure, and the loss of plant and animal species. Global warming will directly affect Western industries including tourism, skiing, fishing, agriculture and forestry and will disproportionally affect communities with limited resources to adapt and cope.
2. Western Governors recognize that while action to reduce greenhouse gas emissions are occurring at the local, state, regional and Federal levels of government, simultaneous efforts should be taken to mitigate current and potential future impacts from climate change.

3. Appropriate actions to decrease greenhouse gas emissions must be taken to avoid, reduce and delay the adverse impacts of global warming to Western states. In addition, adaption is necessary to address impacts to Western states from warming which is unavoidable due to past and current emissions.
4. Predictive modeling is being used by decisionmakers to mitigate potential economic, social and environmental impacts of climate change and this type of planning data should be encouraged. However, these models are still being developed and their effectiveness for application to natural resource planning should be assessed and implemented appropriately.
5. The Western States Water Council (WSWC) and the Western Governors' Wildlife Council (WGWC) are actively pursuing strategies to identify and adapt to impacts from climate variability on water and wildlife resources, as identified in WGA reports.

B. Governors' Policy Statement

1. Western Governors believe that planning for climate change adaptation should be undertaken in a coordinated fashion at all levels of government with state expertise being fully utilized. Such planning must be in cooperation and consultation with the private sector and non-governmental organizations.
2. Western Governors urge Congress and the Administration to fund research to improve predictive capabilities for climate change and related impacts at regional and global levels.
3. Western Governors encourage Congress and the Administration to prioritize investment in Federal programs that study climate adaptation, addressing scientific questions, natural resource management, and protection of infrastructure at the regional, state and local levels.
4. Western Governors support the establishment of new revenue streams to support climate adaptation in relevant climate change legislation.
5. Western Governors support streamlined coordination of Federal agencies that respond to climate adaptation and greater cooperation with state agencies.
6. Western Governors encourage Congress and the Administration to support the development of a National Climate Service to undertake, coordinate and communicate necessary research and modeling with respect to climate change and adaptation. A National Climate Service should provide relevant decision tools for local and state governments in addressing climate change and adaptation issues, should connect social, health and economic trends to climate change (and vice versa), and should include in its mission public education and outreach.
7. Western Governors agree that results from ongoing scientific research should be assessed and incorporated into policies related to climate change adaptation and greenhouse gas emission reduction strategies. (E.g. as predicted impacts worsen; mitigation efforts should be stepped up).

C. Governors' Management Directive

1. The Western Governors direct WGA staff to establish a Climate Adaptation Work Group (CAWG) for the purpose of determining appropriate uses of climate adaptation modeling in informing natural resource and economic infrastructure planning and policies, and for identifying and filling existing gaps in climate adaptation efforts within WGA. This work group could also review current and future climate legislation to assess the impact to states and their efforts to adapt to a changing climate and report their findings to the WGA Staff Council.
2. Chairs or their designees from existing WGA initiatives will comprise the initial membership of the CAWG. These existing groups include WGA's working groups on water, forest health, wildlife habitat, wildlife corridors and air quality. This initial membership of CAWG will compare efforts, share information and identify gaps in their work as it relates to the broad issues of climate change adaptation at the state and regional levels. The CAWG will report these findings to the WGA Staff Council along with recommendations for the need for, mission and composition of an expanded CAWG.
3. The Western Governors direct WGA staff to conduct a workshop to study current climate change modeling and the application of different models to policy decisionmaking, using the North American Regional Climate Change Assessment program as the starting point for consideration.

4. The Western Governors direct WGA staff to work with the CAWG to prepare a report outlining how to more effectively use climate change modeling in policy decisionmaking.
5. WGA shall post this resolution to its website to be referred to and transmitted as necessary.

Prepared by the Western Governors' Association, March 2011

Inventory of Existing NOAA Climate Services and how they are Currently Used: This table identifies existing NOAA climate services [1] and who uses them to make decisions. The table focuses on state applications of climate services and provides several specific examples as illustrations. Many of the services span categories and are used in multiple sectors. They also span climate timescales from extreme events like floods and hurricanes, to seasonal events such as droughts, and decadal-centennial changes like increases in aridity.

Climate Products and Providers	Key Users	Examples
Services to Support the Agriculture and Water Resource Management Sectors		
Temperature Forecasts (National Weather Service—NWS) Precipitation Forecasts (NWS) River Flow Forecasts (NWS-River Forecast Centers [i]) Drought Monitoring and Forecasts (National Integrated Drought Information System-NIDIS [ii]) Climate Normals (National Climatic Data Center—NCDC [iii]) U.S. Drought Monitor (NOAA—USDA—National Drought Mitigation Center Partnership) Crop yield risks (RISAs [iv]) Estimate crop water usage (Regional Climate Centers [v]) Regional Drought Outlooks (NIDIS)	• Farmers • Municipal Water Managers • Energy Companies • Levee/Flood Control Management • State Departments of Agriculture • State Water Resource Boards • USDA/NRCS • Bureau of Reclamation	NOAA provides seasonal surface water runoff projections to resource managers in Idaho. This information has been used for maximizing hydro-power output, irrigation supplies, and conservation flows for endangered fish populations. It has also been used to explore sites in the state of Idaho for potential new hydropower generating stations.
Services to Support the Energy Sector		
Climatology on wind and energy (NCDC) Greenhouse Gas Monitoring (NOAA Global Monitoring Division)	• Energy Companies • State Public Utility Commissions • DOE, NASA, EPA	Energy producers use NOAA projections of precipitation, wind, and weather to plan and manage solar, wind-power, and hydropower facilities.
Services to Support the Transportation Sector		
Navigation charts (NCDC Buoy Data) Real-time Tides and Currents (NOAA Tides and Currents) Surface Airport Climatology (NWS) Extreme Weather Forecasts (NWS-Storm Predication Center [vi])	• Airline Industry • Shipping Industry • Port Managers • State DOTs • DOT, FAA	Engineers are tasked with provid-ing safe roadways under virtually all weather conditions. Caltrans is working with NOAA and other climatologists and hydrologists to develop new methods for estimating peak precipitation and runoff events for the purpose of road design and safety.
Services to Support the Public Health and Safety Sectors		
Hurricane Forecasting (NOAA Nat'l Hurricane Center [vii]) Tornado Forecasting (NOAA Storm Prediction Center) Temperature Extremes (NCDC)	• State and Local Emergency Managers • Public Health Agencies • Hospitals • FEMA	The Oregon state epidemiologist is a member of Oregon's Climate Change Integration Group. One of the 10 key recommendations of the group is to incorporate the implications of climate change on public health into the policy, planning and preparation for climate change.
Services to Support the Oceans and Coastal Management Sectors		
Sea-level Data (NOAA Nat'l Ocean Service [viii]) Tides and Currents (NOAA Tides and Currents)	• Ocean-front Communities • State Coastal Commissions • State Emergency Managers • FEMA	The state of Alaska is responding to thawing sea ice and increased coastal erosion that threaten communities. As Governor Parnell stated in testimony to Congress, ". . . the state of Alaska strongly supports NOAA and its initiatives to improve its observations and research across the Arctic and to develop innovative forecasting models for next week's weather and the next century's climate."

[1] This table focuses on NOAA climate services. Other agencies also provide climate-related information, including the USGS streamgaging network and the NRCS snowpack network. Coordinating with these other agencies would be part of the mission of the proposed NOAA Climate Service.

[i] *National Weather Service River Forecast Centers* (NWS–RFCs) performs continuous river basin modeling and provides hydrologic forecast and guidance products for hundreds of locations along rivers and streams across the U.S.

[ii] *National Integrated Drought Information System* (NIDIS) is an interagency and interstate effort to establish a drought early warning network for the U.S. NIDIS provides a better understanding of how and why droughts affect society, the economy, and the environment, and is improving accessibility, dissemination, and use of early warning information for drought risk management.

[iii] *National Climatic Data Center* (NCDC) provides access and stewardship to the Nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change.

[iv] *Regional Integrated Sciences and Assessments* (RISAs) focus on sector specific users and the environment in which they make decisions and where climate data could be used to improve the quality of those decisions.

[v] *Regional Climate Centers* (RCCs) provide and develop sector-specific climate data products and services and provide integration of climate data from multiple sources.

[vi] *NWS-Storm Prediction Center* issues timely watch and forecast products dealing with tornadoes, wildfires and other hazardous weather phenomena.

[vii] *NWS-National Hurricane Center* issues watches, warnings, forecasts and analyses of hazardous tropical weather.

[viii] *National Ocean Service* translates science, tools, and services into action, to address threats to coastal areas such as climate change, population growth, port congestion, and contaminants in the environment, all working toward healthy coasts and healthy economies.

WGA–WSWC Bibliography

The Western Governors' Association and Western States Water Council have written a series of reports on water, drought and climate adaptation. The reports are available at our website: www.westgov.org under the 'Reports' tab. These reports include:

Drought Response Action Plan, Western Governors' Association, November 1996.

Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System, Western Governors' Association, June 2004.

Water Needs and Strategies for a Sustainable Future, Western Governors' Association and Western States Water Council, June 2006.

Water Needs and Strategies for a Sustainable Future: Next Steps, Western Governors' Association and Western States Water Council, June 2008.

Climate Adaptation Priorities for the Western States: Scoping Report, Western Governors' Association, June 2010.

Improving Drought Preparedness in the West: Findings and Recommendations from the Western Governors' Association and Western States Water Council Workshops, January 2011.

In addition, the National Drought Policy Commission authored a report on drought policy:

Report of the National Drought Policy Commission: Preparing for Drought in the 21st Century, National Drought Policy Commission, May 2000. *http://www.drought.unl.edu/pubs/pfd21main.html*

Senator BEGICH. Thank you very much.

Next we have Dr. Peter Neilley, Vice President, Global Forecasting Services, the Weather Channel Companies.

I hope when I appeared on Weather Channel, we did not ruin your ratings.

[Laughter.]

Dr. NEILLEY. I think you helped very much.

Senator BEGICH. I know you have good morning ratings. Put us on there, things will go the other way. So thank you very much for being here.

STATEMENT OF DR. PETER P. NEILLEY, VICE PRESIDENT, GLOBAL FORECASTING SERVICES, THE WEATHER CHANNEL COMPANIES

Dr. NEILLEY. Thank you, Chairman Begich and Ranking Member Snowe, and members of the Committee. Good morning, and thank you for the opportunity for us to address you today.

Again, my name is Dr. Peter Neilley, and I am the Vice President for Global Forecasting Services for the Weather Channel Companies. I am also the Chair of the American Meteorological Soci-

ety's Committee on Weather and Forecasting, and a member of NOAA's Environmental Information Services Working Group.

The Weather Channel Companies are a major developer and provider of weather services for consumers and businesses across our Nation. Our television, Web and mobile products reach nearly 100 million users each month. We also serve nearly half of the television stations across the U.S., dozens of global airlines, and numerous traditional and renewable energy companies worldwide. We have been serving the Nation's weather interests for 30 years, and we're proud and respectful of the trust the Nation has instilled in us to inform and protect it from the weather.

We are one of many private weather companies that provide weather and forecasting services to serve our Nation.

Weather is woven into the fabric of our society. A recent estimate suggested that nearly 40 percent of our economy is sensitive to the weather. So far this year we have seen 14 $1 billion weather disasters, more than any year on record, and that does not include the accounting of last week's storm in Alaska.

Despite these losses, our Nation enjoys substantial protection from the weather. One recent study estimated that the roughly $5 billion we spend annually producing weather information directly avoids over $30 billion in annual weather-related losses. Hence, our investments in a weather-ready nation are paying substantial dividends to the economy, and continuing such investments will return far more value to our society than their cost.

Our nation is the global leader in the creation of state-of-the-science weather information to serve our society. This is the result of the Weather Enterprise, an effective three-way partnership between NOAA and other weather-related government agencies, private weather services, and academic and research institutions. The effectiveness of the Weather Enterprise to serve society is derived from the cutting-edge science and technology developed by the research community, NOAA's implementation of these technologies to create foundational datasets, weather and climate datasets, and the private sector building upon these foundational datasets to create forecasts and other value-added products.

The private sector is where much of the weather-related job creation has occurred recently, such as the weather-services sector enjoys one of the lowest unemployment rates in the Nation, as recently reported by the *Wall Street Journal*.

It is critical that our Nation designs and funds next-generation weather and climate services with an Enterprise-optimized perspective is used so that we continue to derive optimal value from these investments.

The foundational weather datasets from NOAA are essential to the private sector's ability to create and deliver weather information for the Nation. From our perspective, continued provision and evolution of these data is the single most important function of NOAA. Doing so will enable the broader Weather Enterprise to create new weather services to meet the evolving needs of the Nation and grow our economy.

History has shown that the private sector is the most responsive and effective at developing new applications of NOAA's foundational weather information. Therefore, the private sector

should strategically be relied upon to deliver next-generation weather services that leverage evolving foundational datasets from NOAA.

The specific needs of the Weather Channel Companies for information services from NOAA are, in priority order: one, the sustainment and evolution of all existing weather-observing platforms; two, improved numerical weather prediction capabilities; three, access to all known weather data, including those currently not readily available; four, improved detection of hazardous weather phenomena, particularly those that are not well-observed by the existing weather radars; five, liaison with NOAA's international counterparts to seek open access to all international weather information that enables fair competition in a global economy; six, support of scientific research that improves forecasts of impactful weather by the Enterprise; and finally, seven, climate information and forecasts to inform our Nation about the impacts of a potentially changing climate.

The Weather Channel Companies plays an important role in serving the weather needs of the Nation. We perform this function only through a collaborative partnership with the Weather Enterprise. NOAA's crucial role in the Weather Enterprise is the creation of the foundational datasets and sustaining and involving those datasets as critical to the Weather Channel Companies' ability to help make our Nation weather ready.

Thank you for the opportunity to address the Committee, and I'll look forward to your questions.

[The prepared statement of Dr. Neilley follows:]

PREPARED STATEMENT OF DR. PETER P. NEILLEY, VICE PRESIDENT, GLOBAL FORECASTING SERVICES, THE WEATHER CHANNEL COMPANIES

Introduction

Chairman Begich, Ranking Member Snowe, and Members of the Subcommittee—Good morning and thank you for the opportunity to address you today. My name is Dr. Peter P. Neilley and I am the Vice President of Global Forecasting Services for The Weather Channel Companies. I am also the Chair of the American Meteorological Society's Committee on Weather and Forecasting, as well as a member of the Environmental Information Services Working Group of NOAA's Science Advisory Board. In my remarks today, I am speaking as a representative of The Weather Channel Companies.

The Weather Channel Companies, which includes The Weather Channel and WSI Corporation, is a major developer and provider of weather services for both consumers and businesses across our Nation and around the world. The Weather Channel Companies' content is ubiquitous on nearly all forms of popular communication—The Weather Channel's television network is available in more than 100 million households, and our online and mobile products reach nearly 100 million users each month. In addition to our branded television, radio, print, web and mobile products for consumers, our content also serves the needs of businesses around the world with weather solutions for the media, aviation and energy industries. Through our business-solutions corporation WSI, our weather content is used by nearly half of the local television stations across the country, dozens of airlines around the world and numerous traditional and renewable energy companies worldwide. We are just one of many private companies that provide a wide range of valuable weather and forecasting services to meet the diverse weather needs of our Nation.

We have been serving the weather interests of the Nation for thirty years and are proud and respectful of the trust the Nation has instilled in us to inform, advise and protect it from the weather.

Weather Has a Substantial Impact on Our Nation

Weather plays a role in the daily lives of nearly every American and its impacts are woven into the fabric of our economy. One 2002 published estimate suggested

that nearly 40 percent of our economy or nearly $4 trillion annually is sensitive to the weather. In 2011, so far we have seen fourteen $1 billion weather disasters occur or over 50 percent more than any other year on record. This includes the numerous tornado outbreaks that ravished the Southeast this spring, Hurricane Irene that swept the U.S. eastern seaboard in August, the ongoing devastating Southern Plains drought, and the recent early season snowstorm that hit New England. Despite these losses, our Nation enjoys substantial protection from the weather. One 2009 study estimated that we avoid over $30 billion in losses annually as a direct result of the roughly $5 billion annual investment our Nation makes in producing risk-avoiding weather information. This and other similar studies clearly show that although our Nation has significant weather risk, our investments in becoming a weather-ready nation are paying substantial net dividends to the economy and our society in general. It is imperative that we continue these investments in order to sustain and improve our resilience to the weather. Without such investments we potentially will lose far more value to our society than the cost of these investments.

The Weather Enterprise is Critical in Meeting the Needs of a Weather-Ready Nation

The United States enjoys the broadest and most effective meteorological services in the world. Our nation is the global leader in the creation of state-of-the-science weather information and the provisioning of that information to serve both public and private interests in safety and economic prosperity. This leadership is the result of a strong and vibrant three-way partnership between (a) NOAA and other weather-related government agencies, (b) private weather services such as The Weather Channel® network, and (c) academic and research institutions. Collectively, the players in this partnership are generally referred to as the Weather Enterprise. Each sector of the Enterprise has a unique but critical role to play in serving the Nation. In general terms, research by the academic community leads to cutting-edge science and technology that drives the evolution of the field, NOAA implements and operates these technologies to create foundational weather and climate datasets, and the private sector builds upon these datasets to create forecasts and other products that inform the public and provide value-added services to industry. The private-sector is also where much of the meteorologically related job creation has occurred over the past decade and is a principal reason why the weather-services sector of our economy enjoys one of the lowest unemployment rates in the Nation.

