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FORECASTING SUCCESS: ACHIEVING U.S. WEATHER READINESS FOR THE LONG TERM

HEARING

BEFORE THE

SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES, AND COAST GUARD

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED THIRTEENTH CONGRESS

FIRST SESSION

DECEMBER 12, 2013

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED THIRTEENTH CONGRESS

FIRST SESSION

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FORECASTING SUCCESS: ACHIEVING U.S. WEATHER READINESS FOR THE LONG TERM

THURSDAY, DECEMBER 12, 2013

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

The Subcommittee met, pursuant to notice, at 10:32 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. We'll call this meeting to order, the Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard, on forecasting success. What a better day to have on weather, to talk about it, where Alaska is warmer and the rest of the country is colder.

Senator KLOBUCHAR. That would be minus 20 wind chill in Minnesota.

Senator BEGICH. See that? We had 29 degrees in Anchorage yesterday positive.

Senator KLOBUCHAR. We won't talk about Hawaii.

Senator SCHATZ. 82.

Senator BEGICH. Yes. Senator Schatz can now leave the room.

[Laughter.]

Senator BEGICH. Thank you all very much for being here.

Senator WICKER. It's been December all month in Mississippi.

Senator BEGICH. Does that mean it's gift time, too?

We thank the members for being here today. We are here today to discuss the future of the weather enterprise in the United States. By that we mean the unique public-private partnership between the National Weather Service and their private sector academic partners. This is no doubt—there is no doubt this partnership is key to our physical, economic, environmental system.

Economists tell us 30 percent of all U.S. economic activity is in the weather-dependent sectors, like aviation, agriculture. Extreme weather events, like tornadoes and hurricanes, and climate events like droughts are increasingly frequent. In 2012 we saw 11 weather and climate disasters that exceeded $1 billion in damages, including the historic Superstorm Sandy.

My home state of Alaska certainly has its share. In the winter of 2011 a blizzicane, as we call it, struck the state with hurricane-

force winds over an area that would have stretched from San Diego to Seattle in the lower 48. Just last winter we had historic flooding in the town of Galena.

Increasing weather disasters mean we are more and more reliant on the weather enterprise to keep us safe and protect our economic prosperity. I like to think of making weather forecasts like farming. There's lots of data out there, things like temperature and humidity and barometric pressure, which one could say are like the crops in the field. Just like you need some pretty expensive combines and other farm equipment to go out and gather crops, we need some pretty expensive satellites and radars to harvest the data.

That part is extremely capital-intensive, which is why we are here today, to talk about the importance of satellites so much here regarding our budgets and other issues that regard NOAA, the weather, and the satellite issues.

At some point, the gathered crops get processed into consumable food and sold by retail outlets to the general public. We do the same thing with data. We process it with computer models into forecasts the general public can use and make it available through the Internet and other media. We rely mostly on the government to harvest the data and process it into forecasts, although the private sector has a role there, too. As we rely largely on private sector partners to get the forecasts out to the public, this means, though, that thinking your weather forecast comes from Weather.com is like thinking your food comes from the grocery store.

Alaskans know better. We know better than most where our food comes from. Don't get me wrong. Ninety percent of Americans get their weather information from retail forecasters like the Internet or local television. They are a critical part of the system. But they are only one link in a much longer chain, a chain that starts with NOAA and the National Weather Service.

That's why discussion of the future of the Weather Service is so important. There have been several studies of the Service in the past years by places like the National Academy of Science and the National Academy of Public Administration. They all point to past successes in modernization and modernizing the service, but point out the need for continuing changes and improvements. They say we need to build a Weather-Ready Nation.

The Service has a new leader, Dr. Louis Uccellini, and I have met with him yesterday. We had a great conversation, and his sense of urgency is clearly not only shared from my perspective, but he clearly understands the need of looking at the modernization of our weather system.

There is much work for Congress, for the Service, and for the weather enterprise to do to achieve the Weather-Ready Nation goal. We need a better understanding of the human factors, how people respond to weather information and how the public can act appropriately when the threat becomes severe. We will need to refocus the weather workforce to focus more on partnering and communicating with emergency managers and local stakeholders, to ensure forecasts are acted on.

We will need to adopt a culture of continuous technology improvements instead of big bang periods of intense change followed by relative stagnation. And we will need to improve our weather

and climate research and research into operations processes to ensure the U.S. remains the leader in weather forecasting. There will be significant challenges. We need Weather Service management and the employees union to work well together to bring about these changes. The successful modernization of the Service in the past hinged on cooperation between the union and management, and we will need to do this in times of extremely tight budgets. Indeed, Weather Service budgets in constant dollars have declined by 2 percent since 2004.

I look forward to this hearing and the many discussions that we'll have and again to make sure that the U.S. is second to none in protecting lives and property when it comes to weather forecasts and weather-related threats.

Let me turn to my Ranking Member, Senator Rubio, for his opening comments.

STATEMENT OF HON. MARCO RUBIO,
U.S. SENATOR FROM FLORIDA

Senator RUBIO. Thank you, Mr. Chairman, for holding this hearing. Thank you, Senator Schatz, for requesting it, and to all of you for being here today.

Weather forecasting is important. We rely on it for daily decisions that we make in our private lives, but also in the commercial sector. From farmers to fishermen, forecasting is a very important part of their daily lives. For example, in Florida every person, family, and business, including my own, very closely follows the hurricane season. Every single tropical storm and every hurricane during the hurricane season, you can just imagine we're keeping a close eye on it.

The 2013 Atlantic hurricane season, by the way, was predicted to be an above-average season, with an above-average number of storms. Between 13 and 20 named storms and 3 to 6 major hurricanes were forecasted. Yet we are thankful that that was wrong, at least for Floridians, because it ended on November 30 as the sixth least active hurricane season since 1950, and for that we should take some credit, right?

[Laughter.]

Senator RUBIO. Anyway, I understand that the National Weather Service used a new forecasting model for the 2013 season. So one of the things I would like to hear a little bit more about today is why this model was chosen and whether or not we want to use it again in the future.

Additionally, as we all know, there has been several reports on the structure and the function of the National Weather Service, including reports by the National Academy of Sciences and the National Academy of Public Administration. One of those reports indicated that there has been no change in baseline staffing since the modernization and associated restructuring that occurred in 2000, despite pretty significant technological advances.

After the modernization, the Weather Service was reduced to about 4,700 positions, in spite of some calls for reducing the workforce to an even lower number. However, in 2012 the National Weather Service had grown again, to over 4,900 employees. Last

year 61 percent of the National Weather Service's budget went to labor costs.

I'm concerned that as we review the agency and work to not only maintain a robust forecasting system, but also address potential future data gaps due to satellite launch delays, the demands of the workforce may work against our efforts to streamline and to find efficiencies. As we'll hear today from Dr. Ohanian, the achievements of the National Weather Service Employees Organization, often contradict and impede the agency's ability to implement some external recommendations, for example those made by the National Academy of Public Administration.

We've seen the impact that public sector unions have had on places like Wisconsin and on Detroit and, while I don't think we're that far down the line at the National Weather Service, I think it's important that we address any inefficiencies on the front end before it is too late.

I would also like to better understand how we can best work together as we find the most productive path forward for the National Weather Service.

Finally, I believe our commercial sector for weather forecasting plays a real vital role, both today and in the future. As we face data gaps as soon as 2016, we have to find ways to leverage our secondary value chain in creative ways. I look forward to hearing testimony from our witnesses today as to exactly how best we can use our commercial sector to make our forecasting system the premier system that I believe it can continue to be.

So thank you again, Mr. Chairman, for holding this hearing and I really do look forward to the testimony.

Senator BEGICH. Thank you very much.

I'll ask members if they have any comments they want to make before we start with the Q and A and the statement. Senator Wicker, and then Senator Klobuchar, and then Senator Schatz.

STATEMENT OF HON. ROGER F. WICKER,
U.S. SENATOR FROM MISSISSIPPI

Senator WICKER. Well, thank you very much. I appreciate the opportunity to make an opening statement, because we're going to have votes and we'll be going in and out.

Is it "YOU-chell-EE-nee"?

Dr. UCCELLINI. Yes.

Senator WICKER. Dr. Uccellini, thank you for being here. I've welcomed the witness to the Committee before we convened and he's aware that I'm going to ask about the Coastal Act and the progress that's being made concerning this portion of the Biggert-Waters Flood Insurance Reform Act.

The purpose of the Coastal Act is to lower cost to the FIP by better determining flood losses in the case of slabs, where little tangible evidence beyond a foundation remains for the proper adjustment of insurance claims. This is a problem that occurs whenever there's a named storm that wreaks devastating losses and leaves little evidence other than a slab.

The Act—the purpose of the Act and the belief behind the Act was that scientific data could be used with NOAA, with FEMA, with other agencies, to give us information to assist in assessing

damages between the wind insurance and the flood insurance, and that's the purpose of the Act. So I hope that I have an opportunity, with all the other things going on today, to ask about that. I appreciate the work that our witness is doing in that regard and look forward to delving into that later on, and the other issues.

So thank you very much, Mr. Chairman, for allowing me to speak about this one particular item of interest.

Senator BEGICH. Thank you very much, Senator Wicker. That's exactly why I'm asking for openings, because it's going to be kind of a little chaotic here. But we want to make sure people get their voices heard.

Senator Klobuchar.

STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Well, thank you very much. And thank you, Senator Schatz, for requesting this hearing. I did just check and it is currently minus 16 degrees in International Falls, Minnesota. So you can see why this is important. People have to know what to wear when they go across the street.

So we care a lot about weather forecasts in Minnesota, not only because of the cold weather, but also because, unlike Senator Rubio with hurricanes, we have tornadoes that can come up with a moment's notice. But still the predictions—even a 10-minute notice can make a huge difference. We've had many instances where the sirens going off saved literally hundreds of lives, kids in a school where the school was completely destroyed.