The stated mission of NOAA's National Weather Service is to protect life and property and to enhance the national economy. It has been able to meet this mission only through the mutual collaboration of all members of the Weather Enterprise. The Weather Channel Companies and the other private sector weather services play a crucial role in communicating timely weather information to the Nation. We are dependent on NOAA, and in particular its National Weather Service for creating and serving some basic components of our overall service. The Weather Channel Companies' ability to continue to inform and serve the Nation effectively is strongly dependent on continued reliable and accurate foundational information services from NOAA. Further, it is critical that as our Nation designs and funds next-generation weather and climate services, that it considers a holistic, Enterprise-optimized perspective to these services, rather than focusing solely on optimizing or broadening the roles of the Enterprise's individual components.

NOAA's Focus on Creating and Serving State-of-the Science Foundational Weather Datasets

Key to the ability of The Weather Channel Companies to deliver critical and actionable weather information to serve the Nation are the foundational datasets from NOAA that provide relevant observations of the state of the atmosphere, timely watches, warnings and advisories of threatening weather, and numerical weather prediction datasets that are reliable and accurate. The creation of these data is a function that only the government-sector of the Weather Enterprise can adequately perform. From our perspective, this is the single most important function of NOAA and it must remain the central focus of the Agency moving forward. We believe that NOAA's priorities should be the maintenance and modernization of its weather observing platforms, sustaining and evolving its world-class numerical weather and climate prediction capabilities, and ensuring robust and effective accessibility to its complete set of weather information by the Weather Enterprise outside of NOAA. Maintaining this as NOAA's core competency will then enable the broader Weather Enterprise to create new, value-added weather services to meet the future needs of the Nation. History has shown that the private-sector is much better equipped, more responsive and more effective at providing new types of applications of NOAA's foundational weather information. Therefore, the private-sector should strategically

be relied upon to develop and deliver next-generation weather services such as forecasts of weather's impacts, and new communication services for a rapidly evolving digital society that leverage next-generation foundational datasets from NOAA.

Critical Information Needs of The Weather Channel Companies

In order to continue to meet the needs of a weather-ready nation, The Weather Channel Companies will require new and evolved information services, many of which we believe are best met by capabilities developed and provided by NOAA. In priority order, our overall needs for services from NOAA are:

1. Sustaining state-of-the-science weather observation platforms and capabilities including weather radars, satellite observing systems and traditional weather observing systems.
2. Improved numerical weather prediction capabilities that employ state-of-the-science initialization techniques and other improvements that optimize the accuracy and usable duration of their output.
3. Implementing new approaches that enable timely access and use of the complete set of weather and forecast data that NOAA currently creates but for which practical considerations limit the ability to share outside of NOAA. This includes full-resolution, ensemble numerical weather prediction datasets that are generally too large to practically and timely communicate, and therefore are not fully leveraged to serve society today.
4. The deployment of new sensors and technologies to better detect hazardous weather near the surface of the earth such as tornadoes and other forms of severe weather. This includes a denser weather radar network that can detect the many low-level tornadoes that are not well observed by the existing NOAA radars.
5. Aggressive liaison with its international counterparts to provide open and fair access to international weather and forecast information so that we may effectively and fairly compete on the world marketplace in the provisioning of weather information for a global economy.
6. Continued funding and other support of scientific research that will improve the Enterprise's ability to detect threatening weather, forecast its occurrence, and inform society of its impacts in effective ways.

Climate Services needs for The Weather Channel Companies

Our Nation faces uncertain but potentially substantial impacts from a changing climate. In order for our Nation to make informed and effective choices on responses and adaptation, it is important that our society be informed with factual, accurate and relevant climate information. Although The Weather Channel Companies' traditional focus has been in the provision of real-time and short-term weather information, we recognize and accept a responsibility to help inform the Nation regarding climate changes and its potential impacts. We believe that The Weather Channel Companies should play a leading role in educating our Nation about climate matters in a balanced and scientifically sound manner. In order to serve that role, The Weather Channel Companies will rely on NOAA to develop rich climate data services, including but not limited to accurate long-term weather archives, analyses of these data to elicit regional climate variations and trends, as well as state-of-the-science climate forecasts. We believe these are critical needs of the Nation and are services best provided by NOAA as part of its weather and climate foundational datasets mission.

Summary

The Weather Channel Companies, as a major member of the broader Weather Enterprise, plays an important role in serving the weather needs of our Nation. We have been able to perform this function only through a collaborative partnership with NOAA and its various weather-related divisions. NOAA's crucial role in the Weather Enterprise is the creation and provisioning of foundational datasets and we believe this must remain the core focus of the Agency. Continued modernization and evolution of these datasets is critical to The Weather Channel Companies success in its role in making our Nation weather ready.

Thank you for the opportunity to address the Committee. I look forward to any questions you may have.

Senator BEGICH. Thank you very much.

Our next panelist is Robert Marshall, President and CEO of Earth Networks.

STATEMENT OF ROBERT S. MARSHALL, FOUNDER AND CEO, EARTH NETWORKS, INC.

Mr. MARSHALL. Thank you, Chairman Begich, Ranking Member Snowe, and members of the Committee, for your continued interest in innovation in weather forecasting and prediction, and allowing me to testify.

My name is Bob Marshall, and I am the Founder and CEO of Earth Networks. I don't need to spend any time talking about the great impact that severe weather is having on our society. We all know it, and we see it every day.

I will focus my remarks on the innovations that can help cost-effectively improve the accuracy and timeliness of our forecasts and warnings and to help save more lives.

There is one thing that all scientists and meteorologists can agree to, and that is that high-quality observations of the atmosphere are required to produce accurate forecasts and warnings. You simply must measure what is happening to predict what will happen in the future.

Of course, NOAA has developed a strong backbone infrastructure of observations over the past couple of decades, ranging from surface-based, in-situ and remote sensing platforms to satellite observing platforms. However, in 2008, the National Academy of Science report entitled "From the Ground Up: A Nationwide Network of Networks" documented critical gaps in NOAA's observing infrastructure.

Among other recommendations, this report called for NOAA to first take advantage of all existing surface-based weather station networks, otherwise known as mesonets. If properly integrated, these observational data will clearly improve both forecasts and warnings. For example, had the National Mesonet been fully integrated into NWS operations, it is quite possible that better warnings could have prevented six deaths in the Indianapolis State Fair tragedy.

It is important to note that these existing networks were not federally funded but are owned and operated by private sector companies, states and universities. NOAA must simply acquire the data and operationalize it, which makes this very cost effective relative to deployment of new observation networks.

I am pleased to report that the National Mesonet program has received some limited funding for pilot programs to date, but it is not yet in the NOAA base budget, nor has it been fully funded or operationalized. The National Mesonets should be fully funded and completed.

Now I want to talk about some exciting advances and innovations in Mesonet technology. Earth Networks is spearheading one very exciting innovation to provide improved severe weather warnings, and that is the integration of total lightning sensors into our National Mesonet. Researchers have long known that severe storms have very high total lightning rates. Simply said, if you can measure total lightning, it is a precursor to severe weather, and lead times for severe weather warnings can be improved.

We have deployed these sensors at no up-front cost to the taxpayer, and our dangerous thunderstorm alerts are now fully operational in the Continental U.S. Let me briefly mention two exam-

ples. In the terrible super-tornado outbreak across the South this past spring, where hundreds of our citizens perished, we evaluated seven of the most devastating of those tornados. In those events, total lightning-based alerts provided an extra 13 minutes of warning, on average, over and above the National Weather Service severe thunderstorm and tornado warnings. The deadly Springfield, Massachusetts tornado of June 1 of this year is highlighted on the easel to my left. Total lightning alerts provided an additional 38 minutes of increased warning in that situation.

Now let me say that NOAA and the National Weather Service generally do a fantastic job of warning our citizens to severe weather dangers, and that is especially true in the super-tornado outbreak from this spring. But minutes do matter when it comes to severe weather and saving lives. With improved lead times, more people will find shelter and more lives will be saved. I'm pleased to say that total lightning is currently being trialed in National Weather Service field offices, but this must be quickly funded and moved to operations.

Again, to provide perspective, NOAA and the National Weather Service have spent about $4.5 billion over the past couple of decades, and this investment has yielded an impressive improvement in lead time, from 4 to 14 minutes. However, this new and innovative ground-based sensor technology on the National Mesonet can provide a step-function increase in warning time for a tiny fraction of the previous investment. Let me repeat, this technology is here and ready today, and more lives can be saved.

Lastly, I want to touch on NOAA's overall observational model. Given the current fiscal and budget reality, it is not an understatement to say that NOAA's traditional model, to purchase and own all of the observations it needs, is severely challenged, if not outright broken. NOAA must embrace public-private partnership models whereby the cost of the networks are shared by many users, such as energy and transportation companies. In our case, NOAA pays a small percentage of what it would have cost them to deploy a comparable network.

To summarize, even with the budget challenges that NOAA faces ahead, there are public-private partnerships and innovative new technologies that will enable us to collectively and cost-effectively create a weather-ready nation and to better protect the lives and property of our citizens. Earth Networks stands ready to do our part.

I thank you for the opportunity to testify, and I'm happy to take any questions.

[The prepared statement of Mr. Marshall follows:]

PREPARED STATEMENT OF ROBERT S. MARSHALL, FOUNDER AND CEO, EARTH NETWORKS, INC.

Introduction

Thank you, Mr. Chairman and Members of the Committee for this opportunity to testify on the importance of continuing innovation to improve weather forecasting and warnings. My name is Bob Marshall, founder and CEO of Earth Networks and I am very appreciative of this opportunity to discuss topics relating to the weather observing and forecasting programs of the National Oceanic and Atmospheric Administration. We thank the Committee for its continuing interest in addressing the

complex requirements of observation, prediction, planning and response, and the critical role these efforts play in protecting lives and property.

Earth Networks' particular expertise is in owning and operating large, dense environmental and atmospheric sensor networks. We utilize the data from these observational networks to deliver daily environmental information and alerting to millions of consumers; Federal, state and local governments; and the myriad of industries impacted by weather. While we certainly rely on many NOAA services, and incorporate NOAA data and forecasts into our products and services, we have found that the needs of the marketplace (and of government) often require higher resolution solutions and data sets that are more locally targeted and in much greater frequency than NOAA is currently able to provide through its own observing networks. In this manner, existing local networks of this type are able to supplement NOAA's in a unique and powerful public/private partnership.

Weather is having a greater impact on our society than ever before. This includes impacts to the lives and property of our citizens and to our economy. To provide the most accurate forecasts and warnings for weather, dense high quality observations are required, so I will focus my comments on that component of the overall system. Without observations of the atmosphere, quality forecasts and warnings are not possible. And meteorological observations on the mesoscale (*i.e.,* local/county scale) are of the greatest importance as evidenced by the fact that the vast majority of severe weather life and property losses are associated with mesoscale events such as tornados, thunderstorms, fronts, squall lines, etc.

The need for improvements in observations of this kind are well documented and compelling as recently indicated within the National Research Council report *From the Ground Up: A Nationwide Network of Networks.* Among other recommendations, the Council advocated that a first priority be the development of a surface based *National Mesonet,* with comprehensive data collection, quality control and dissemination capabilities, which will provide the critical information needed to improve short and medium term weather forecasting (down to local scales), plume dispersion modeling, and air quality analyses. In this manner, not only will the overall capabilities of the atmospheric community be substantially improved, but decision-making will be significantly enhanced across a broad spectrum of market sectors and end user constituencies including energy, agriculture, homeland security, disaster management and emergency response, insurance and economic forecasting, transportation, education, recreation and scientific research.

From an observing perspective, there are a number of specific areas that NOAA weather and climate programs should focus on in order to establish a truly Weather Ready Nation. Three key areas are: (1) a comprehensive and robust observing system; (2) early warning capabilities that leverage key mesoscale observing systems; and (3) strong public-private partnerships. While each of these components could be examined more closely to identify key requirements, assess the current condition of readiness and prescribe appropriate efforts and investments necessary for a more capable domestic program, my testimony today will only touch upon these aspects at a high level. Please note that my recommendations here today are rooted in recent reports from the National Academy of Sciences, national efforts by leading industry associations regarding weather and climate services, as well as my own experiences in leading an organization that interacts with all aspects of the American Weather Enterprise, *i.e.,* public, private and academic interests involved in sourcing and distributing weather information. Finally, I'll also touch briefly upon climate considerations in this regard.

(1) Comprehensive and Robust Observing Systems

The objective of weather and climate observing systems is to provide critical information on the current state of the atmosphere and terrestrial biosphere in a timely manner such that informed decisions can be made at varying time scales. In this context, decisions on the long term may involve potential global temperature changes and sea level rise that require development of climate mitigation and adaptation strategies. Intermediate term decisions may include flood, drought and winter weather or tropical storms expected to affect large areas and many sectors of the economy over prolonged periods of time. Alternatively, short fuse decisions more often entail those relating to convective (*i.e.,* thunderstorm) weather events that while often widespread, occur quickly and dramatically impact people, property and critical assets.

Supporting these varying decisions and timescales requires various types of observation platforms, including surface based in-situ and remote sensing monitoring networks as well as space based satellite systems. When seamlessly integrated, these complementary resources provide the raw data foundation upon which an entire nationwide decision support system is built. These data are critical inputs to and re-

quired for the establishment of situational awareness, the generation of forecasts, as well as the subsequent dissemination of warnings and alerts for the protection of life, infrastructure and optimization of weather sensitive market sectors. With regard to the latter, it should be noted that the impact of weather on our Nation's economy was recently estimated to be as much as $485 billion or 3.4 percent of the 2008 U.S. gross domestic product. (Lazo, Lawson, Larsen and Waldman, *Bulletin of the American Meteorological Society,* June 2011, (*http://www.sip.ucar.edu/publications/PDF/Lazo_sensitivity_June_2011.pdf*).

Recent advances in electronics technology have enabled surface based sensors to become smaller, faster, more accurate, more reliable and less expensive. Networking of the sensors via the Internet and wireless networks has enabled dense surface based observation networks to proliferate rapidly. Environmental parameters that were once not practical to observe at the surface are now proven and operational. In some cases, these breakthroughs in surface based network technology potentially obviate the need to observe these parameters from space, where the costs and risks to do so are far higher. Generally, anything that can be observed from the surface should be observed at the surface due to the extremely high costs and risk factors inherent in any satellite launch. Satellites should only be considered where ground based sensors are inadequate.

These advances are similar to the advances seen in astronomy. Ten or twenty years ago, the technology available from ground-based telescopes was not adequate to capture data at sufficient resolution for all research purposes; space based telescopes like Hubble were necessary. Now, technological advances have significantly improved the capability of ground-based observations. As a result, we collect from space only that data which we cannot collect from the ground—the two domains complement each other. Like in astronomy, improvements in the technology of ground-based in situ sensors, communications, power management, data handling and storage have all enabled the deployment of cost-efficient sensor networks with a density sufficient to allow applications thought impossible just a few short years ago.

But sometimes a satellite is the appropriate answer. For example, the JPSS satellite is critical to NOAA's ability to forecast weather accurately, especially in the 3–5 day period and longer. This was never more apparent than the terrible southern tornado outbreak from this spring. The NWS was able to predict a very high potential for severe weather in the region many days in advance which helped communities to prepare. Studies have shown that the polar orbiting satellite data was critical to this success. Winter storms forecasts and warnings are also another area where the polar orbiting satellites are critical. In last year's "snow-mageddon", NWS forecasts allowed for up to a week's advanced warning of this storm, which again allowed time for communities to prepare in advance of the severe weather. There is no surface based technology that can provide an alternative for the observations that will be delivered by JPSS. It is critical for JPSS to be funded to prevent a significant decline in forecast and warning accuracy for these type events.

(2) Early Warning Capabilities

As mentioned previously, most severe weather occurs at the mesoscale, *i.e.,* local and regional scale and NOAA/NWS generally does a very good job of generated severe weather warnings to cover this domain. However, while warning lead times correspondingly improved during the NWS modernization that began in the 1980s, during recent years the warning lead times have not improved appreciably. This is a direct reflection of operational observing systems also not significantly improving. With the frequency and severity of weather events increasing and our population growing, further improvements in warning lead times are necessary to better protect life and property. High resolution mesoscale observations enable more accurate and timely forecasts and warnings in the 0–6 hour's timeframe. Fortunately, this committee and the National Weather Service have taken steps toward making this capability operational by appropriating monies for and implementing demonstration programs and pilot projects. For example, the National Mesonet Program championed by Senator Barbara Mikulski after the 2004 Baltimore Water Taxi Incident, involves a broad cross section of weather and climate network operators throughout the country who are supplying comprehensive surface observations and associated metadata from stationary and mobile platforms. But more should be done; we need to move beyond pilot projects to operational implementation.

To this end, I maintain that following the recommendations of the 2008 NRC report *From the Ground Up: A Nationwide Network of Networks,* and leveraging to the maximum extent existing and proliferating surface observations, be fully implemented as soon as possible. Doing so will significantly enhance NOAA's ability to forecast near-term severe weather and do so in a highly cost-effective manner. This

is particularly germane in a year where the Nation experienced an historic number of severe weather outbreaks, including destructive Tornado outbreaks in Tuscaloosa, AL and Joplin, MO as well as severe droughts, crippling snow storms and devastating hurricanes in other parts of the country. And the situation is only being exacerbated as our population grows and migrates toward urban and coastal areas. In fact, the previous annual record of 9 individual $1 billion weather-related catastrophes has been surpassed already in 2011 with a record setting 14 as of today.