We also have flooding challenges every single year. I think of Georgetown, Minnesota, which is threatened every time the Red River rises and the Buffalo River overflows, or the severe flooding that hit Duluth, Minnesota, in 2011. So we really truly appreciate the work of the Weather Service and ensuring that NOAA and the National Weather Service can make timely and accurate forecasts is incredibly important, and I'm looking forward to asking you about the effects of sequestration and how you foresee we continue with this Service, because it's very important to our state livelihoods as well as the economics.

Thank you very much.

Senator BEGICH. Thank you very much.

Again, Senator Schatz, thank you for making the request for the meeting and this subject matter, because I think, as you get a sense from cold to warm climates, it's an issue in many different ways.

So Senator Schatz, and then we'll go right into your testimony if that's OK. Senator Schatz.

STATEMENT OF HON. BRIAN SCHATZ,
U.S. SENATOR FROM HAWAII

Senator SCHATZ. Well, thank you very much, Mr. Chairman and Ranking Member. I just got handed this by my staff, but it was not necessary, because I already knew that it was 70 degrees right now, with a high of 82, without checking.

Before we move on, I'd like to submit for the record, with your permission, Mr. Chairman, a letter from a leader in the academic

community: from Robert Gagosian, President and CEO of the Consortium for Ocean Leadership.

Senator BEGICH. Without objection.

[The information referred to follows:]

CONSORTIUM FOR OCEAN LEADERSHIP
December 11, 2013

Hon. MARK BEGICH,
Senate Commerce, Science, and Transportation Committee,
Oceans, Atmosphere, Fisheries, and Coast Guard Subcommittee,
Washington, DC.

Hon. MARCO RUBIO,
Senate Commerce, Science, and Transportation Committee,
Oceans, Atmosphere, Fisheries, and Coast Guard Subcommittee,
Washington, DC.

Dear Chairman Begich and Ranking Member Rubio,

As you prepare to hold a hearing regarding U.S. weather readiness, I would like to share with you the perspective of the academic oceanographic community. As you may know, Ocean Leadership represents 95 of the Nation's leading ocean research and education institutions, including thousands of researchers working to better understand the ocean's role in driving weather and climate systems.

Naturally, when we think of weather and storms we look to the sky and clouds. Yet the most powerful influence on weather resides in our ocean, which contains 1,000 times more heat in its top seven feet than is held in the entire atmosphere. The ocean is truly the flywheel of the Earth's climate system, driving the transfer of massive amounts of heat and water across the globe. Despite these facts, the National Climate Prediction Center collects roughly 1,000 times more measurements in the atmosphere than the sub-surface ocean for their storm models. This is a reflection of the difference in the level of investment in observing systems and the difficulty of maintaining comprehensive systems in the marine environment. Recent scientific research and analyses of the Earth's climate and weather systems leads to the conclusion that critical advances in weather models and forecasts will be achieved through better monitoring of ocean processes that drive coupled ocean/atmosphere heat transfer dynamics.

While storm intensity forecasts will be improved with additional ocean observations, so will our ability to understand crucial oceanic processes such as El Niño-Southern Oscillation, thermohaline circulation, sea-ice dynamics, and sea-surface heat exchange, all of which are vital in predicting regional and seasonal weather patterns. Beyond protecting lives and property, these forecasts are critical for many sectors of our economy including agriculture, transportation, energy, and tourism. While many are urging prioritization of short-term weather forecasts, the reality is that these forecasts are dependent on longer-term sustained observations of both the ocean and the atmosphere.

Unfortunately, there are many examples of how the dearth of oceanographic data has impacted communities and economies. For instance, forecasts for Superstorm Sandy underestimated the amount of storm surge in Manhattan by nearly eight feet, largely because the models underestimated the winds because they did not account properly for ocean temperatures. Inaccurate forecasts of waves over the Columbia River Bar (known as the Graveyard of the Pacific) can cost shippers over $100,000 for each day that a container ship is tied up in Portland, Oregon, rather than setting sail. Rapid acceleration in sea-level and ocean temperatures along with changes to ocean currents and chemistry will put our predictive capabilities to the test, with increasing impacts on society and economies hanging in the balance.

While our Nation and the world has suffered mightily from recent ocean-derived storms such as Sandy, Katrina, and Haiyan, there are also non-weather related threats from the sea that have also devastated communities and economies such as the *Deepwater Horizon* oil disaster, the Fukushima nuclear catastrophe, and the great Indian Ocean tsunami of 2004. So, as you craft legislation to help improve the nations' ability to forecast extreme weather events, we hope you will not do so at the expense of our ability to be better prepared for the next tsunami, oil spill, red tide, or fishery disaster. Ultimately, improved forecasts require additional research, continuous observations, advanced modeling and powerful computing of both the atmosphere and the ocean. We hope you will advance legislation that promotes and sustains a balanced research and observational portfolio, while also fully leveraging the scientific expertise within and outside of the Federal Government.