Beginning in the 1980s, NOAA invested heavily in infrastructure for observing, analysis, visualization and dissemination capabilities which resulted in significant tornado warning lead time improvements from 4–14 minutes. This important and necessary advancement was the outcome of an approximately $4.5 billion investment. Since then, however, there have only been marginal improvements. What I want to stress is that new and innovative technologies can immediately deliver *step-function* improvements in early warning times at a fraction of the previous cost. These advancements in sensor technologies are the result of motivated and fully engaged private, academic and state government organizations that have enabled the deployment of dense, surface based observation networks throughout the country.

A specific recent innovation in mesonet technology is the integration of total lightning sensors. For many years, researchers have demonstrated that monitoring cloud flash lightning data at high detection efficiencies would provide insight into early stage convective development and that such total lightning observations could potentially provide significant improvements in storm warnings. But the technology was never available to cover large, continental areas at a reasonable cost. Using innovative new technology, Earth Networks has rapidly and efficiently deployed a continental scale total lightning network on its nationwide mesonet. This network is operational today and is automatically producing severe storm alerts with lead times as much as 30 minutes in advance of NWS Severe Thunderstorm and Tornado Warnings. During the April 25 to 28, 2011 Super Outbreak that killed more than 346 people and included the tornado that tore through Tuscaloosa, AL, Earth Networks total lightning system achieved an average lead time increase of 13 minutes for a broad subset of these events. Similar lead time performance achievements have been repeatedly observed for many other events throughout the country over the past several years and as such, the NWS is currently piloting the technology in 27 field and regional forecast offices.

As mentioned, this type of technology has only been made available on a broad scale and for such purposes during the past couple of years. It should also be emphasized that its cost is only a small fraction of that required to achieve the same from space and was accomplished without consuming a single dollar of taxpayer money. With the Earth Networks total lightning network being fully operational, the need to observe lightning in the future from satellites should be evaluated. The forthcoming GOES–R satellite includes a lightning sensor at a cost of more than $100M. The Earth Networks ground based total lightning network already delivers many of the benefits of the GOES–R satellite lightning sensor including higher resolution and accuracy. This is the kind of issue that should be looked at carefully, so that the government can be assured that a proper cost-benefit analysis has been completed. Even if the GOES–R lightning sensor initiative, scheduled for operations in 2017, is too far along to be shelved the Earth Networks total lightning capability should leveraged immediately to improve severe weather forecasting and alerting as well as to provide ground truth for satellite calibration, forecast validation and after action reports.

I have attached a Power Point presentation to this statement that demonstrates the power and effectiveness of this currently available and cost effective technology.

(3) Public Private Partnerships

Achieving a condition where the Nation is adequately equipped to foresee weather related threats and alert the community with sufficient warning lead-times requires vision, coordination and continued investment. It is particularly clear, however, that the Federal Government cannot achieve this goal alone, particularly in the face of an increasingly difficult budget environment. Therefore, it is imperative that vigorous public-private partnerships be nourished to drive innovation and allow for the appropriate mixture of baseline government provided services and market based offerings. By utilizing the capabilities of private networks, NOAA can acquire the data and services it needs at a fraction of the cost of owning the network assets. The return required for the network deployment costs are amortized over a variety of market segments; the costs and risks are shared. Only this type of partnership will ensure that available government funding is being deployed most effectively and efficiently.

Consistent with the 2003 NRC report entitled *Fair Weather: Effective Partnerships in Weather and Climate Services,* the NWS has initiated and expanded upon a dialogue with the private sector. These conversations have improved coordination among the sectors by providing greater insight into each other's respective needs, plans and capabilities. These efforts should be continued and identified synergies should be acted upon with greater urgency in order to rapidly fill the gaps in capabilities and services.

While the Federal Government is well suited to act globally and nationally, it is limited in its capacity to act locally beyond the provision of oversight and funding support. As such, it is envisioned that a public/private partnership structure, with guidance from the National Oceanic and Atmospheric Administration, facilitate and integrate these disparate networks and delivery of customized services. An organizational model of this type is particularly applicable given that many networks have been deployed by local organizations with local considerations in mind. These stakeholders can react quickly and efficiently, and are uniquely positioned to recommend future network evolution within their domains. These networks are in-place and available today. As such they offer the ability to deliver immediate returns.

(4) Climate Considerations

Before turning to my conclusions, let me comment briefly on another related monitoring initiative that Earth Networks is pursuing.

NOAA is charged with conducting research on the complex carbon cycle and its impact on climate variability. Currently, there are very limited carbon observations available to scientists for this research. NOAA operates about 10 such surfaced based carbon observationsites and there are a few dozen operated by others around the world. The current carbon observation network is limited to global and continental scale measurements and analysis. Many more observations are required to develop a better understanding of the carbon cycle at local and regional scales and to provide measurement, reporting and verification to support international treaties, as well as any regulatory or market-based reductions schema.

Similar to the advances described above, advances in electronics technology have also significantly improved the ability to accurately and reliably measure carbon from the surface. Earth Networks is deploying the largest surface-based greenhouse gas observing network in the world, with 50 sensors planned for the continental United States, 25 in Europe, and 25 distributed around the rest of the globe. Again, with this innovative new technology there is the potential for significant cost savings by increasing investments in ground based carbon measurements relative to satellite-based measurements. Unfortunately, the original Orbiting Carbon Observatory (OCO) satellite launch failed on launch. The cost of that mission was approximately $280 million. A second carbon satellite, OCO_2, is being developed at a cost of another $200 million. While all scientists, including those at Earth Networks desire data from both surface and space based platforms, the question is whether this is practical given the current budget constraints. Before funds are fully committed to a new or replacement satellite program, an exhaustive analysis should be accomplished to determine the tradeoffs associated with these funding decisions. As the previously referenced National Academies report title intimated, we should always start "from the ground up."

Conclusion

While NOAA has built up significant observational assets and capabilities over many decades, there remain significant gaps that limit our ability to further improve forecasts and warnings. Further, with budget challenges that will no doubt confront us for the foreseeable future, NOAA's model for acquiring and maintaining critical observations is infeasible. Overall budgets will likely be flat or lower. Satellite program costs are consuming an ever larger proportion of the NOAA budget and the current trajectory is simply not sustainable.

Immediate improvements, however, in forecasting and prediction can be realized by utilizing Public-Private partnerships to enhance existing space and ground based observing platforms. Therefore, specific strategies adopted in this regard should:

- Guarantee annual funding of the National Mesonet in NOAA's budget to fully integrate locally collected mesoscale surface weather data into the forecasting and warning functions at every National Weather Service field office;
- Guarantee that NOAA incorporate continental scale total lightning data into the National Mesonet and into its storm warning capability to achieve a step-function improvement in warning times;
- Fund cost efficient surface based carbon networks to improve local and regional scale climate science;

- Establish a standing NOAA advisory panel whose sole mission is to look at the balance of NOAA's forecasting needs for both weather and climate, and then recommends in a public way how those requirements should be met between the three observational domains of surface, airborne and space based measurements;
- Hold annual Congressional hearings on the state of innovation in forecasting and warning to measure the progress on the important objectives that the public demands and which must be done in a fiscally prudent manner given the challenging economic times.

Through the types of strategies and initiatives that I have highlighted today, the broader weather and climate industry will be able to expedite and support NOAA in establishing a truly Weather Ready Nation.

Thank you for the opportunity to testify today. I would be happy to answer any questions you may have.

Senator BEGICH. Thank you very much.

Let me first start, if I can. Again, this will be a 5-minute round.

Mr. Iseman, let me again thank the WGA for their partnership with NOAA, and I guess the first question I have is, from your perspective, what, if any, hurdles are there in the development or the expansion of the partnership that you see that maybe are being caused by our end of the equation?

Mr. ISEMAN. I think the big challenge for us right now in moving forward with this Memorandum of Understanding is taking it from the conceptual phase of a memorandum and into implementation, and we're working through that right now. We've had great support from NOAA in taking these steps. I think the real test of this partnership will come when we move to apply the memorandum in specific places and to work on the ground to develop the improvements that we've envisioned. So we're hopeful and optimistic for now.

Senator BEGICH. Do you think they have—and this is not a criticism of NOAA. It's just kind of my view of the Federal Government in general as a former mayor. Do you think they have the capacity to be regional as you had described? You know, the Federal Government has a bad habit of let's make everything national and all will work out for the best, and usually it doesn't because they don't recognize the regional differences and the uniqueness of certain areas. I mean, our state has multiple weather systems, compared to just one state that might have one weather system.

So can you—tell me your kind of confidence level. I know you have a good partnership with them, but this is, I think your comment was—I noted that your concern is can you bring it down to the regional level.

Mr. ISEMAN. Right.

Senator BEGICH. What's your confidence level in that capacity?

Mr. ISEMAN. I think there are some positive signs. One is the MOU itself. Two, I've seen some of the ways that they have organized and are delivering services at a regional scale, and one of those is through the NIDIS program, where they're working on regional early warning systems for drought and actually working with the people in the local community to develop those systems and deliver the services. And another is the Regional Integrated Sciences and Assessments where they are marshalling capacities at the universities to help states and local communities address on-the-ground problems.

So I think there are positive signs, and we'll be happy to report back on our progress under the MOU.

Senator BEGICH. I think that would be great, because I think the more NOAA partners, and that's kind of what this panel is really about, is how do you partner with other organizations and groups and private sector to expand the capacity of NOAA to provide the necessary information for forecasting and prediction that benefits everybody. So I'd be very interested in knowing how you progress on that and what are those challenges that might start to appear in the implementation of it, because that's always the—it's great and easy to do an MOU. I used to do those a lot when I was mayor. But then as mayor, you had to implement them, and so you had to make sure they were real. And so I would look forward to that commentary as you move forward.

Mr. ISEMAN. Thank you, Senator.

Senator BEGICH. Mr. Marshall, I appreciated your presentation. Your comment, which again caught me, and I want to follow up on it, do you think there is enough or are there areas that NOAA could really expand in maximizing the private sector capacity of what's now developed? I mean, if this was 20 years ago, it's a whole different ballgame with weather services in the private sector, but it's a different business now, proven by the Weather Channel and many of the industries that are related now to it.

Can you tell me, do you think there is more opportunity that's not being taken advantage of? And I'll pause for a second by saying this is a challenge we have also at the Coast Guard, and that is they want to own everything, and to partner means less authority or less jurisdiction, and I think there's a way probably to meld the two. But in NOAA, is that something that you would hope they would start looking at because of financial conditions, but also because of technology development?

Mr. MARSHALL. Yes. Thank you, Senator. I think there are really two sides to the public-private partnership from my perspective. I mean, on one side you have companies like the Weather Channel, myself, and many others that take the very important information from NOAA, develop value-added products, and help distribute that information to businesses and consumers.

I think one of the new areas that has evolved over the last decade or so, for sure, is that with advances in technology and with the ubiquitous nature of the Internet as a communications platform, virtually every sensor in the world is being connected to the Internet, and the data is flowing in real time every second. You know, the sensors are smaller, faster, more accurate, more reliable, and less expensive. So you have companies like ourselves that are deploying sensor networks all over the place, and this is a new area where the private sector can form a public-private partnership in NOAA to provide that data to NOAA to integrate into their operations, and it can be done very quickly and very cost-effectively.

So NOAA does not have to necessarily invest in all of the observational technology. It can just acquire the data. And I think that's a relatively new circumstance, and NOAA is embracing that model to some degree. But technology is evolving so rapidly that it can certainly be adopted faster, and this information can be put into

the hands of the forecasters to make sure that warnings and forecasts get better immediately.

Senator BEGICH. Very good. I'll probably follow up again in just a minute on that.

Mr. Neilley, let me ask you again. Thank you for your efforts here. You had seven points, I think, and one of them that stood out I think was access to weather data not available now. Can you elaborate on that?

Dr. NEILLEY. Thank you, Senator. NOAA creates a tremendous amount of weather information routinely throughout the day. The volume of it is so vast that it is impractical to communicate a lot of that information outside of NOAA, and decisions must be made about how to filter that data to provide general services to partners of NOAA.

However, the data that is unfiltered still has a tremendous amount of value to providing forecasting information, and we need to seek ways in which we can have access and use that information to create more value from that information.

As I mentioned earlier, I sit on the Environmental Information Services Working Group of NOAA, and we're exploring that question and expect to have recommendations to the NOAA Science Advisory Panel perhaps later this month.

Senator BEGICH. And do you think NOAA is responsive to this idea of sharing some of the—it's basically the raw data?

Dr. NEILLEY. I think—I believe they are. In preliminary discussions with NOAA, they certainly embrace this. Dr. Jack Hayes made a public endorsement of some of the concepts that were put forth and how we might be sharing some more of these data, and recent discussions with Kathy Sullivan have indicated strong endorsement of trying to figure out ways in which overall the society can benefit from all the data that NOAA has, yes.

Senator BEGICH. Very good.

Senator Snowe?

Senator SNOWE. Thank you. Just a follow-up on that question. Has there been information that you haven't received in the accumulation of that data, that raw data, that could have had an effect on the public, do you think?

Dr. NEILLEY. Oh, absolutely. We wouldn't be seeking this information if we didn't think it had a great deal of value to the public. It probably would be difficult to cite a specific example offhand, but there are—it would probably be conveyed in everyday weather, the frequency with which we update the information, the precision of which we can provide the information to the public so they can make daily decisions in going about their lives and businesses.

Senator SNOWE. So do they filter the data that gets to you, or what is the answer? Are they just accumulating it so fast that they can't transmit that data?

Dr. NEILLEY. It's both of those. The data gets accumulated so fast. Super-computers run and create the information at a great deal of precision and resolution, and fundamentally we don't have communication systems to make it practicable to send that data outside of those super-computing facilities.

Senator SNOWE. You mentioned in your testimony that the private sector should be strategically relied upon to deliver next-gen-

eration weather services, and I know that you, and Mr. Marshall as well, probably use a lot of mobile phone technology, desktop applications and so forth. Would that suggest reaching a broader audience through those mechanisms and through the advanced technologies that people use every day?

Dr. NEILLEY. Absolutely. History has shown that the private sector has been much more adaptable and responsive and faster in developing services that the public uses and can consume in their everyday lives, and I believe it's one of those—relying on the private sector to be the voice of the weather to the Nation is one of those ways that the private sector can most effectively do and should be the strength of what we should rely on from the strengths of the private sector.

Senator SNOWE. Thank you, Dr. Neilley.

Mr. Marshall, you were mentioning this national Mesonet program. How has NOAA reacted to that?

Mr. MARSHALL. Well, I think they've embraced the National Academy's report that came out in 2008. I think there has been some activity and there has been some limited funding put in place. I mean, we are somewhat disappointed that the Mesonet activities have not made it into the President's budget yet, despite the fact that the national Mesonet is briefed routinely by Dr. Hayes and his team as something that's very important for the National Weather Service strategically. So we certainly would like to see that become a reality, because this is very cost effective. It's leveraging existing sensor networks that are out there, that all you have to do is integrate them into the operations of the forecast offices and immediate improvements can happen for forecasts and earlier warnings.

So relative to the cost of deploying a new satellite, which is measured in the billions of dollars, this is very, very inexpensive and something that can happen very, very quickly.

Senator SNOWE. So are you suggesting there could be more sensors in different locations?

Mr. MARSHALL. Well, I mean, there are tens of thousands of sensors out there today that are in different networks. We have our own, universities, other companies, and that data just needs to be integrated into one database and leveraged by the National Weather Service. Again, there has been some work done, but I think it's really a clear opportunity to make substantial progress in the short run, particularly when you have a difficult budget environment where you can't fund everything that you want to do. This is low-hanging fruit.

Senator SNOWE. Right. So you're suggesting instead of having to deal with major satellites, that you could do some limited investments to gather all the information that's out there that's being accumulated on a daily basis.

Mr. MARSHALL. Yes, and I want to make sure I'm clear. I mean, in certain situations, yes. You can take advantage of existing networks, and they can fulfill the needs of many things, even stuff that satellites can do; not for all things, though.

Senator SNOWE. Right.

Mr. MARSHALL. So when you come to, like, the JPSS satellite, there is no surface-based alternative sensors out there today that

would fit the need for that. So that's an important and critical initiative for NOAA that needs to move forward, or else there will be a big gap in their ability to forecast weather, particularly in the 3 to 5 day time-frame for winter storms and tropicals. So there isn't surface-based alternatives for that, but there are for other things that can really make a material improvement for forecasts and warnings.

Senator SNOWE. Does NOAA integrate all your data?

Mr. MARSHALL. Not all of it. I mean, no. I mean, it's partial. At the end of the day, we've done some limited pilot projects, but clearly it would not take a significant amount of money to make sure that the data from our network, from other company private-sector networks, from academic networks gets integrated, assimilated, and used operationally within the forecast offices and in the numerical forecast models, and that's really what we would like to see happen.

Senator SNOWE. I see.

Mr. Iseman, you were discussing the importance of tailoring information to the appropriate scale for regions and resource managers. Could NOAA make better use of their weather service stations, for example, as a way of doing that?

Mr. ISEMAN. I'm not prepared to comment on that question right now. I'd like to get back to you.

Senator SNOWE. Are there ways in which NOAA could better engage local communities right now?

Mr. ISEMAN. Well, absolutely, and I'm sorry, I'm not familiar with all of the efforts that NOAA has under way to work directly with local communities, but we see a lot of ways that they could engage with the states, ways that we're trying to implement through this Memorandum of Understanding that we think can improve this relationship.