We appreciate your consideration of our recommendations and the ocean science community remains committed to working with the Committee to ensure that our Nation can be better prepared for weather-derived events.

Regards,

ROBERT GAGOSIAN,
President and CEO,
Consortium for Ocean Leadership.

cc:
The Honorable John Rockefeller IV
The Honorable John Thune
The Honorable William Nelson
The Honorable Maria Cantwell
The Honorable Richard Blumenthal
The Honorable Roger Wicker
The Honorable Kelly Ayotte
The Honorable Dan Coats
The Honorable Tim Scott
The Honorable Ted Cruz

Senator SCHATZ. Thank you very much.

The quickening tempo of super-disasters demands that we have a weather enterprise that strives continuously to improve outcomes on our communities, on the economy, and on human lives from severe weather. That's why I wanted this hearing today, and I'm very appreciative of the chair and the ranking member.

Consider the period from 1980 to 2011. After studying this period, world reinsurance giant Munich Re concluded that North America faced in excess of a trillion dollars in damage. This is only the economic loss. According to the same study, 30,000 North Americans lost their lives due to weather catastrophes. The reinsurance industry has no agenda other than to try to understand risk.

No matter what you may think about climate change or greenhouse gases, the human toll and economic loss from severe weather is staggering. In just over 2011 and 2012, the United States suffered $25 billion worth of disasters, and I'm concerned about the many more that we may face in the years ahead.

The American weather enterprise is up to the challenge, but I also believe that we as a Congress need to do more and begin the conversation about whether further steps are warranted. As our witnesses here today will show, improving outcomes from severe weather will take all hands on deck—environmental observations, basic and applied science, and outreach to individuals, communities, and businesses. We are doing well, but we have to do better in order to ensure that observations, science, and outreach to the public work together so that they directly support the ultimate goal of improving outcomes from severe weather.

That means taking deliberate choices about the environmental data that we pay to collect. It also means scrutinizing the link between research and operations to hone in on the most critical science. And most of all it means strengthening our efforts to educate the Nation about how to use the environmental data and forecasts that we provide.

So I look very much forward to hearing from our panelists. Thank you, Chair Begich.

Senator BEGICH. Thank you very much.

Everyone gets to do their weather reports. In Barrow, Alaska, it's minus 14.

Senator KLOBUCHAR. We beat you.

Senator BEGICH. I know. With wind chill factor, minus 25. But the good point is above the Arctic Circle it is still warmer than Minnesota, and we like that.

Let me say, Dr. Uccellini—did I pronounce that right?

Dr. UCCELLINI. Yes.

Senator BEGICH. Thank you very much for being here. You can sense the interest that we have in this issue, so I appreciate you're here. As Assistant Administrator for Weather Services, National Oceanic and Atmosphere Administration, and Director of the National Weather Service, your role is important for all of us in many ways. So please go ahead and have your testimony. Then we'll open up for questions, and then we do have a second panel that comes after you. Please.

STATEMENT OF DR. LOUIS W. UCCELLINI, ASSISTANT ADMINISTRATOR FOR WEATHER SERVICES, AND DIRECTOR OF THE NATIONAL WEATHER SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Dr. UCCELLINI. Good morning, Chairman Begich, Ranking Member Rubio, and members of the Subcommittee. I appreciate the opportunity to testify before you today on the state of the United States weather forecasting capabilities and opportunities to take weather forecasts and services to the next level.

Our Nation is experiencing an increase in and impacts from extreme weather events. I am sure this committee recalls the record-breaking weather events over just the past few years: devastating wildfires, floods, heat spells, snow and ice storms, violent tornado outbreaks, and catastrophic hurricanes, especially Sandy. These events were well forecast days in advance and the connections with Federal, State, and local emergency managers ensured that decisions could be made in advance to save lives and mitigate impacts.

Now, there are four fundamental components to our forecast process that contribute to these accurate forecasts: global observations, numerical weather prediction models, supercomputers, and a well-educated, trained, and dedicated workforce. Throughout all of these major weather events, dedicated Weather Service employees issued the lifesaving warnings, even though their own families were often impacted by the same weather events. It is this incredible dedication to the Weather Service mission that defines the National Weather Service employees.

Now, building on these successes in providing decision support services, we are ready to take weather prediction to the next level. We must advance our weather forecast capabilities and better connect with a wide range of decision makers, partners, and customers to ensure the United States becomes a Weather-Ready Nation, ready, resilient, and responsive, in the face of these extreme events.

To ensure that we are a Weather Service second to none, we need to provide our forecasts, indeed the entire weather enterprise

needs to provide forecasts, based on improved weather prediction models that rely on global observations, especially the modern polar and geostationary satellite observations.

We need a Weather Service workforce trained to meet the growing needs for decision support services for our core partners in the emergency management community. And we need active and engaged collaboration across the entire weather enterprise to ensure we support the secondary value chain, our commercial partners, who are continuing to expand their services around the world.