Senator SNOWE. Yes, I am aware of the MOU that was just reached, and that certainly would be an important step forward to have that common understanding and that partnership. But the outreach by NOAA to states and local communities could be extremely important in all of this, as well.

Mr. ISEMAN. Agreed. Thank you, Senator. And one of the things that NOAA has been doing is more Webinars and updates on a regular basis with the communities that are affected by these events, and I know right now they've got a series going on in the Southwest for drought, and they're going to be starting one in the Upper Missouri to look at the forecasts for snowpack and river runoff, and I think they're getting ahead of the game in trying to do a better job of communicating that.

Senator SNOWE. I appreciate that. Thank you.

Mr. ISEMAN. Thank you.

Senator SNOWE. Thank you all.

Senator BEGICH. Thank you all very much. I just have two quick questions, and one, just to make sure, Mr. Marshall, only because, being parochial here for a moment, Mesonet, is it connected to Alaska or not? Is it continental? Did I hear continental; right?

Mr. MARSHALL. Yes. They are absolutely. Thank you, Senator. No. The Mesonet is really, they're a global Mesonet. So we have sensors in Alaska. There are others that have sensors in Alaska.

And all of that information should absolutely be integrated into one national Mesonet to make sure that the Weather Service takes advantage of that existing data in your state, in all the other states.

Senator BEGICH. Very good. Thank you.

Mr. Iseman, let me end my—I just have one final question, and that is you heard the last panel that was here. I talked about the Centralized Climate Service Program and that there was a group, a small percentage, a very small percentage, that are concerned that when you centralize it, you may not create enough information flowing out. I'm assuming the same comment you had earlier on my other question about making sure it's regional, local, the work that NOAA does and the MOU you have, same situation probably here, that you want to make sure if they centralize, that there's still a local understanding of what's going on. Is that a fair statement?

Mr. ISEMAN. Yes, it is, Senator. And——

Senator BEGICH. I just didn't want to assume that based on your earlier statement.

Mr. ISEMAN. We have supported a national climate service. We think there's value in coordinating and centralizing this information and disseminating it. But one of our important comments on that topic has been that it be regionalized.

Senator BEGICH. OK. Very good.

Senator SNOWE. May I ask a question?

Senator BEGICH. Yes, Senator Snowe.

Senator SNOWE. I wanted to ask you, Dr. Neilley, so it's not our imagination that we're experiencing extreme weather events? Is it unprecedented in this last year?

Dr. NEILLEY. Certainly from an economic——

Senator BEGICH. Microphone? There we go.

Dr. NEILLEY. Thank you, Senator. Certainly from an economic perspective, so far and with still sort of 2 months of accounting to go, we've seen 14 $1 billion weather disasters this year. I believe the previous highest number was 9. So we're almost 50 percent higher this year than we've seen in any year.

Senator BEGICH. I know just from Alaska's perspective that the storm we just had—I mean, it was a big storm, earlier than usual in the sense of the magnitude it had, and more damaging because you have no ice buildup. You have no capacity to protect against erosion. And that's still being analyzed in Alaska. When we have erosion, it's not a few feet of ground that disappears. It could be upwards of 50 to 70 feet inward, inland that disappears, gone.

So it's an interesting pattern of weather we have now. As I tried to explain to my son yesterday when our neighbor was watering her plants, her flowers outside, as we turned on the TV or Internet to check in with my wife where it just snowed lots of inches of snow in Anchorage, and then Juneau just had a record snowfall at this time of year, which doesn't make sense for Juneau. They're trying to figure that one out. But it's very different than it was in the past, that's for sure.

Thank you all very much. And again, this gave us a lot of good information, a lot of opportunity to look at ideas, and this last panel I really appreciate some of the innovation that you all are doing in the private sector in organizations, because that, I think,

as we deal with the budget issues, we're trying to find innovative ways to continue to make sure we have robust weather prediction, and I think you all have offered some good suggestions and some ideas and food for thought here. So I think on behalf of both of us, we thank you very much.

The record will be open for 14 days for any additional questions we may have that we might submit to you. But again, thank you all very much, and at this time the meeting is adjourned. Thank you very much.

[Whereupon, at 12:13 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF JOHN D. ROCKEFELLER IV, U.S. SENATOR, WEST VIRGINIA

Today we will be examining the many important weather programs of the National Oceanic and Atmospheric Administration (NOAA). From the streams of data provided by environmental satellites, to the severe weather alerts of the National Weather Service, the products, services, and warnings that NOAA provides benefit all Americans. Every day, decisions are made based on NOAA weather information, whether it helps one decide to carry an umbrella, or to seek life-saving shelter during a storm.

This year has unfortunately shattered almost every weather record imaginable in the United States. Record-breaking snowfall, cold temperatures, extended drought, high heat, severe flooding, violent tornadoes, massive hurricanes—all of these events have amounted to the greatest number of multi-billion dollar weather disasters in our nation's history. For each of these record-setting events, human lives were lost, and entire communities and livelihoods were torn asunder. Thinking of the many Americans harmed, I believe the public's need for timely and accurate weather forecasts and emergency warnings could not be more critical.

Though the hardships of many are devastating, the death and destruction could have been far worse had it not been for the guidance and expertise of NOAA scientists, meteorologists, and climatologists. NOAA forecasts and warnings provided crucial lead times that protected property and saved lives. In my own state of West Virginia, innovations in forecasting have provided greater notice of flash flood events, allowing people to better protect their property and evacuate safely when needed. In times of emergency, minutes can save lives.

It's clear that NOAA atmospheric services are invaluable to all Americans, yet this year in a terrible demonstration of irony the agency's important functions have again been taken for granted. House Republicans have repeatedly sought to slash NOAA's budget and prohibit the agency from conducting basic research and weather observational science. As a result of continued underfunding and programmatic delay in NOAA's Joint Polar Satellite System, or JPSS, the nation faces the likely loss of essential weather forecasting capability in the coming years, because our current weather satellite capabilities will degrade before JPSS is launched and becomes operational. Such a gap would take our forecasting capabilities back decades, detrimentally hindering the ability to warn the public about severe weather events. This penny wise, pound foolish approach threatens to leave millions of Americans, communities, and first responders without the life-saving forecasting information we all expect and depend on to make timely decisions that ultimately save lives. This is a risk we cannot afford. I believe we must work now to mitigate the impacts of such a later gap in the most responsible and cost-effective way possible.

I have also supported NOAA's good governance proposal to better align the agency's atmospheric science and services. This would continue NOAA's mission of providing reliable and accurate scientific information and support services to a public looking for answers. This is why we're here today. We must assess if current NOAA weather services are meeting our growing needs. Where they are not, we need to find ways to fill those gaps and push for innovation. And we need to have a better grasp of the necessities of the future. This is not an easy task, but I'm confident that our two panels of witnesses can help us make a big step forward. I'm grateful to each witness for sharing your testimony and expertise with the Committee.

PREPARED STATEMENT OF DANIEL A. SOBIEN, PRESIDENT, NATIONAL WEATHER SERVICE EMPLOYEES ORGANIZATION

Thank you, Chairman Begich and Ranking Member Snowe, for inviting the National Weather Service Employees Organization to submit written testimony for the Subcommittee's hearing on the need for continued innovation in weather forecasting

and prediction. I am the Lead Emergency Response Meteorologist at the Tampa Bay Area Forecast Office and National President of NWSEO.

The 3,800 employees of the National Weather Service represented by our union are pleased that the Subcommittee considers this issue one worthy of attention. Our organization and its members have been encouraging the National Weather Service to develop innovative forecasting techniques, products and services for several years. I am pleased to report that through collaborative labor-management efforts, NWS and NWSEO have identified and are now in the early stages of implementing nine pilot projects to deliver innovative weather services to the Nation. We are also in the early stages of designing an additional seven pilot projects to implement in 2012. In order to pay for these projects and the additional forecasters that will be assigned to them, the union and the NWS's Chief Financial Officer jointly identified and agreed to efficiencies in current NWS operations and expenses, that will free up $50 million over 5 years. These cooperative efforts constitute a milestone in Federal sector labor-management relations, and demonstrate how public employee unions can be part of the solution to providing better services to the taxpayer despite tight fiscal constraints.

Nearly two decades ago, the National Weather Service underwent a $5 billion modernization and restructuring. By all accounts this modernization was a huge success; a recent National Academy of Sciences report found the NWS modernization; "allowed more uniform radar coverage and surface observations across the United States. Improvements were particularly evident in the forecasting and detection of severe weather such as tornadoes and flash floods. The probability of detecting these events improved over the course of, and after, the MAR, and the lead times of the warnings increased." But since that time, the agency has made only modest and incremental changes and improvements in service delivery. Last year, however, the NWS tested a pilot project to improve aviation forecasting services which it referred to as the "Golden Triangle." The NWS assigned three additional forecasters—one per shift—at the New York, Chicago and Atlanta Forecast Offices. These nine additional forecasters were charged with providing air traffic controllers with real-time site specific aviation forecasts. *Within 3 months, the assignment of these additional forecasters dedicated to aviation needs was responsible for reducing weather related air traffic delays by 50 percent when compared to periods of comparable weather in prior years.* (See chart attached hereto).

NWSEO and NWS used the success of this initial pilot as a basis for developing other test beds as part of the NWS's "*Weather Ready Nation*" initiative. Management and the union jointly solicited suggestions and proposals for local offices across the nation; local management and labor teams drafting proposals that were sent to the national level where they were reviewed and refined by senior management and union officials. The parties then agreed to move forward with the following pilot projects, which will involve approximately 27 new positions at the nine offices involved:

- A National Operations Center at NWS headquarters in Silver Spring that will serve as a national incident command center for multi-region or national large scale weather events; respond to sudden and unexpected demands for services that exceed NWS's local or regional resources; and liaise with other Federal agency command centers and assist with public information during large scale events.
- A Regional Operations Command Center at the NWS Southern Region headquarters in Fort Worth, Texas that will serve as an incident command center for regional large scale weather events and, among other products, prepare a twice daily Threat Briefing Package.
- An "Impact-Based Decision Support Services" program at the Sterling, Virginia (Washington, DC) Forecast Office staffed by three "Emergency Response Meteorologists" who will assist local and state emergency management agencies to with response to natural and man-made emergencies that have a weather related component (i.e, terrorism, toxic chemical discharge, or severe weather). One of these "ER Mets" will be embedded with the Maryland Emergency Management Agency, one at the FEMA National Capitol Regional Coordination office and the third will staff a Decision Support Desk at the Sterling Forecast Office and will support the needs of the Virginia Department of Emergency Management. They will be dispatched to field locations during emergencies to assist local authorities in decisionmaking in which weather plays a factor.
- A similar pilot program will be established at the New Orleans Forecast Office consisting of three Emergency Response Meteorologists who will test the provision of decision support services to local and state authorities for events impacting the coastal environment. This pilot will build on the experience which the

NWS gained in assisting Federal, state and local authorities during the Deepwater Horizon spill. These ER Mets will be prepared for dispatch to the site of disasters or to local emergency management operation centers.

- An "Ecosystem Forecasting" pilot at the Tampa Bay Forecast Office will provide enhanced coastal forecasts for maritime interests (*i.e.,* oil platforms) and new ecosystem forecasts for water temperature, salinity, currents and red tide. Hydrological runoff forecasts will be issued to mitigate the development and transport of harmful algal blooms. The forecasters will also serve as emergency response meteorologists for the Tampa area, which regularly hosts national security events such as the Super Bowl, the World Series and the 2012 Republican National Convention.
- A "Mesocale Science to Operations" pilot will be established at the Charleston, West Virginia Forecast Office that will attempt to improve localized short-fused warning lead-times of convective weather and flash flooding by applying new research on mesoscale (intermediate scale weather) forecasting techniques and models in an operational environment. The goal will be to provide more specificity in time and space in the forecasting of warning-level weather events.
- A pilot at the Boulder, Colorado Forecast Office will test the integration of the work of the NWS's Space Weather Prediction Center in Boulder to daily aviation forecasting.
- The MidAtlantic River Forecast Center in State College, Pennsylvania will test production of high resolution QPF (Quantity of Precipitation Forecasts) in a digital format for any point along rivers.
- The "Golden Triangle" pilot project will be expanded into San Francisco (Monterrey) Forecast Office in an effort to reduce weather-related air traffic delays in the San Francisco area.

Six of these pilot projects are in the early stages of staffing. Staffing for the Boulder, State College and Monterrey projects may be delayed until next year.

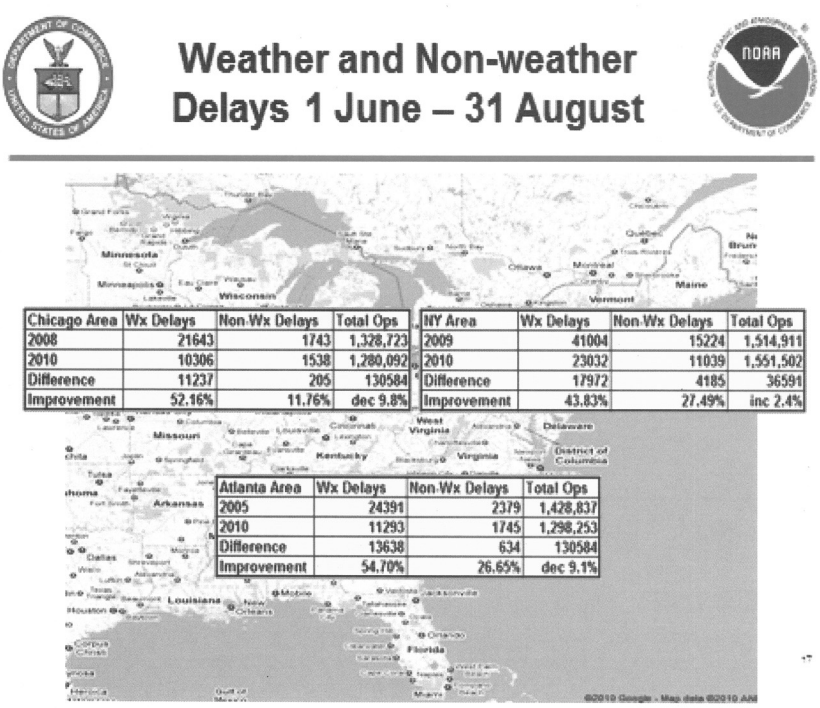
The NWS and NWSEO are in preliminary discussions about seven additional pilot projects for 2012. Five of these pilots will be located in "tornado alley"—Kentucky, Missouri, Alabama, Oklahoma and possibly North Carolina. The NWSEO and NWS jointly recognize that while much progress has been made over the past few decades in warning the public of tornado dangers, the capability of forecasters to give adequate lead time, accuracy and intensity forecasts of the strongest tornados is not adequate to allow the public to reach safety in many circumstances. In addition urbanization of areas prone to these extreme tornados has led to catastrophic situations such as the 2011 tornado season with over 500 fatalities reported. These pilots will incorporate the latest neighborhood scale modeling techniques in an attempt to improve lead times and accuracies to a point where residents can be evacuated from areas under a threat of extreme tornados. They will also test the concept of Emergency Response Meteorologists utilizing the latest communication technology to maximize warning effectiveness. Two other pilots under discussion will involve tsunami mitigation outreach efforts in Puerto Rico and the Pacific Northwest.

In addition to these national-level initiatives, regional NWS and NWSEO officials have agreed to a number of new initiatives to improve weather services in Alaska:

- The Alaska Aviation Weather Unit has implemented a new product called the Hazardous Weather Graphic that gives users information not covered in regular aviation forecasts such as solar activity that would cause jamming of communications; debris expected from wind or fires in long term situations; strong surface winds 3 days in advance and significant turbulence or low level winds shear expected in heavily trafficked areas. The AAWU will also be developing gridded forecasts of wind shear, turbulence and icing and other meteorological parameters up to 60,000 feet creating a "3-D" forecast.
- The Alaska Region has added a Decision Support Meteorologist in the Regional Office who has developed a social networking site on Facebook to assist the public in getting weather information during storms. The three forecast offices in Alaska contribute to this site as well. The Decision Support Meteorologist has enhanced communication between the NWS and the Alaska Department of Homeland Security and Emergency Management. An example is a daily conference call which he organized between the forecast offices, the state emergency management agency and the villages affected by the early November storm.
- A new forecast desk (and four additional forecasters to staff it around the clock on a rotational basis) at the Anchorage Forecast Office that will improve decision support services as well as watches/warnings and aviation forecasts for the forecast office's service area.

- Marine satellite phones are being deployed at several Weather Service Offices that allow the staff to receive calls from ships in remote Alaskan waters. The staff will receive marine observations from previously data-sparse waters in the Gulf of Alaska, Bering Sea and Chukchi Sea, which will improved forecast accuracy for those areas.
- The operations of the Sea Ice forecasting desk at Anchorage will be expanded to 7 days a week.
- The creation of a experimental Arctic Ocean Offshore Forecast from 60 to 200 nautical miles of the Arctic Coast of Alaska. Until 5 years ago, this area was iced over nearly year round. However, due to climate change, the Arctic Ice Pack has melted and there is now much open water in this area during the summer. This forecast in being developed in anticipation of further melting which will result in the movement of commercial ventures (oil exploration, shipping) into the area.

Our members appreciate the support of the National Weather Service that Congress has shown by full funding of the agency for Fiscal Year 2012. We hope we can count on your support for our efforts at innovation.



RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO HON. MARY M. GLACKIN

Projected Gap in Polar-orbiting Satellite Data

Question 1. In November, my staff met with Mary Kicza, Assistant Administrator for NOAA satellites. She was unable to indicate concrete steps that NOAA was taking to deal with the likely gap in satellite data, beyond the drafting of a Request for Proposal (RFP), to be issued by NOAA only after the loss of satellite capacity occurs. NOAA has repeatedly stated that full funding is necessary to minimize any gap, but recent reports even if the program received full funding going forward, a gap is still likely to occur. Shouldn't NOAA be pursuing a dual track of securing funding for JPSS while simultaneously proactively exploring opportunities to mitigate the forecasted loss of data?

Answer. There are no viable operational alternatives in the event that Suomi NPP (S–NPP) fails before JPSS–1 becomes operational. Neither the Department of Defense nor the Europeans, our well-established operational partners, fly weather satellites in the afternoon orbit. However, NOAA is taking several steps to plan for gap mitigation. First, the Assistant Administrator of NESDIS has tasked her team to look at ways of maximizing the life of S–NPP starting now. This includes conditioning the batteries, minimizing heat stress, minimizing fuel use, etc. The Suomi NPP satellite is flying the same instruments that will fly on JPSS–1. Second, NOAA will take a second look to determine if there is any way to move up the launch date of JPSS–1. At this point, moving up the launch date of JPSS–1 may not be possible simply due to the fact that it takes a certain amount of time to actually build the satellite and put it through the various testing required before launch.

Third, NOAA is also assessing other international missions, such as the China Meteorological Administration (CMA) Feng Yun 3B (FY–3B) satellite that is currently flying in the afternoon orbit with instruments similar to NASA EOS legacy satellites, however, the data will need to be analyzed to ensure it is of a quality comparable with current data streams. Currently, there are no other countries that are flying microwave sounders in the afternoon polar-orbit. NOAA will continue to assess whether other U.S. and international government or private sector satellites are launched that could provide the type of data that are needed for NOAA's numerical weather prediction models.

Fourth, NOAA will take a look at whether there are different, non-traditional ways of using data that we have not done before. To that end, the NOAA Administrator has directed NOAA's Assistant Secretary for Environmental Observations and Prediction to develop a written, descriptive, integrated, end-to-end plan that considers the entire flow from candidate alternative sensors through data assimilation and on to forecast model performance. She is assembling a team that includes independent technical consultants to make an enterprise-wide examination of contingency options that could be exercised in the event of a gap in polar satellite observations. This will include the use of alternative observations (from, *e.g.,* other satellites or in situ instrumentation), changes in data assimilation and/or modeling methods and so forth. The work being initiated by the NESDIS Assistant Administrator, mentioned above, will be included in this larger enterprise-wide assessment.

In addition, NOAA's National Weather Service is looking into ways to mitigate the impact to weather forecasts should a gap in polar afternoon orbital coverage occur. Unfortunately, many of those forecasts use Numerical Prediction Models as a primary input, these models rely heavily on polar data and there is no getting around the fact that any gap in polar coverage would impact the accuracy of model outputs.

Question 2. Given that a significant gap in satellite coverage in 2016 and 2017 is almost a certainty, what other types of data and infrastructure can NOAA utilize to ensure continuity in weather and climate forecasting capabilities?

Answer. NOAA assimilates many types of observational data (*e.g.,* satellite-derived observations, radar, aircraft observations, weather balloon profiles of the atmosphere, surface observations across the country, marine observations from buoys, ships, etc.) into numerical weather prediction (NWP) models. These models generate weather guidance, or weather forecast simulations via operational supercomputers, which are used by forecasters to provide accurate and reliable forecasts from hours to several days in advance. Despite NOAA's numerous sources of observational data, data from polar-orbiting satellites are unique because they provide global coverage that cannot be replaced by in situ data. Loss of polar-orbiting satellite data would result in degradation in forecast skill beyond day one for regional prediction and day three and beyond for global prediction.

NWS has assessed the impact to operations and all possible mitigations for the expected gap between Suomi NPP and JPSS. While we will continue to leverage our current data streams, there are no viable operational alternatives that will cover the projected data gap in the afternoon orbit that will occur due to the delayed launch of the first JPSS–1 satellite in the afternoon orbit. Neither Department of Defense nor the Europeans, our well established international partners, fly weather satellites that would provide global data in the afternoon.

Question 3. While recognizing the budget-constrained environment, what steps is NOAA taking to identify and secure alternate types of technology and infrastructure that aren't satellite-based?

Answer. Weather and climate forecasts and warnings use integrated observations from different systems such as satellites, radars, weather balloons, automated surface observing systems, and coastal weather buoys. NOAA operates a suite of computer weather models from global models to regional scale models to high resolution

local scale models. For regional prediction and forecasting, loss of satellite data can be partially mitigated through surface-based remote sensing, aircraft, and in-situ data.

Satellite data cannot, however, be replicated through ground observations. Any loss in satellite observations will decrease NOAA's ability to protect lives and livelihoods from extreme weather events. Polar-orbiting environmental satellites provide global coverage and other systems provide local in situ observations. Ninety four percent of data assimilated into numerical weather prediction (NWP) models is from satellites and 84 percent is from polar-orbiting satellites. Polar-orbiting satellites provide data required for Global NWP models needed for weather forecasting

Through the World Meteorological Organization (WMO), NOAA will continue to utilize access to worldwide data from the WMO's 189 member states and territories including ground stations and radiosondes. WMO facilitates the exchange, processing and standardization of observational data between its members. NOAA will continue to leverage this resource.

Prioritization of NOAA's Climate and Weather Data Collection Activities

Question 4. How does NOAA incorporate the needs of natural resource managers, policymakers, and the private sector when determining what types of weather and climate data it will collect?

Answer. NOAA's observation requirements are derived from the data needs of NOAA's operational and research programs which support Nation's operational need for weather forecasting and environmental monitoring. NOAA actively works with external partners such as the Department of Homeland Security, Department of the Interior, Department of Transportation to ensure that their mission needs are reflected in NOAA's mission requirements. NOAA's data policy of full, free, and open exchange of data facilitate the wide use of NOAA data by domestic and international users. NOAA continues to encourage the use of these data by these users. The NWS' mission is to provide weather, water, and climate data, forecasts and warnings for the United States, its territories, adjacent waters, and ocean areas for the protection of life and property and enhancement of the national economy. NWS regularly collaborates with users of these end products. To the extent possible, NWS incorporates other user needs as data are collected and processed; NWS makes the data available for open and unrestricted use, unless specific non-disclosure agreements are in place when private data sources are used.

An example of NOAA's incorporation of external partner needs is the Weather-Ready Nation initiative—a collaboration of government agencies, researchers, and the private sector to:

- Improve precision of weather and water forecasts and effective communication of risk to local authorities;
- Improve weather decision support services with new initiatives such as the development of mobile-ready emergency response specialist teams;
- Provide innovative science and technological solutions such as the nationwide implementation of Dual Pol radar technology, Integrated Water Resources Science and Services, and the Joint Polar Satellite System;
- Strengthen joint partnerships to enhance community preparedness;
- Work with weather enterprise partners and the emergency management community to enhance safety and economic output and effectively manage environmental resources.

Question 5. What types of weather and climate data are given highest priority, and why?

Answer. No one type of weather or climate data is given highest priority. Weather and climate forecasts and warnings use integrated observations from different systems as varied as satellites, radars, weather balloons, automated surface observing systems, and coastal weather buoys. The mix of observations also depends on the weather event being monitored. For example, the instruments used to monitor a hurricane versus a tornado are quite different. Also, different observations are required depending on how far out the forecast is in time. Short term weather forecasts would be more likely to utilize a combination of radar data, geostationary satellite data, and other surface observing data whereas weather forecasts further than three days out would rely more heavily on polar satellite data, and climate forecasts depend on observations from the Tropical Ocean Array data buoys as well as a suite of other technologies. While 94 percent of data assimilated into numerical weather prediction models are from satellites and 84 percent is from polar-orbiting satellites, the quantity of observations does not necessarily reflect a priority of importance.

Question 6. Are there any types of data that public or private sectors routinely request from NOAA that are currently not being collected by the agency?

Answer. In general, no. However, while NOAA can supply meteorological data for a given weather station on a given date or over time, that data may not be representative of a nearby location of interest to a third party. It is common knowledge that weather can be quite variable over short distances, and additional information and analysis may be needed to adequately describe the weather at the secondary location. NOAA views this as a private sector role. (see more at *http://www.nws.noaa.gov/im/* and *http://www.noaa.gov/partnershippolicy/*)

NWS primary responsibility is to collect and process data needed to meet NWS mission requirements. The NWS' mission is to provide weather, water, and climate data, forecasts and warnings for the United States, its territories, adjacent waters, and ocean areas for the protection of life and property and enhancement of the national economy. To the extent possible, NOAA works to accommodate the needs of our other external partners, but our primary responsibility remains to provide forecasts to the American public to protect lives and property. NWS makes the data available for open and unrestricted use, unless specific non-disclosure agreements are in place when private data sources are used.

NOAA continues to explore opportunities to partner with private and public and international environmental observational networks.

Proposed Climate Service

Question 7. In the FY 2012 President's budget request for NOAA, the agency proposed a reorganization of its existing climate related programs, which are currently housed in multiple NOAA line offices, into a single line office. NOAA says that this will result in a line office dedicated to climate research in the same way that the Weather Service line office is dedicated to weather research. Since the Climate Service is purported to be "budget neutral" and will not add any new programs, in what ways would reorganization improve NOAA's climate science services?

Answer. Building on efforts initiated in the previous Administration, NOAA proposed reorganizing climate resources into a new line office, the NOAA Climate Service Line Office, in the President's Fiscal Year (FY) 2012 budget. This proposal was not included in the final FY 2012 Appropriations Act that President Obama signed in November 2012.

Question 8. Would new activities be undertaken within this proposed Climate Service in the future? If so, what types of activities would be anticipated?

Answer. The proposal to reorganize NOAA's climate resources into a new line office was included in the President's FY 2012 budget request; however, it was not included in the FY 2012 Appropriations Act that President Obama signed in November 2012.

Question 9. Some have raised concerns that a NOAA climate service would be rigid, jurisdictionally narrow, and inherently non-collaborative, given it being housed in one agency. How is NOAA addressing these concerns to ensure its proposed climate service could effectively address the diverse needs of multiple agencies, jurisdictions, and stakeholders?

Answer. The proposal to reorganize NOAA's climate resources into a new line office was included in the President's FY 2012 budget request; however, it was not included in the FY 2012 Appropriations Act that President Obama signed in November 2012. As a sound steward of American taxpayer dollars, NOAA will continue to work as efficiently and effectively as possible under our current organizational structure and within the resources we are provided to meet the growing public demand for information—including access to NOAA's information assets, and enabling improved information sharing and more productive partnerships with a broader enterprise that includes: Federal agencies, local governments, private industry, other users, and stakeholders.

Leveraging Private Sector Capabilities

Question 10. Several witnesses today spoke about the benefits that NOAA and the private sector share when leveraging each other's weather data. For example, Bob Marshall highlighted the value of a national comprehensive weather observing system—an integrated network or meteorological sensors that complements and enhances NOAA's own array of sensors—so as to provide more accurate and faster warning capabilities throughout the country. Similarly, the National Research Council professed the same benefits of a National Mesonet in their report "From the Ground Up: A Nationwide Network of Networks."

However, NOAA has never requested funding for a National Mesonet. For the past few years, the Senate has understood the potential of such a partnership by including funding the National Mesonet in NOAA's annual appropriation bills. Out

of a roughly $1 billion budget for the National Weather Service, the National Mesonet has only accounted for $8 million to $19 million. It appears that at the most, that's 2 percent of NOAA's budget for what has amounted to a relatively significant increase in weather data capacity for NOAA. Why has NOAA not requested funding for the National Mesonet?

Answer. The President's Budget reflects the Administration's highest priorities for maintaining NOAA's weather observing systems and assets. NOAA recognizes the value of leveraging data from local observing networks or "mesonets" which provide denser, local scale detail of the weather and environment. This information can be effectively used to improve short and local forecasts in areas with this local data. NWS will use FY 2012 funding to convene a peer-reviewed study to develop a plan for NOAA's role in a National Mesonet, with recommendations for implementation as appropriate.

Question 11. Please explain whether NOAA has—or has not—achieved value in this public private partnership.

Answer. NOAA recognizes the value of leveraging data from local observing networks or "mesonets" which provide denser, local scale detail of the weather and environment. This information can be effectively used to improve short and local forecasts in areas with this local data. Mesonet system data are used in NWS operations as supplemental data sources. Mesonets are broadly consistent with the spirit and recommendations of From the Ground Up, in that they provide the types of observations that augment NWS's ability to detect, forecast, and warn for localized, high-impact weather events. NOAA will continue its current approach to developing a National Mesonet by leveraging existing networks (operated by state and local governments, the private sector, and other Federal agencies), when and where available.

A key to successfully leveraging existing data is to gather and provide detailed and enhanced metadata ("data about the data").

Question 12. The Commerce Committee remains strongly committed to the success and swiftest possible implementation of the Joint Polar Satellite System. However, it is clear to me that we must simultaneously continue to invest in additional, cost-effective innovations to ensure a weather-ready nation. As we face the gap in polar-orbiting weather satellite coverage, how will NOAA better integrate data and information from public private weather partnerships, such as the National Mesonet, to augment—or even improve—forecasts and warnings? Specifically, will NOAA incorporate data from the lightening mapper that Mr. Marshall spoke about in his testimony into NOAA's models? If not, why not?

Answer. NOAA applauds the Committee's recognition of the importance of investing in cost-effective innovations to ensure a Weather-Ready-Nation. While there are no viable operational alternatives that will cover the projected data gap that will occur due to the delayed launch of the first JPSS–1 satellite in the afternoon orbit, NOAA will continue to work with the private sector to obtain mesoscale observations whenever possible and cost-effective. For example, NOAA is working with the renewable energy sector to investigate the use of local scale data in NWS numerical weather prediction models to provide more accurate and timely weather forecasts that can be used by both NWS forecasters and private sector forecasters.

Mr. Marshall references the GOES–R Lightning Mapper (GLM), which will provide total lightning data (cloud-to-ground and in-cloud flashes) for the entire Western Hemisphere, complementing and expanding beyond existing ground-based systems. NWS currently obtains mainly cloud-to-ground lightning data from terrestrial networks. NOAA is assessing other research-based terrestrial systems which provide total lightning data. Total lightning data offers more information about storm severity and structure than cloud to ground lightning data and continuous monitoring of total lightning flash rate from the GLM is expected to improve tornado and severe storm warning lead time and improve hurricane track and intensity forecasts. Total lightning data from this research is used to simulate the data that will come from the GLM. Researchers are in turn using this simulated data in different local scale numerical weather prediction models to assess potential forecast improvement particularly in data-sparse regions where radar and other observations are not available.

In order to continue to improve weather forecast skill, NOAA is and will continue to invest in the science of better understanding environmental processes, improved modeling and data assimilation, and the supporting computing infrastructure.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO HON. MARY M. GLACKIN

Spectrum

Question 1. The National Telecommunications and Information Administration (NTIA) evaluated four spectral bands currently in government use for possible 'Fast Track' reallocation for wireless broadband service within the next five years. One spectral band they considered was the 1675–1710 MHz band used for downlinks from geostationary and polar-orbiting weather satellites that are administered by NOAA. This weather data is directly accessed by any number of Federal, state, and tribal government first-responder agencies in support of their missions. Additionally, foreign polar satellites also transmit signals to the United States in this band under international agreements.

NTIA recommends that "15 megahertz (MHz) of the 1675–1710 MHz (specifically 1695–1710 MHz) spectrum could be made available for wireless broadband use within five years, contingent upon timely allocation of funds to redesign the Geostationary Operational Environmental Satellite-R satellite and other costs the National Oceanic and Atmospheric Administration (NOAA) and other Federal agencies will incur in connection with sharing this spectrum."

Please provide the list of actions NOAA needs to take over the next five years in order for the agency to share the 1695–1710 MHz band with the wireless broadband service? How much will these actions cost? How will they be paid for? How far along is NOAA in its planning activities? In particular, what is the potential impact on design, development, and deployment of JPSS?

Answer. NOAA currently operates a number of polar-orbiting and geostationary operational environmental satellites in the 1675–1710 MHz range. NOAA and its European mission partner, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), operate polar satellites using identical direct broadcast imagery systems in the 1695–1710 MHz band. Assets that are currently in orbit cannot be retrofitted to change the transmission frequency. NOAA expects replacement satellites to be launched by 2017 for the Joint Polar satellite System and 2015 for the Geostationary Operational Environmental Satellite-R Series.

In November 2010, the Department of Commerce, through its National Telecommunications and Information Administration (NTIA) and working with other impacted Federal agencies, including NOAA, concluded a months-long analysis in response to the President's June 2010 Broadband Initiative. In the report, *Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675–1710 MHz, 1755–1780 MHz, 3500–3650 MHz, and 4200–4220 MHz, 4380–4400 MHz Bands (Fast-Track Report),* the Department recommended—and has formally proposed to the Federal Communications Commission—that a 15-megahertz portion of the band, 1695–1710 MHz, be made available for commercial use within five years, in a manner that protects critical government sites via exclusion zones. The exclusion zones would protect key earth station sites, including NOAA's operational facilities, to minimize the likelihood of interference. Devices or reception sites that operate outside of these exclusions could face interference.