This focus on decision support will be accomplished by embracing a number of interrelated fields of physical and social sciences, examining the atmosphere, the ocean, land, ice, and space. This can only be accomplished closely with the entire research community both inside NOAA and externally. We are all working together to improve and extend accurate weather prediction and to determine the best ways to communicate forecasts and warnings to ensure preparedness and response that can save lives and protect property.

We are very good at what we do. But as we all know, forecasting the weather still has its challenges. We know we must improve. The National Weather Service structure in service delivery has been largely static since the restructuring efforts in the 1990s, which reflected the best technology and communications capabilities at the time. We also currently have aging facilities and infrastructure and increasing operations costs. We have minimal capacity for testing and demonstrating changes in our service delivery and to support our workforce and stakeholders as we test any changes.

We cannot address the challenges ahead without considering better, more flexible and agile service delivery methods. Congress recognized the need for the Weather Service to change and directed that two studies be conducted, the 2012 National Academy of Science study and the 2013 National Academy of Public Administration study. Both studies reaffirmed NOAA's Weather-Ready Nation strategy and also supported the strategic goals outlined in the Weather Service strategic plan for impact-based decision support services.

Furthermore, the reports emphasized that we must change in order to keep pace with stakeholder and societal needs and emphasized that changes need to be transparent, orderly, deliberate, and continuous. The reports also emphasized that we must involve the entire public, private, and academic weather enterprise and the National Weather Service Employees Union as we evolve the National Weather Service, and we have attempted to do that for all ongoing activities.

We agree with the study recommendations and embrace them fully. We are moving forward to address the main challenges set forth in the NAPA study to create an organization capable of change. This is essential as we move forward toward a more fully integrated field office structure, issuing improved and consistent forecasts and warnings, especially for high-impact events.

Changing the National Weather Service will be a long process, a marathon rather than a sprint. NAPA suggested restructuring the Weather Service budget structure and streamlining head-

quarters as a good place to start. Both of these are proceeding as our top priority efforts, with NWSEO participation.

Let me emphasize, we are committed to managing the budget provided by Congress and improving those areas where increasing vulnerabilities to extreme weather demand it. I want to thank Congress for the Disaster Relief Appropriations Act of 2013. The funding provided by that legislation is a game-changer for NOAA and the National Weather Service. It allows us to increase our operational high performance computing capacity by ten times, which is a crucial element which allows us to improve the numerical weather prediction models and supporting weather research.

Our Fiscal Year 2014 budget request builds on this to increase consistency in our forecasts, to solidify our technical and communications infrastructure, and to increase decision support service, to accelerate the transition of proven research into operations by engaging the research and academic communities, perhaps through a reinvigorated United States weather research program.

In conclusion, extreme weather events cause loss of life and significant damage. We recognize we must improve to meet society's needs to avoid these losses and mitigate the damage. We cannot shy from the challenges ahead. We will need your help and support to meet these challenges.

I believe the Weather Service is a national treasure. The protection of the American people from weather-induced devastation is a sacred trust and duty given to us. Together we must ensure our services and operations live up to this trust and responsibility.

I look forward to your questions.

[The prepared statement of Dr. Uccellini follows:]

PREPARED STATEMENT OF DR. LOUIS W. UCCELLINI, ASSISTANT ADMINISTRATOR FOR WEATHER SERVICES, AND DIRECTOR OF THE NATIONAL WEATHER SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Good morning Chairman Begich, Ranking Member Rubio, and Members of the Subcommittee.

It is my honor to testify before you today on the state of United States (U.S.) weather forecasting capabilities and opportunities that now enable us to take weather predictions to the next level, especially for extreme events. We at the National Oceanic and Atmospheric Administration (NOAA) welcome your interest and the opportunity to discuss this important topic. As a mission-driven, operational agency, NOAA is responsible for global satellite observations, in-house research, research collaborations with our valued external partners, operational forecast excellence, and the delivery of critical products and services. The NWS works with NOAA's other Line Offices to realize our mission.

NWS has the sole Federal responsibility for issuing weather and water warnings to communities across the country and in U.S. territories to protect lives and property. NOAA, as an agency, is trusted with the responsibility to provide environmental information and forecasts to American citizens, businesses, and governments to enable informed decisions on a range of issues and scales—local to global and short-term to long-term. NOAA provides a suite of products and services to the American people, including the reliable and timely delivery of public weather warnings which help safeguard lives. To do so, we work closely with the larger community of federal, state, and local emergency officials, other Federal agencies, and the commercial weather enterprise to deliver the best possible information that science and technology can provide. Put simply, NOAA provides critical information that saves lives and enhances our national economy. We also work with the academic and research community to continually conduct weather research to improve our forecasts and warnings.

Driving Change—Society's Changing Needs

Our Nation is experiencing an increase in extreme weather events. Over the past two years, our country has endured devastation from fires in the South and West; drought over the plains and western states; Hurricane/Post-tropical Cyclone Sandy; destructive tornadoes and severe storms in Oklahoma, Washington, Illinois, and the Midwest; and the massive floods in Colorado and Utah. The NWS has the best forecasters in the world providing critical life-saving forecasts and warnings. However, to take weather prediction to the next level we must evolve to ensure that the U.S. becomes a Weather-Ready Nation in the face of increasing threats related to extreme events. To ensure that forecasts are better used by a diverse group of decision makers, we need to provide accurate and consistent forecasts through a fully integrated field office structure comprised of all field and headquarters units working together to create fully consistent and seamless products and services. And we must organize ourselves internally to ensure our forecasters are linked to, and trained to communicate with, decision makers at the federal, state and local levels. This evolution will help create a Weather-Ready Nation. In addition, we need to bring additional capabilities in environmental prediction to the forefront as we work toward integrating land, sea, and air predictions into an environmental prediction capability.

Congress recognized the need for NWS to change and directed that two studies be conducted. The first, done by the National Academy of Sciences (NAS): "Weather Services for the Nation: Becoming Second to None" (August 2012),[1] examined the NWS Modernization and Restructuring of the 1990s as a background for moving forward. The follow-on study was conducted by the National Academy of Public Administration (NAPA): "Forecast for the Future: Assuring the Capacity of the National Weather Service" (2013).[2] Both studies reaffirmed NOAA's Weather-Ready Nation concept and supported the strategic goals outlined in the NWS Strategic Plan[3] for impact based decision support services for a wide variety of extreme events. Furthermore, the reports emphasized that NWS must change in order to keep pace with stakeholder and societal needs and emphasized that any changes need to be transparent, orderly, deliberate, and continuous and must involve our stakeholders. We know we cannot do it alone. We also know we must not fear change.

We need more than just the best forecasters. We need improved numerical weather prediction models to meet increasing demands for more accurate and reliable forecasts and warnings. We need a NWS workforce trained and structured to meet growing needs for decision support services for our core partners in the emergency management community. We need a fully integrated field structure to produce a consistent set of forecasts for a wide range of extreme events. We need to streamline multiple ways of disseminating our forecasts, watches, and warnings. We need well-resourced observing platforms including NOAA's next generation geostationary and polar orbiting satellites. We need an integrated weather-water approach to advance environmental predictions, especially along our coasts. We need active and engaged collaboration across the entire weather, water and climate enterprise to enhance what the NAS called the "secondary value chain" to build out enhanced services for the whole U.S. economy. In short, to meet the country's expanding needs, we need to institute a challenging set of changes in NWS science and technology, services, workforce, partnership relations, and to a significant degree, culture. And we need to do all this during this period of budget uncertainty.

In order to advance weather forecasting as a whole, NOAA must realize advances across all of the interdisciplinary fields of earth science, research, technology and observations. We must leverage partnerships within government, academia, and the commercial sector, and we must actively pursue, in concert, a balanced program to advance all of the factors critical to success.

NWS agrees with the NAPA recommendations and embrace them fully. We are moving forward to address the main challenges set forth in the NAPA study:

- Pace of Change: Working toward an orderly and deliberate process
- Budget: Aligning budget to function and linking to performance, transparency
- Managing Innovation: Engaging all stakeholders and avoiding hidden costs
- Consistent Services: Timely, accurate, reliable services consistent across the Nation
- Labor/Management Relations: Building a strategic partnership

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[1] *http://www.nap.edu/catalog.php?record__id=13429*
[2] *http://www.napawash.org/2013/1455-forecast-for-the-future-national-weather-service.html*
[3] *http://www.nws.noaa.gov/com/weatherreadynation/files/strategic__plan.pdf*

There is an ever increasing demand for additional lead time ahead of severe weather events. Emergency management officials and Federal partners have indicated that at ideal capabilities, NWS would provide highly consistent and accurate hurricane landfall predictions at days five and six, allowing for pre-positioning of crews, enhanced mitigation and evacuation efforts, and improved recovery planning—all of which can result in many more lives saved. Similarly, an hour of warning before a powerful tornado, versus the minutes of warning we provide today, might allow hospitals to move patients, people to seek secure shelter and avoid being caught in vehicles, homes, or schools not robust enough to withstand a powerful storm.

NWS strives to integrate the best advances in science and technology in order to provide the most accurate and timely forecasts possible. Much of our success comes from scientific and technological breakthroughs made by research that spans across disciplines, time, and space scales. The dynamic systems of this planet are interconnected in rich and complex ways, and success in forecast improvement comes by looking broadly across those linkages.

Furthermore, NWS, driven by demand from our customers, has evolved to provide more than just short-term weather forecasts. Our prediction capabilities are becoming a fusion point that emergency managers, broadcasters, Federal agencies, and the public increasingly turn to as a trusted source that distills scientific information into "impacts coming my way." This is done by embracing a number of interrelated fields of physical and social sciences, examining the atmosphere, oceans, land, ice, and space, and determining the best ways to communicate forecasts and warnings to ensure preparedness and response that can save lives and protect property.