NOAA is also participating in an NTIA-led engagement process with industry to develop options for repurposing this spectrum that maximizes its commercial use, while protecting essential NOAA capabilities. This may include more detailed interference modeling, which could allow for smaller exclusion zones, moving downlinks to less populated areas or other options.

NOAA expects additional costs from redesigning observational systems and technical studies related to potential interference issues. NOAA is still evaluating the potential cost impacts and costs would be incorporated into its transition plan as required by the Middle Class Tax Relief and Job Creation Act of 2012. Examples of modifications that would entail additional costs include:

GOES–R: NOAA's next generation geostationary satellite program (GOES–R), which is currently under development for launch mid-decade, redesigned its direct broadcast communications subsystem to move below 1695 MHz to comply with the spectrum sharing regime identified in the Fast-Track Report. Changes to current contracts were executed and costs paid using GOES–R Program contingency funds.

Radiosondes: As a result of the GOES–R redesign, NOAA's radiosondes (balloon-borne instruments for atmospheric measurements) require redesign to reduce spectrum usage in time to support the GOES–R redesign. Redesign of NOAA systems attributable to making the frequency available for auction is expected to be paid for by auction proceeds.

Additionally, NOAA is eligible for funding for certain pre-auction planning costs, consistent with the terms articulated in the Middle Class Tax Relief and Job Creation Act. Funding from the Spectrum Relocation Fund, where proceeds from auctions of spectrum previously used by Federal agencies is held, is contingent upon approval by a technical panel, comprised of representatives of NTIA, OMB and the Federal Communications Commission, of a NOAA transition plan. NTIA is creating the procedures for the panel now and NOAA is working with NTIA to develop its transition plan.

Question 2. My understanding is that NOAA intends to establish wireless radio 'exclusion zones' surrounding satellite downlink sites to help minimize the impact to meteorological services from harmful interference. How many exclusion zones are being proposed? What are the sizes of the exclusion zones? How practical is this approach? Do you believe use of exclusion zones will diminish the relative value of the spectrum?

Answer. In the report, Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675–1710 MHz, 1755–1780 MHz, 3500–3650 MHz, and 4200–4220 MHz, 4380–4400 MHz Bands (Fast-Track Report), the Department recommended—and has formally proposed to the Federal Communications Commission—that a 15-megahertz portion of the band, 1695–1710 MHz, be made available for commercial use within five years, in a manner that protects critical government sites via exclusion zones. The exclusion zones would protect key earth station sites, including NOAA's operational facilities, to minimize the likelihood of interference.

The report proposed exclusion zones around 18 Federal ground stations, of which five are critical to NOAA meteorological satellite operations. The other 13 sites are non-NOAA U.S. Government user locations. The exclusion zones proposed for protection of these five ground stations range in size from 90 km to 121 km. Proposed zone size varies from site to site due to differences in receiver characteristics, topography and other factors.

NOAA is not well-positioned to assess the relative value of the spectrum. However, NOAA is participating in an NTIA-led engagement process where Federal agencies and industry are working together to develop options for repurposing this spectrum that maximizes its commercial use, while protecting essential NOAA capabilities. This may include more detailed interference modeling, which could allow for smaller exclusion zones, moving downlinks to less populated areas or other options. Also, the model used to determine the exclusion zone sizes proposed in the Commerce report did not fully consider anomalous propagation because it was not clear whether this effect is applicable when considering the aggregate interference from a deployment of geographically dispersed commercial handset as analyzed in the Fast Track Report. Through the NTIA process, NOAA will have a better understanding of the technical and deployment parameters of the commercial systems and the potential risks to in-band and adjacent band earth station receivers. Based on the additional information for the commercial systems further modeling may be necessary before an auction or license conditions to clarify NOAA's protections.

Question 3. Are you concerned that there may be out of band emissions from wireless devices operating in the 1695–1710 MHz band that may impact the operations of radiosondes (weather balloons) and sensors (many of which are unlicensed) in the 1675–1695 MHz band? If so, what steps can NOAA take to help minimize the impact of harmful interference?

Answer. Yes, out-of-band emissions are always a concern for operational impacts. NOAA radiosondes operate on National Telecommunications and Information Administration (NTIA) authorized (licensed) frequencies. Out-of-band interference analyses will be performed as part of the radiosonde system redesign process. Any out-of-band interference concerns will be brought to the attention of the NTIA Interdepartment Radio Advisory Committee (IRAC) so that the concerns can be addressed during the NTIA/FCC process for reallocation of the 1695 to 1710 MHz band. NOAA will also improve the receiver out-of-band rejection performance as part of the radiosonde system redesign effort, when funding for repurposing the existing Federal allocation becomes available.

JPSS

Question 4. How long can NOAA wait to launch JPSS–1 before our weather modeling systems begin to suffer?

Answer. NOAA currently estimates that JPSS–1 will launch no later than the second quarter of FY 2017. As such, NOAA cannot afford to have any further slips to the JPSS–1 launch date without further increasing the already high risk of a loss of data for numerical weather prediction (NWP) models and impact to the accuracy of National Weather Service forecasts and warnings.

The Suomi NPP satellite is currently expected to provide suitable data for weather forecasting through mid-2016. Assuming Suomi NPP provides data as planned, there is a high probability of a gap in data from the afternoon orbit from the end of the Suomi NPP mission until JPSS–1 has completed its in-orbit calibration and validation phase. NOAA is utilizing its resources to ensure that the launch date for JPSS–1 does not slip any further. In the absence of data from the afternoon orbit from an operational polar-orbiting satellite such as either NOAA's POES or Suomi NPP satellites, there will be an immediate degradation to the National Weather Service's numerical weather prediction (NWP) models.

Question 5. Will the geostationary satellite system (GOES–R) maintain weather prediction at or near current levels during the gap in JPSS coverage? If not, how will coverage now be different during the gap including GOES–R in your analysis?

Answer. The instruments on the current Geostationary Operational Environmental Satellite (GOES) cannot be used as a substitute for future Joint Polar Satellite System (JPSS) mission data needs and requirements. NOAA GOES and Polar-orbiting Operational Environmental Satellite (POES)—JPSS is a POES satellite—constellations were developed to provide complementary space-based data to meet NOAA's weather, ocean, space weather and climate mission.

GOES does not provide the global coverage that POES provides. GOES satellites cover the Western Hemisphere that includes eastern Pacific to the western Atlantic and from southern Alaska to South America. The imagers and sounders on GOES satellites are optimized to provide the coverage that is required for a geosynchronous orbit (*i.e.,* providing environmental data over fixed geographic regions). Data from GOES satellites, in conjunction with Doppler radar, are used for "nowcasting" severe weather events as they unfold; POES data cannot provide the same constant observations that GOES provides.

Polar-orbiting satellites (current POES and the future JPSS) circle the Earth longitudinally from the North Pole to the South Pole and provide environmental data at periodic intervals over the entire globe. These global measurements are vital for the accuracy and reliability of the National Weather Service's computer weather models that forecast the weather at 3 days and beyond. Additionally, polar-orbiting satellites provide satellite imagery over data -sparse areas like parts of Alaska above 60 degrees latitude. Access to these data has proven critical to protecting the people of Alaska and the U.S. Pacific Insular Areas because GOES satellites are unable to image accurately in those areas.

In conclusion, NOAA's polar orbiting and geostationary satellite systems provide mission critical, complementary data that is minimally redundant. NWS needs both the global coverage and higher resolution of polar orbiting satellites, and the "constant look" of the geostationary satellites to provide the full spectrum of short-term weather warnings to long-term forecasts.

Question 6. In preparation for the gap in weather satellite coverage, is NOAA working with military, other governments and/or corporations, which have weather satellite capability to meet the United States weather prediction needs?

Answer. There are no viable operational alternatives which will cover the projected data gap in the afternoon orbit that will occur due to the delayed launch of the first JPSS–1 satellite and the end of life of Suomi National Polar-orbiting Partnership (Suomi NPP) in the afternoon orbit. Neither Department of Defense nor the Europeans, our well-established operational partners, fly weather satellites in the afternoon orbit.

NOAA is also assessing other international missions, such as the China Meteorological Administration (CMA) Feng Yun 3B (FY–3B) satellite that is currently flying in the afternoon orbit with instruments similar to NASA EOS satellites.

NOAA will continue to assess whether other U.S. and international government or private sector satellites are launched that could provide the type of data that are needed for NOAA's numerical weather prediction models.

In addition, NOAA's National Weather Service is looking into ways to mitigate the impact to weather forecasts should a gap in polar afternoon orbital coverage occur. Unfortunately, many of those forecasts use Numerical Prediction Models as a primary input, these models rely heavily on polar data and there is no getting around the fact that any gap in polar coverage would impact the accuracy of model outputs.

Question 7. We learned from NOAA that there has been internal reallocation of funding to meet the immediate funding needs of the JPSS program. How much funding was reallocated to JPSS?

Answer. The FY 2011 Consolidated Appropriation bill amount continued the FY 2010 funding level of $382.2 million for the JPSS Program. The Administration determined, and the Congress approved, an additional $89.7 million for the JPSS Pro-

gram in the FY 2011 Spend Plan for a total of $471.9 million. The total of $471.9 million represents the amount NOAA established for the program in FY 2011.

In FY 2012, the Congress appropriated $924 million of the President's Budget Request of $1.070 billion for the JPSS Program. In FY 2013, NOAA requests $916.4 million for the JPSS Program.

Question 8. Which program or line offices had funding redirected to meet the needs of the satellite program? How much funding did each of these program or line offices loose?

Answer. The Administration's FY 2011 spend plan for JPSS is $471.9 million from funds appropriated to the Department of Commerce by PL 112–10. Given the importance of JPSS in maintaining the Nation's weather prediction capabilities, NOAA received Congressional approval to allocate that amount to JPSS for FY 2011 to support critical work on the spacecraft, instruments, and mission operations and sustainment activities. A portion, $39.8 million, of the $89.7 million increase in FY 2011 for the JPSS program was provided though a transfer from other bureaus within the Department of Commerce.

Question 9. Did any of these programs impact critical data required for fisheries management: observer coverage, stock assessment data, or ship time?

Answer. The FY 2011 Spend Plan represents a comprehensive strategy that aims to address multiple and interrelated missions of the agency. We believe that all of these missions have considerable value to the Nation. Given the importance of JPSS in maintaining the Nation's weather prediction capabilities and with Congressional approval, NOAA chose to allocate $471.9 million to the JPSS program for FY 2011 to support critical work on the spacecraft, instruments, and mission operations and sustainment activities.

Core fisheries research and management activities funded by NMFS are supported by the Fisheries Research and Management sub-activity. Between FY 2010 and FY 2011 funding for this sub-activity increased by $5.6M ($432.9M and $438.5M respectively). This funding supports NMFS Regional Science Centers which provide the scientific knowledge base for the management and rulemaking process supported by NMFS Regional Offices and Regional Fishery Management Council and Interstate Marine Fisheries Commissions, which are also supported with this funding. Funding is also included specifically for stock assessments and survey and monitoring projects which provide data on abundance, distribution, and biological characteristics of fish stocks, the scientific basis for setting annual catch limits and other fishery management measures.

The NOAA fleet provides the base data collection platforms to support fisheries research and management. The FY 2011 spend plan funded the NOAA fleet to allow for maximum utilization in FY 2011 without the need for Program Funded Days at Sea. FY 2011 actual base funded Days at Sea were 2,609. This is an increase from FY 2010 base funded Days at Sea of 2,395.

Dual Polarization Doppler Radar Installation and Early Lessons

Question 10. Over the last two years, NOAA was appropriated $9 million to acquire and install a coastal Doppler radar in Washington state.

Please quantitatively describe how the new dual polarization Doppler radar has improved weather prediction and forecasting in Washington state.

Answer. The NEXRAD program is a tri-agency effort between NOAA/Department of Commerce (DOC), The Department of Defence (DOD), and the Federal Aviation Administration in the Department of Transportation. The new Dopplar radar installed in Western Washington State is an example of excellent synergy between NOAA and DOD. Key NEXRAD assets for this project were transferred to NOAA/NWS from the DOD Keesler, MS, Air Force Base maintenance and training facility, which no longer had the requirement for the equipment.

This is the first winter in which dual-polarization radar (dual-pol) data are available. NWS will continue to analyze the data and quantify the radar's contribution to improved weather prediction. However, qualitative benefits are already known. For example, the coastal radar has been used to issue and refine high wind warnings along the coastal zone. In one case, the radar indicated stronger winds than expected from the forecast models and provided the knowledge necessary for the forecaster to put up the warning before the winds hit. The dual-pol capability has allowed the NWS to detect the transition from rain to snow near the surface and accurately detect the elevated warm layer needed to form freezing rain or sleet. During the 19 January ice storm, NWS forecasters were able to better detect the developing event (leading to Emergency Alert System activation) and were able to monitor the freezing rain intensity and location with frequent updates to the emergency management community.

The coastal radar has improved our forecast and warning capability for areas that previously did not have radar coverage. The new radar also provides NWS forecasters with estimated location/intensity/amounts of precipitation in areas of Southwest and Coastal Washington that previously were terrain blocked to other radars. We believe the improved understanding of rainfall amounts and snow level has already provided information for more accurate flood forecasting than would have been provided if the new radar was not in place.

Question 11. Some local weather programs, such as Seattle's Storm Watch, are not yet incorporating the new dual polarization Doppler radar data. Is NOAA working with small local weather forecasters to ensure effective and timely use of dual polarization data?

Answer. NOAA provides the operational dual-pol and legacy radar data in real-time through multiple data access points and providers. Our partners are encouraged to use these data in application development and in providing commercial services. Specifically regarding the new radar data in Washington State, the data are going directly to the University of Washington and they are processing and posting them to a live web page for others to use. They are also currently assessing the value of adding these new data to their Rain and Snow Watch programs. NOAA stands ready to assist them in this process. To help private sector/media meteorologists and non-meteorologists understand how to use dual-pol, NOAA developed an on-line dual-pol training module series. The local WFO is also working with local media to provide "lessons-learned" training following this first winter season.

Question 12. How is the new Doppler radar funding pushing national weather prediction and modeling forward? In other words, how are algorithms developed for the Washington state dual-pol Doppler radar being utilized nationally?

Answer. Precipitation algorithms developed for the Washington dual-pol radars will be employed by all the radars in the west and mountainous region. The precipitation algorithms are specific to western radars and mountainous terrain, and useful for orographic (mountain) precipitation situations. Algorithms for rain/snow delineations are useful nationwide. Other algorithms are more useful in the plains states and used for tornado detection.

Question 13. In addition to acquiring the new Doppler, Washington state is now the first state to have complete dual polarization Doppler radar coverage. How is NOAA handling this new influx of data? Has NOAA acquired the super computers required to adequately employ this new, high quality data into weather prediction models?

Answer. The additional data from the dual polarization capability is incorporated into the national radar network and used by local NWS forecast offices and NWS National Centers for Environmental Prediction. The existing NWS Advanced Weather Interactive Processing System (AWIPS) has the capacity to handle this additional data, and the data is used by the forecasters and incorporated into their forecasts and warnings. No additional supercomputing resources are necessary for this data. Since radar commissioning, NOAA has been collecting, distributing, and archiving data from the new Washington radar similar to other network radars and making the data available to the public and all users. NOAA continues to develop the capability and capacity to include data from the Doppler radar network into its computer models. The data are most useful in NOAA's short-range models and are being incorporated at this time.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. AMY KLOBUCHAR TO HON. MARY M. GLACKIN

Improvements to Timely and Relevant Forecasting and Prediction

Question 1. One of the biggest impacts NOAA has on my state is making sure that communities have up to the date and accurate weather information. Floods are an annual issue for communities across Minnesota, and last year we led the Nation with 145 confirmed tornadoes. That's more than Kansas and Nebraska combined. We are not supposed to be number one in this category. Will the work that NOAA is doing help us to not only better predict and prepare for severe weather, but also help understand and develop new weather trends that may be developing?

Answer. Yes. NOAA invests in the prediction and understanding of the environment. NOAA's National Weather Service strives to continuously improve operational weather, water and seasonal climate watches, warnings and forecasts by investing in advanced technologies including models, supercomputers, observations and leveraging other NOAA investments and partner's investments. NOAA's Office of Oceanic and Atmospheric Research invests in research and development of the next

generation science and technology for weather and climate prediction including understanding new developing weather trends. NOAA also leverages and relies on a national and international investment in weather and climate science including academia, government agencies, and non-governmental organizations. These investments enable the Nation to better prepare for and respond to severe environmental events.

Question 2. Is the science for flood forecasting continuing to improve, or have we reached a plateau for the accuracy of our flood forecasts?

Answer. Advancements in hydrological science and service delivery enable continuing improvement in flood forecasting lead times and accuracy. NOAA's Advanced Hydrologic Prediction Service (AHPS) provides the Nation with improved forecast and decision support tools including scenario based uncertainty information at more than 3000 specific locations along the Nation's rivers and water ways. NOAA's Community Hydrologic Prediction System (CHPS), a new and advanced open software architecture hydrological modeling system will become operational in FY 2012. These technologies are among the suite of tools that will enable NOAA to continue to improve flood and flash flood forecast skill. In addition, ongoing nationwide deployment of dual polarization of the NEXRAD (Next-Generation Radar) network in FY 2012 and 2013 will enable improved estimates of precipitation type and amount, leading to better flash-flood forecasts and warnings.

In order to explore further opportunities for improving water and flood forecasting, NOAA is working to leverage interagency investments. In 2009, NOAA, the U.S. Geological Survey (USGS) and the U.S. Army Corps of Engineers (USACE) launched a new partnership called the Integrated Water Resources Science and Services (IWRSS). In May 2011, this partnership was formalized through a Memorandum of Understanding signed by the three agencies. Specifically, NOAA seeks to accelerate flood forecasting skill and create flood maps over a larger geographic region by leveraging USACE's Core Water Information Management System (CWMS) flooding and inundation modeling capability and USGS' WaterSMART National Water Information System.

On September 22, 2011, NOAA announced the award of a contract to build a new National Water Center (NWC) in Tuscaloosa, Alabama, which will be ready for initial occupancy in mid-2013. The NWC will create a first-of-its-kind national center for water forecast operations, research and interagency coordination. The NWC will be staffed by multiple Federal partner water agencies to ensure strong coordination and collaboration. The NWC will be the nerve center for coordinated water resources forecasts and decision support from floods to droughts and minutes to years.

Interagency Coordination

Question 3. In Minnesota, whether it's flooding or tornadoes, we also work closely with the Federal Emergency Management Agency (FEMA). How does NOAA affect disaster response efforts by Federal agencies such as FEMA?

Answer. NOAA/NWS works with the Department of Homeland Security (DHS), including FEMA, to prepare for, and respond to disasters. NWS provides weather information to emergency response decision makers at multiple organizational levels as critical decisions are made in anticipation of and in response to weather or water events. NWS has a liaison position embedded at FEMA Headquarters as well as at the DHS National Operations Center to coordinate weather from a national perspective and provide decision support services. NWS also provides on-site support to FEMA Regional Headquarters Offices when damaging weather is expected. NWS provides specific webinars to impacted state and local emergency management offices, if resources cannot be provided for on-site support in the field. NWS support for FEMA and state and local emergency management continues after the event to ensure response efforts have the weather information available when they make their decisions.

Question 4. Are there ways we can improve coordination, so that we can identify possible extreme weather events quicker, and respond to them in a timelier manner?

Answer. NWS will continue to improve its forecast and warnings, including possible extreme events. For FY 2012, NWS is beginning six pilot projects as part of NOAA's Weather-Ready Nation Initiative designed to improve coordination for the emergency management community and to improve effective response by the public and business community as necessary. These pilot projects will help set the direction for NWS services of the future to better meet its protect life and property mission.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO HON. MARY M. GLACKIN

Question 1. In a particularly troubling section of the Inspector General's report, the report describes the efforts of both the National Weather Service's National Centers for Environmental Prediction (NCEP) as well as the National Environmental Satellite, Data and Information Service (NESDIS) (pronounced NEZ-diss) to seek solutions to the anticipated data gap in the afternoon polar satellite orbit.

While it is positive that efforts are being made to mitigate the risk of a data gap, the report also noted that there was "little evidence that these efforts are being tracked or coordinated across NOAA's line offices." NOAA has agreed with the recommendation to increase coordination across line offices and take a "NOAA-wide" view. To what do you attribute this communication breakdown between line offices? What specific steps are being taken to remedy it?

Answer. We do not believe there has been a "communication breakdown between line offices," nor did the report state that there was a breakdown. Instead, NCEP, NWS, and NESDIS had been focusing on their own priorities, reflecting the high visibility of internal efforts to clarify and quantify the impact of the potential data gap within each NOAA Line Office. The Office of NOAA's Deputy Under Secretary for Operations continually works across NOAA Line Offices to discuss and establish plans to address possible gaps in polar coverage to minimize the degradation of weather and climate forecasting.

The decision to end the NPOESS Program in 2010 and initiate the JPSS Program has resulted in the need to modify the means by which coordination occurred.

With the JPSS Program NOAA is engaging in a wide-ranging dialogue about the importance of data from NOAA's satellites to meet NOAA's missions and goals. This dialogue has received high visibility since many of the measurements are used by NOAA programs in conjunction with external partners. There has been, and continues to be, constant programmatic and scientific coordination among the NOAA Line and Program Offices. Examples of these coordination activities include:

- *NOAA Program Management Council (PMC):* The PMC provides the forum for regular review and assessment of selected NOAA programs and projects. All NOAA Line-Offices are represented.
- *Environmental Satellite Users Group (ESUG):* The ESUG is a recently reorganized user collaborative forum comprised of operational and research users of environmental satellite data. Participants are from the NOAA Line and Program Offices, the National Aeronautics and Space Administration (NASA), the U.S. Air Force, the U.S. Navy, and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).
- *NOAA Observing System Council (NOSC)/Low earth-Orbiting Requirements Working Group (LORWG):* The NOSC is a forum for coordinating earth observing and environmental data management activities across NOAA. The LORWG manages the key requirements documents for the NOSC, which includes the JPSS Program's Level 1 Requirements Document.
- *Joint Center for Satellite Data Assimilation (JCSDA):* JCSDA is a forum dedicated to developing and improving the ability to exploit satellite data more effectively in the United States. Representatives include senior leaders from NOAA, NASA, the U.S. Air Force, and the U.S. Navy.
- *NOAA/NESDIS Satellite Products and Services Review Board (SPSRB):* SPSRB is responsible for the oversight and guidance necessary to effectively manage the satellite product life cycle process. This process ensures satellite products are provided to all NOAA Line Offices, a wide range of Federal government agencies, international users, state and local governments, and the general public.

To ensure Line Office coordination continues to provide a NOAA-wide/enterprise mitigation effort on the potential data gap, NOAA Administrator Jane Lubchenco, NOAA's Deputy Administrator Kathryn Sullivan, and myself as the Deputy Under Secretary for Operations, have initiated dialogue between NOAA Line and Program Offices through multiple meetings including the PMC, the NOSC, and one-on-one meetings with senior managers.

Recently, the Assistant Administrator for Satellites and Information Services initiated directed requests for input from fellow Assistant Administrators and Program Office Directors seeking input on their space-based data requirements from all the systems in NOAA's satellite portfolio.

Question 2. One of the potential risks that could cause a gap in polar satellite data continuity would come from the NPOESS (EN-pose) Preparatory Project (NPP)

satellite, which was just launched on October 28, or its sensors, failed prior to the launch of the JPSS–1 satellite, now estimated to occur five years from now in early 2017. A June report by the NASA Inspector General reported that the NPP sensors *may only last three years* because of problems in the development and testing of these sensors that compromised their integrity. These sensors were *supposed to last seven years* because the satellite was expected to operate for five years. Does NOAA agree with the Inspector General's assessment that there were workmanship issues with the NPP satellite's sensors?

Answer. NPP was initially designed as a research and risk reduction spacecraft and was tested to NASA standards consistent with a five year mission life. NPP was pressed into operational service due to slips to the NPOESS program.

The three year life expectancy identified in the NASA Inspector General report is consistent with the full mission success criteria in the NPP Level-1 Requirements. NASA chose three years as the NPP mission success criteria for NPP due to concerns about residual risk remaining in the Visible Infrared Imaging Radiometer Suite (VIIRS), Cross-track Infrared Sounder (CrIS), and Ozone Mapper Profiler Suite (OMPS) instruments and that the development and testing of the NPOESS Integrated Program Office (IPO)-developed NPP sensors were not subjected to NASA's standards or oversight. The evaluation for mission success also includes engineering judgment based on factors such as first-of-its-kind sensors and first space use of 1394 communications bus, which added to NASA's concerns about the life expectancy of those sensors.. Recall that these sensors (VIIRS, CrIS, and OMPS) were developed under the oversight and management of the now-closed NPOESS IPO using Department of Defense acquisition methodologies and delivered to NASA's spacecraft contract for integration onto the NPP satellite.

While there were well documented development, testing and workmanship issues with some of the sensors, each issue was eventually addressed either through design changes, or rework and testing methods that were agreed to by the contractors and the government, and were based on proven practices and processes.

NOAA plans to use the NPP satellite operationally and requires the satellite to provide usable data for at least five years. Currently these sensors are being calibrated and initial data sets are being validated.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. ROGER F. WICKER TO HON. MARY M. GLACKIN

Question 1. The Joint Polar Satellite System (JPSS), and the predecessor the National Polar-orbiting Operational Environmental Satellite System (NPOESS), has faced concerns regarding cost overruns and timeline slippage. The Government Accountability Office (GAO) has reported that NOAA has not finalized their plans or fully implemented the recommendations from previous GAO reports. What is NOAA currently doing to reduce costs for the JPSS project to meet the $9.4 billion budget established by Congress?

Answer. The appropriations bill adopts by reference all House and Senate report language regarding JPSS with the exception of the Senate report language regarding the lifecycle cost cap of $9.4 billion. Instead, the conferees direct NOAA to provide outyear funding estimates for this program prior to the submission of the Fiscal Year 2013 budget request. We have made great strides within the limits of the budget shortfalls to successfully launch NPP, to have its ground system become operational, and to continue to move forward on the development of the instruments and bus for JPSS–1. Moving forward, we recognize the importance of efficiently allocating scarce resources and are working with NASA to determine the best available options for maintaining a Life-Cycle Cost through FY 2028 of $12.9 billion or less for the JPSS program.

NOAA has recently submitted a response to GAO recommending closure of its previous recommendations regarding the transition of the NPOESS program.

Question 2. How will the potential gap in weather data from satellites impact the ability of NOAA to provide accurate hurricane warnings which coastal communities rely on to keep their residents safe?

Answer. Hurricane warnings are typically issued when a storm is forecast to make landfall within 36 hours. By this time, operational forecasters rely on model forecasts that incorporate data from hurricane reconnaissance aircraft, both the Air Force Reserve "hurricane hunters" and the NOAA P3 fleet and Gulf Stream IV aircraft. These data are critical to NOAA's immediate hurricane warning mission. The polar orbiting satellites provide data most essential to longer range forecasts of the hurricane track and intensity, particularly when storms are over the central or eastern Atlantic Ocean. Loss or degradation of these satellite observations will make

NOAA forecasts less certain at the 3–5 day and beyond range, and hamper evacuation planning efforts that require significant lead time on the order of days, such as is needed for Key West, Florida, or the U.S. Navy facility in Norfolk, VA.

Question 3. Are NOAA weather data used to study storms retroactively (storms in the past)?

Answer. Yes. NOAA scientists conduct post analysis on storms to understand how the atmosphere and waterways responded to the storms and incorporate these lessons learned into operations to provide improved forecasts and warnings of future events. Universities and the private weather enterprise also use NOAA data to conduct their own research into storms.

Question 3a. What can NOAA gain from looking at storms in hind-cast?

Answer. NOAA scientists learn how the atmosphere and oceans behaved under those particular circumstances and incorporate these lessons learned into operations to improve forecasts and warnings via model improvements. Should such atmospheric conditions arise in the future, operational forecasters can use their knowledge of what happened during these past storms and incorporate their newly found knowledge into forecast models that aid them in issuing more reliable warnings. Much of the historical improvement in storm track, storm intensity, and lead time, including hurricane forecasts, has come from careful analysis of historical storms, including efforts to improve models by forecasting previous storms better.

Question 4. Can you summarize our Nation's current public and private efforts in place today to collect and study weather related data?

Answer. The Nation's efforts to collect and study weather data take many forms. NOAA is the source of foundational data for a diverse set of services provided by the media and by others in America's weather industry. These services contribute to public safety and to economic efficiency. NOAA also receives a wide variety of data from others, *e.g.,* satellite data from EUMETSAT and weather model data from other modeling centers including the United Kingdom, Canada, and the European Centre for Medium-Range Weather Forecasts.

NOAA and Federal efforts focus mainly on larger scales, while state and local governments, universities, and the private sector have built infrastructure to monitor smaller scales. NOAA has access to much of the data from these non-federal sources, and is working on data rights issues with the private sector to ensure market viability for these companies is not compromised by NOAA's use of their data. Some companies charge NOAA for the data, others provide it for free, with limited redistribution rights. NOAA also works with the aviation community to obtain weather data from aircraft, which is used by NOAA computer weather models to analyze and predict the weather.

Question 5. How does NOAA leverage private investments in weather observations and forecasting to ensure that Federal dollars are being optimally utilized?

Answer. Observations are critical to NOAA's mission. NOAA makes use of all available data, either international, federal, state, local government funded, university funded, or private sector data, whenever data rights issues can be addressed. NOAA is not duplicating others' efforts for observing systems, but is accessing and using these data. For example, NOAA works with the aviation community to incorporate weather data from aircraft into NOAA analysis and forecast models. Non-federal data are quality controlled by NOAA to ensure data quality and integrity (*e.g.,* mesonet data ingested through NOAA's Meteorological Assimilation Data Ingest System (MADIS)).

Question 6. Going forward, what priority does NOAA and the National Weather Service place on facilitating continued open access to taxpayer-funded weather data and research?

Answer. NOAA has always maintained open access to its data for the public. NOAA provides these data and associated products without seeking reimbursement because these products are considered a public resource and part of NOAA's core mission. The NOAA Partnership for the Provision of Environmental Information [*http://www.noaa.gov/partnershippolicy/*] has at its core existing Federal policies for providing taxpayer-funded data and information. NOAA data and information are essential for the protection of life and property and enhancement of the national economy. NOAA will always place a very high priority on providing open access to this taxpayer-funded information.

Question 7. How do you see the National Weather Service's role evolving over time with respect to the incorporation of the private sector?

Answer. The National Research Council of the National Academies of Science published a report in 2003 entitled "Fair Weather: Effective Partnerships in Weather and Climate Services." This report laid the foundation for improved partnerships be-

tween the private, public and academic sectors, broadly describing the roles of each sector, recognizing that collaboration and discussion best facilitates future services and changing boundaries. Open discussion of NOAA plans for future services allow the academic community to focus research and training efforts while the private sector can build its business model knowing the direction NOAA is headed. NOAA's mission relates to protection of life and property and providing NOAA observations and forecasts, which have broad general value for many users. Many users of weather information require specific, tailored information which NOAA does not have the resources to provide, nor should it. For example shipping companies require detailed forecasts, and the private weather support companies use NOAA information to determine where ships need to be re-routed. Construction companies may require detailed continuous forecasts for their work and large retailers may use tailored forecasts for shipping certain products for sale in stores, (*e.g.,* generators in the path of ice storms or hurricanes). Providing these tailored forecasts for specific user needs to obtain a market advantage is the role for the private sector. NOAA cannot provide all weather products and services to all those who need specific services, and NOAA relies on the private sector to communicate lifesaving information to the public. NOAA is working with the private sector to provide the information in industry standard formats to make it easy for the private sector to use. There is a symbiotic relationship between the sectors, and the current climate of open discussion seems to be working well.

Question 8. How could the further expansion of public-private partnerships to collect weather related data ease the burden on the NWS and allow it to focus on the continued collection of core weather data necessary for public safety?

Answer. NOAA will continue to use all available data to ensure the best possible forecasts and warnings for the protection of the public. NOAA will expand the public-private partnerships whenever possible, however recognizing that the private sector is a business, and its primary goal is to turn a profit. The Federal government has the core mission to protect its citizens and ensure public safety. NOAA will explore and leverage all opportunities, including those with the private sector that improve the economy and efficiency of the organization and provision of weather services.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO HON. TODD J. ZINSER

Solutions to Projected Gap in Polar-orbiting Satellites

Question 1. Just a few months ago, the OIG released a report after a comprehensive audit to assess the adequacy of the JPSS program. Among the key findings, the report confirmed that a coverage gap will occur and weather forecasts will be degraded with a disruption in climate data. Given that a gap in polar-orbiting satellite coverage is now inevitable, what do you think are NOAA's best options for keeping up its weather and data capabilities during this time?

Answer. As noted in our audit report, we recommended that NOAA should coordinate efforts across its line offices to minimize the degradation of weather and climate forecasting during coverage gaps. A NOAA-wide view will help senior management ensure the adequacy of efforts and facilitate improvements.

In response to our report's recommendation, NOAA stated it is developing an integrated strategy to obtain and sustain foreign partner opportunities. It is also establishing a commercial assessments initiative to determine what polar data it can acquire commercially. Key considerations NOAA requires the commercial sector to demonstrate include:

- an ability to provide sustained and uninterrupted observations, based on operational requirements;
- compliance with NOAA's data policy for full and open exchange of data;
- technical feasibility to acquire and deliver the observations in a reliable and timely manner; and
- affordability of operations and cost-effectiveness to the government.

Question 2. Based on your findings, do you think NOAA is doing everything it can to minimize gaps in important climate and weather data?

Answer. No, as noted in our report, NOAA is not doing everything it can to minimize gaps in important climate and weather data. In response to our report, NOAA stated it is developing an integrated strategy to minimize gaps in climate and weather data from the afternoon polar orbit. However, NOAA's strategy must ensure that senior management at NOAA and the Joint Polar Satellite System (JPSS)

program, through close management of the program, take steps to prevent additional slippage in the schedule. We believe NOAA needs to focus their planning in the following areas:

- *Finalizing a program baseline that includes costs, schedule, and requirements—and keeping the Department and Congress informed of the program's performance against that baseline.* In doing so, the JPSS program should prioritize all requirements and contingencies in order to maintain the current planned launch date.
- *Coordinating across the agency to develop contingencies for a coverage gap.* For example, scientists who work for the National Weather Service (NWS) need to work with the scientists from the National Environmental Satellite, Data, and Information Service to develop options for using data from all available sources to compensate for the loss of afternoon polar satellite data. We are concerned that there has not been a coordinated approach to the problem across NOAA's lines of businesses—and that there should be.

Question 3. Additionally, Committee staff recently received a briefing from NOAA's Assistant Administrator for Satellite and Information Services, Mary Kicza, about options to fill the coverage gap. She mentioned that the JPSS program is the only way the Nation can maintain weather data continuity and any investment in alternative solutions would be taking critical funds away from JPSS. Have you spoken with NOAA officials about non-satellite options? What was their response?