While our computer predictions have improved, it is the dedication of our skilled workforce that makes it all possible. Recent tornado outbreaks throughout the south and Midwest, land falling hurricanes, and snowstorms in the Midwest all attest to the forecasting skill and dedication of the NWS workforce. NWS employees stayed on the job issuing life-saving warnings to the public at large even though their own families were living in the direct path of the devastating hurricanes and tornadoes. The South Dakota snowstorm occurred during the October furlough and dumped 3–4 feet of snow. The staff at the Rapid City, SD forecast office stayed at the office for 2–3 days, despite the personal impact on them and their families. It is this dedication to the NWS protect life and property mission that I find most admirable.

State of Predictions

Hurricane/Post-tropical Cyclone Sandy (Sandy) is an excellent example of how far we have come and yet how far we have to go to become a Weather-Ready Nation. Sandy devastated the eastern U.S. from North Carolina northward to Maine, with impacts reaching west as far as Wisconsin. Days prior to Sandy, NWS forecasters used models, integrating satellite, aircraft, and other weather observations to predict the path of the storm. Our forecasters gave emergency personnel and the public an accurate track forecast a full five days before the October 29 U.S. landfall which bought local communities the time they needed to issue evacuations and move or secure valuable infrastructure. We deployed fourteen forecasters to emergency operations centers in the northeast including Federal Emergency Management Agency (FEMA) regions, and state and local emergency operations centers, including New York City. We also provided forecasts of total rainfall, storm surge, wave height, and other phenomena that would impact the mid-Atlantic and northeastern states. Our accurate predictions enabled FEMA to preposition response assets and emergency managers to more precisely evacuate coastal areas in the path of this unprecedented storm, saving countless resources and lives. Our forecasts also allowed New York City Metropolitan Transportation Authority officials to move valuable resources supporting the mass transit system out of harm's way enabling a rather quick return to relatively normal system operations. It is these types of Decision Support Services to our critical partners in the emergency management community that we believe we must expand and orient ourselves to deliver.

I am proud of the work NOAA did during Sandy and especially proud of the work NWS forecasters did. Our people rose to meet the challenge this unprecedented storm presented. Last spring we released our Sandy assessment. This assessment found that our forecasts saved lives and property. It also highlighted areas we can improve. Most significantly, the report recommended that NOAA accelerate improving our storm surge products. Consistent and accurate storm surge forecasts further in advance will help affected states in their response to tropical cyclone hazards. NWS is working across NOAA, and especially with the National Ocean Service (NOS), to work with the coastal and water communities to improve storm surge and inundation products and determine how best to communicate that information. We could not advance in this area without the NOS. The synergies of having the NWS

and NOS working together within NOAA to improve the storm surge products and services available to the Nation cannot be overstated. We are committed to serving our users. To make good on that commitment we must continue to direct resources to ocean and coastal research, observing, and mapping.

While we did well with our predictions for Sandy, some computing and communication shortfalls were apparent. Congress recognized these issues and provided "game changing" funding in the Disaster Relief Appropriations Act of 2013. In the summer of 2013, NWS completed a major upgrade to the operational weather supercomputers which brought operational forecast computing a threefold hardware capability increase. This base-budget-funded upgrade included major resolution enhancements and an advanced global model that runs more economically on the new hardware. Funds from the Disaster Relief Appropriations Act of 2013 will be used in FY 2014 and FY 2015 to improve operational and weather research computing capability. With these funds, NOAA's operational computing capability will increase tenfold by late 2015. The FY 2014 President's Budget requests additional funds for NOAA to upgrade operational computing, which when implemented will provide a 27-fold increase in operational computing capability by 2015. That advancement will give the NWS unmatched operational computing capability and the ability to run the latest long-range forecast models with improved resolution and physics, and the ability to more accurately assimilate the data from new NOAA polar orbiting satellites and geostationary satellites.

This increase in capacity will allow NWS to bring proven research and forecast model development into operation as it is completed, rather than wait simply because the computing resources are not available. The Disaster Relief Appropriations Act of 2013 not only provided funds to improve our computing capabilities, but also to implement scientific research activities into operational weather, storm surge and coastal forecast models, to accelerate weather research, and to enhance observations. In addition to computing capacity, the President's FY 2014 budget request continues this trend of pulling proven research improvements into operations. Transitioning science developed in NOAA's Office of Oceanic and Atmospheric Research (OAR) into operational use at the NWS and NOS is a high priority for NOAA as a whole.

Increasing Focus on Decision Support and Outcome Measures

Over the past three years it has become apparent that we cannot measure the success of our mission only by the accuracy of information, but we must also measure success by how effectively we apply our information, predictions, outlooks and forecasts to societal needs. As such, we are pursuing a number of innovative approaches not only to provide significantly more lead time for forecasts, but also to ensure that people truly understand these warnings and take informed and appropriate actions to protect their own safety. Our Nation needs to be ready for weather impacts, respond to them, and be resilient to recover from them. Our emphasis on technological and social science advancements is a new approach to building a "Weather-Ready Nation" and one that we expect to provide large returns—measured in avoided economic losses and saving of lives and property.