Answer. Yes, we spoke with NOAA officials about non-satellite options. During our recent audit fieldwork, NOAA did not identify any non-satellite options to fill the coverage gap.

However, NOAA told us that it has agreements (in place or being considered) with other agencies and foreign partners to obtain satellite data. In addition, we interviewed NOAA's National Centers for Environmental Prediction (NCEP) leadership. Anticipating a gap in data from the afternoon orbit, NCEP told us they have been working with the Department of Defense to improve the data from satellites in the early-morning orbit. Additionally, NCEP is working to use data from NOAA's next-generation geostationary satellite, which is currently scheduled to launch in October 2015. According to NOAA, however, NWS does not believe this data would mitigate the loss of polar satellite data from the afternoon orbit.

Question 4. Are you aware of any non-satellite options for minimizing the continuity gap?

Answer. At this point in time, we are not aware of any non-satellite options for minimizing the data continuity gap in the afternoon polar orbit.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. AMY KLOBUCHAR TO DAVID C. TRIMBLE

Question. Agriculture is a major driver of Minnesota's economy, producing $18 billion dollars worth of products. Farmers make planting and harvest decisions based on weather forecasts. How can improved weather forecasting provide better tools for farmers and ranchers, and help fuel this important sector of our economy?

Answer. As we reported in October 2009 (GAO–10–113), climate change is a complex, crosscutting issue that poses risks to many existing environmental and economic systems, including agriculture, infrastructure, ecosystems, and human health.[1] According to the National Academies and others, greenhouse gases already in the atmosphere will continue altering the climate system into the future, regardless of emissions control efforts. Therefore, adaptation—defined as adjustments to natural or human systems in response to actual or expected climate change—is an important part of the response to climate change. We reported that insufficient site-specific data, such as local projections of expected changes, makes it hard to predict the impacts of climate change and thus hard to justify the current costs of adaptation efforts for potentially less certain future benefits.

Federal actions to provide and interpret site-specific information would help address this challenge. For example, based on the responses by a diverse array of Federal, state, and local officials knowledgeable about adaptation to a web-based questionnaire designed for our October 2009 report, about 80 percent (148 of 185) of respondents rated the "development of processes and tools to help access, interpret, and apply available climate information" as very or extremely useful. Decision makers will need tools to interpret what regional and local climate data mean for activi-

[1] *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions,* GAO–10–113, (Washington, D.C.: Oct. 7, 2009).

ties like farming and ranching. In addition, about 61 percent (107 of 176) of respondents rated the "creation of a Federal service to consolidate and deliver climate information to decisionmakers to inform adaptation efforts" as very or extremely useful.

In our October 2009 report, we recommended that the appropriate entities within the Executive Office of the President, such as the Council on Environmental Quality and the Office of Science and Technology Policy, in consultation with relevant Federal agencies, state and local governments, and key congressional committees of jurisdiction, develop a national strategic plan that will guide the Nation's efforts to adapt to a changing climate. We are monitoring the government wide implementation of this recommendation by the Interagency Climate Change Adaptation Task Force, co-chaired by the Council on Environmental Quality (CEQ), the Office of Science and Technology Policy (OSTP), and the National Oceanic and Atmospheric Administration (NOAA), and including representatives from more than 20 Federal agencies.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. OLYMPIA J. SNOWE TO DAVID. C. TRIMBLE

Question. While NPOESS was disbanded because the interagency management approach among Department of Defense, NOAA and NASA made it difficult to prioritize the requirements of three agencies, recent testimony by the GAO before two House Subcommittees raises concerns that the lack of interagency strategy for environmental observations may actually result in an inefficient approach that does not address the priorities of additional Federal research priorities, and could ultimately limit our ability to understand long-term climate change. Given the budget uncertainties that we face, if interagency applications are now being limited, do you believe the division of NPOESS into two separate programs is still the best approach to meet both civilian and military data requirements as cost-effectively as possible?

Answer. At the time of the White House's decision to disband the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program, the program was at risk of not meeting the near-term satellite data needs for military or civilian users. The program's expected cost had more than doubled and there was a clear expectation that costs would continue to grow. Further, an independent review team reported that there was a very small probability of success if the management of the program were to continue as it was. Now, almost 2 years after the decision to disband NPOESS, a gap-filling environmental satellite is in orbit and is expected to provide satellite data needs through 2016. However, it is not yet clear what will be delivered, by when, and at what cost on either of the NOAA or DOD follow-on programs. NOAA expects to establish cost and schedule baselines on its Joint Polar Satellite System (JPSS) by July 2012, and it is not clear how DOD will proceed with its Defense Weather Satellite System (DWSS). Given our current budget uncertainties, it is not clear that the current approach will meet requirements cost effectively. We have ongoing work assessing these programs.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. ROGER F. WICKER TO REAR ADMIRAL CARI B. THOMAS

Question. How will U.S. Coast Guard rescue and response efforts be impacted if NOAA experiences a decrease in satellite function?

Answer. The loss of the National Oceanic and Atmospheric Administration's (NOAA's) geostationary or polar-orbiting satellite data would have a cascade effect throughout the oceanographic and meteorological modeling community and their ability to provide high-resolution, accurate models of present and future on scene conditions required by the Coast Guard for Search and Rescue (SAR) response and Marine Environmental Response. The Coast Guard SAR response relies upon accurate and timely forecasts of the oceanographic and meteorological conditions.

By tapping into the Environmental Data Servers through its SAR Optimal Planning Scenario, Coast Guard SAR planners are able to access the meteorological numerical models for:

(a) Sea Surface Currents,

(b) Sea Surface Winds,

(c) Waves (height, direction and period),

(d) Visibility,

(e) Sea Surface Temperature,

(f) Sea Surface Air Temperature,

(g) Sea Surface Air Pressure, and

(h) Ice Coverage.

NOAA's geostationary and polar-orbiting satellite constellations provide oceanographic and meteorological models that the Coast Guard uses for forecasting on-scene conditions necessary to plan searches. These models provide SAR planners with meteorological and ocean conditions, surface currents and wind data to accurately estimate the drift of survivors and survivor craft. Additionally, timely accurate weather forecasts are critical to identifying potential risks during operational planning to ensure the safety of the Coast Guard personnel that are responsible for conducting our missions.

In its role as the Federal On-Scene Coordinator (FOSC), the Coast Guard is responsible for ensuring the cleanup of spills of oil and hazardous substances in the coastal zone. The FOSC depends heavily on NOAA and its cadre of Scientific Support Coordinators (SSC) for providing timely and accurate information related to the trajectory and environmental fate of a spill. The SSCs typically obtain and process this critical information from the wealth of data provided by NOAA's satellite constellation. The resulting forecast models or real-time pictures are critical for decisionmaking by the FOSC and Unified Command during a spill.

Lastly, if a decrease in satellite function impacts NOAA satellites carrying SAR repeaters (which receive and retransmit the 406 MHz distress signal) or SAR Processors (which transmits 406 MHz distress signal real-time), this will most likely result in a coverage gap and SAR planners may see a substantial increase in the length of time it takes to receive distress alert(s). These coverage gaps/delays will ultimately delay SAR response efforts and will continue to exist until the new SAR/Global Positioning System becomes fully operational (expected sometime between Fiscal Years 2018–2020).

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO TOM ISEMAN

Access to Climate and Weather Data

Question 1. How does NOAA disseminate their climate and weather data to state and local entities such as the WGA? Please provide examples.

Answer. NOAA employs a range of tools and partnerships to disseminate weather and climate information, ranging from weather forecasts and websites to on-the-ground engagement with states, private sector and local communities.

The most visible form of outreach is television and radio, and specifically the local weather forecast, where NOAA's National Weather Service field offices provide information on day to day conditions. Citizens tune into their forecast every day to decide whether to bring an umbrella or how long their morning commute might be.

Another tool is websites, like weather.gov, climate.gov, or drought.gov (which was a direct outgrowth of our partnership on the National Integrated Drought Information System (NIDIS)). These websites are designed to collect and aggregate relevant information and to make it available as a 'one-stop shop' for states and users. They allow interested viewers to find a range of information and to focus on geographic or topical issues of interest. However, these are passive services that require some user initiative and knowledge to exploit.

NOAA also provides periodic Climate Outlook Forums. In these forums, NOAA experts provide the latest climate forecasts to interested users, and they are available for dialogue and Q&A with the audience. These vary in geographic and temporal scale, from an annual climate outlook for the Nation to a seasonal climate outlook for a particular region of interest, for example, drought in the Southwest or flooding in the Upper Missouri.

Finally, NOAA works directly with states and local users to engage in the development of information services, for example in the case of "Early Warning Systems" being developed by NIDIS. In these cases, NOAA works with stakeholders to understand the key weather and climate variables of interest for a relevant geography, and they "co-develop" a system to monitor and report on those variables over time. NOAA's Regional Integrated Sciences and Assessments (RISAs) conduct stakeholder-driven research needed to inform these systems at the scale of watersheds, cities, and local communities where managers make decisions. Early Warning Systems are being developed for the Upper Colorado River, the Apalachicola-Chattahoochee-Flint Basin in the Southeast, and the ongoing drought in the Southern U.S.

These are the services that WGA is trying to promote through its MOU with NOAA: regional services that more actively engage states and other on-the-ground stakeholders in the identification and development of new tools to track and respond to key weather and climate events. By engaging states and other stakeholders, tools will address the key issues of interest—like how drought may affect a municipal water supply, or when flooding may delay the shipping of goods by rail, or whether infrastructure design criteria are sufficient to address severe storm events—and will be more widely adopted and employed than national websites. We recognize that regional, stakeholder-designed services may require additional resources and time; however, they are the best way to address the regional variability inherent in climate and its impacts to on-the-ground decisionmaking.

Question 2. What concrete improvements can be made to increase access to this information?

Answer. While portals like drought.gov have broad utility and should be continued, we support efforts to promote more active, stakeholder-initiated services that address key regional priorities. Regional systems provide a targeted assessment of key indicators, along with the expertise and resources to interpret and apply them to on-the-ground decisionmaking. Regional systems can stimulate efforts to plan and prepare for climate and weather events, rather than simply responding after the fact. We want to get to the point where a farmer uses the seasonal outlook to decide whether to plant certain crops, or a water utility uses long-range snowpack projections to design new infrastructure—just like you or I listen to the weather forecast to decide whether to carry an umbrella.

We recommend a rigorous assessment of existing regional early warning systems, including those developed under NIDIS, to inform the design and implementation of future efforts.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ROGER F. WICKER TO DR. PETER P. NEILLEY

Question 1. Public-private partnerships to improve weather data collection not only ease the burden on Federal agencies, but also create jobs and bolster the economy. How does The Weather Channel Companies build upon baseline NOAA weather data to provide higher resolution forecasts for specific geographic regions?

Answer. The Weather Channel Companies builds upon baseline NOAA weather data to provide value-added services to consumers and businesses in many ways that serve the weather needs of the Nation. Increased resolution is just one significant enhancement. However, there are many other dimensions of value-adding that we perform. These include providing forecasts in formats that consumers can easily acquire and utilize; operating a 7x24 cable television network; building consumer-friendly weather applications for the Internet and mobile devices; providing forecasts for specific business needs and personal interests; creating more accurate and timely forecasts; and providing an overall satisfying engagement experience for our consumers and clients.

We are able to achieve this with a laser focus on the needs and interests of our viewers and clients that results in provisioning the weather content that they need and can act on. We accomplish this by making specific investments in people, jobs, technology and products that use foundational weather datasets from NOAA and others and then improve upon those data using proprietary scientific methods. For example, one forecasting method that we have developed and deployed starts by ingesting all of the computer-based (numerical weather prediction) forecasts created by NOAA, and augments these with similar forecasts purchased from other countries and our own computer-generated forecasts. We then use a complex artificial intelligence based statistical engine to distill all of these different computer forecast "opinions" into a final forecast optimized for accuracy and relevance to the particular application.

Our ability to create such value-added products and services is critically dependent on the foundational data from NOAA. It would not be possible for The Weather Channel Companies or any other private entity to build and operate networks of weather radars across the country, fund and operate fleets of weather satellites, or capitalize the vast supercomputing facilities used by NOAA. It is critical that as nation we continue to appreciate and invest in these foundational weather services from NOAA so that companies such as The Weather Channel can continue to provide the best possible weather services for our Nation.

Question 2. How can the public-private partnership process be improved to promote effective collaborations?

Answer. First, it is important to recognize that there have been tremendous gains in the degree of cooperation and collaboration between NOAA and the weather and climate industry in the past decade or so. Guided heavily by the groundbreaking 2003 report by the National Research Council "Fair Weather: Effective Partnerships in Weather and Climate Services", there have been numerous formal institutions created (*e.g.,* The NOAA Science Advisory Board's Environmental Information Services Working Group) that promote and sustain effective partnerships across our Nation's weather and climate "Enterprise". Critically important in these advancements has been the deep recognition within NOAA of the essential need for strong partners in order to serve the Nation and meet the mission of NOAA's National Weather Service (NWS). For example, the NWS could not fulfill its mission of protecting life and property without an effective cooperation with private-industry in order to publish time-critical warnings of impending severe weather.

In order to promote effective public-private partnerships in the Nation's weather enterprise, it is important that the participants in the enterprise continue to recognize the particular strengths and assets that each constituent of the enterprise has and that those strengths and assets be leveraged and fostered so that our Nation receives maximum benefit and value and all players in the partnership remain strong. In particular, NOAA should continue to consider where the private sector may be better able to serve the weather needs of the Nation and leverage those strengths in order to serve the Nation most effectively and efficiently. For example, the private sector has proven very agile in the development of a rich set of weather information applications for digital and mobile devices and hence the need for NOAA to consider creating similar functionality may not only be unnecessary but likely decrease the value the enterprise provides to the Nation possibly disrupt the established partnership balance.

A specific area where NOAA could help strengthen the partnership is to work with the private sector and others outside of NOAA to find ways to gain access to the vast sets of NOAA weather data that are currently created but for which practical considerations make them inaccessible outside (and often times even inside) of NOAA. For example, the National Centers for Environmental Prediction division of the NWS produces high-resolution and high-frequency forecast data that must be filtered significantly before publication via the Internet outside of NOAA. If it were possible for the private sector to place value-adding computer servers inside of NOAA to process the high-resolution data, valuable and skillful forecast content could be derived from those data to help serve the Nation's needs better. This is an example of the Open Weather and Climate Services paradigm that was recently endorsed by the NOAA Science Advisory Board and passed onto NOAA for consideration. Embracing the adoption of the Open Weather and Climate Services paradigm by NOAA will significantly advance the partnerships and the products and services provided.

Question 3. Does The Weather Channel Companies currently have operations in the Northern Gulf of Mexico to improve hurricane forecasts and better determine impacts on coastal communities?

Answer. The Weather Channel provides weather services for the entire nation. We are continuingly investing in operations and technologies that provide improved services for all of our consumers and clients. For the most part, our approach is to improve all forecasts and services that cover a range of weather types and locations. However, we recognize the significant impact that hurricanes can have along our Gulf of Mexico and Atlantic coastal communities and accordingly invest materially in being sure that state-of-the-science forecasts and communication services are available to those that might be threatened by tropical cyclones. In general when such storms threaten a specific community or region we shift our resources to ensure that the best, most-timely and most accurate weather information is conveyed to those in the storm's path.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ROGER F. WICKER TO ROBERT S. MARSHALL

Question 1. Public-private partnerships to improve weather data collection not only ease the burden on Federal agencies, but also create jobs and bolster the economy. How does Earth Networks build upon baseline NOAA weather data to provide higher resolution forecasts for specific geographic regions?

Answer. Earth Networks ingests all NOAA weather data and incorporates it into Earth Networks products and services. In addition to NOAA weather data, Earth Networks also operates its own observation networks (surface weather stations, lightning sensors and a weather camera network). By integrating both NOAA data

and proprietary Earth Networks data into our products and services we are able to provide high resolution and very local forecasts and warnings for our customers.

Question 2. How can the public-private partnership process be improved to promote effective collaborations?

Answer. There are two sides to the public/private partnership that exists between NOAA and private sector weather companies. The side where private sector companies ingest NOAA data and distribute it with value added products to specific users is working relatively well.

The second side of the partnership where NOAA ingests and uses data from private sector observation networks is not working as well. For reasons that are not completely apparent, NOAA has not fully embraced this model despite solid recommendations to do so by the NRC in its 2008 report, "From the Ground Up: A Nationwide Network of Networks". In the challenging budget times that exist today and will continue for the foreseeable future, it is more critical than ever that NOAA embrace this form of the public/private partnership to cost effectively obtain observations that it needs to fulfill its mission of protecting life and property. NOAA should develop a peer reviewed plan and budget to achieve a National Mesonet. The plan should be developed in conjunction with and embrace private sector and academic institutions that operate observing assets that can support NOAA's mission.

Question 3. Does Earth Networks currently have operations in the Northern Gulf of Mexico to improve hurricane forecasts and better determine impacts on coastal communities?

Answer. Yes, Earth Networks operates a number of weather observation stations along the northern gulf coast and on oil platforms in the gulf. Further, the Earth Networks Total Lightning Networks covers a significant portion of the entire Gulf of Mexico. These observation assets as well as those of other private and academic network operators in the region have the potential to improve hurricane forecasts and will clearly improve the ability to determine impacts on coastal communities.