There is much more to be done if we are to achieve new life-saving advancements in the future, and we are committed to working with our Federal, academic, private sector, and international partners in the broader enterprise to continue this record of success.

NWS' environmental predictive capabilities are supported by four foundational pillars: observations, scientific research, computer modeling (including High Performance Computing), and our people—who provide forecasts, warnings, and decision support services to key decision makers and the public. In order to advance forecasting capabilities, we must strengthen all four of these pillars in concert. For example, our forecast models are only as good as the data we put in them. Without investments in high quality global observational data, the accuracy of our operational forecast models would suffer. Only by evolving in concert across each of these realms can we realize significant, sustained improvement in forecast capabilities.

Of the data actually assimilated into NWS numerical weather prediction models that are used to produce the longer term weather forecasts three days and beyond, over 93 percent comes from satellites, of which over 80 percent are from polar-orbiting satellites. These polar-orbiting satellites include NOAA's Polar-orbiting Operational Environmental Satellite (POES), Suomi National Polar-orbiting Partnership (Suomi NPP) satellite, and the National Aeronautics and Space Administration (NASA) Earth Observing Satellites (EOS) in the afternoon orbit, and the European Metop satellites which fly in the mid-morning orbit. GOES satellites, along with Doppler Radar, assist operational weather forecasters to monitor existing conditions

and provide essential information over data-sparse areas, including the oceans and the Gulf of Mexico. Maintaining continued development of the JPSS and GOES–R Series satellites is critical for not only maintaining current capabilities, but supporting advancements in forecasting capabilities.

The benefits and planned advancements of our predictive capabilities are realized only if people receive the information and take appropriate actions. Taking responsibility not only for advancing prediction but also for understanding how to communicate our predictions as effectively as possible is a major part of our Weather-Ready Nation initiative and a major piece of my vision for the future of the NWS. NWS uses many different ways to disseminate warning information ranging from conventional methods including our own NOAA Weather Radio All-Hazards network and the broadcast media, to social media including Facebook and Twitter. Cell phones are rapidly becoming a major way for the public to receive emergency information. Wireless Emergency Alerts (WEA) are credited with saving lives during the November tornado outbreak in Illinois. News media reported WEA simultaneously activating many cell phones during church services in Washington, Illinois. People received the warning then went to shelters in the churches as the tornado roared through the neighborhood. This is exactly what was envisioned when Congress appropriated the funds for the wireless alert program, managed by FEMA, Federal Communications Commission, and NOAA, and implemented by the cellular phone industry. Contrast this with the 1994 Palm Sunday Tornado Outbreak in Alabama, when a tornado warning was issued, but 20 people were killed in a a Cherokee County Alabama church because they did not receive the tornado warning prompting them to take shelter. We have come a long way, but there is more we need to do to become a Weather-Ready Nation—to be ready for the event, to be responsive, and to be resilient. Our work with social science is allowing us to provide our information in ways and words that people can understand and take action.

While advances in observing, computing, and forecast model development are important, innovation is necessary in order to meet the Nation's weather and water needs. NWS is conducting six pilot projects at local Weather Forecast Offices (WFOs) to test the evolution of decision support services to meet society's needs. One such innovative effort is in the Tampa Bay, Florida, WFO. This effort is integrating weather forecasts into ecological forecasting for Tampa Bay and the local estuaries. This and other Pilot Project innovations aim to test and demonstrate new products and services that can have broader use elsewhere to address changing and evolving customer needs.

While these advances and innovative efforts are important, addressing aging infrastructure, improving scientific understanding, and implementing enhanced services are also necessary to reduce risk to the Nation. Perfect forecasts don't save lives without the infrastructure to disseminate them and an understanding of how best to communicate to spur individuals to take action. I plan to evolve the NWS to devote more time and attention into working with partners in the social sciences to understand how to communicate better and then in training our workforce to implement the best practices learned.

In addition, NWS must increase its capacity to collect and assimilate ever-growing quantities of data to improve forecast model performance, and hence weather predictions and forecasts. This, too, can only be achieved through scientific research and technological advancement. Future technology improvements and computing assets are crucial pieces of our National infrastructure.

Weather Enterprise Collaboration

To provide the best possible weather services to the Nation, NOAA has developed a close working relationship with the U.S. commercial weather sector. This has been growing since the National Academy of Sciences report, *Fair Weather: Effective Partnerships in Weather and Climate Services,* and has gained momentum in recent years with NOAA's "Weather-Ready Nation" initiative. The NOAA Science Advisory Board established (and has recently re-chartered) the Environmental Information Services Working Group to strengthen connections between public and commercial sector activities in weather and climate. The American Meteorological Society also responded to the report and sponsored a productive set of meetings and interactions among the full weather enterprise, including Federal, academic and commercial sectors. NOAA works continuously to enhance its efforts across the weather enterprise, allowing more participation of the commercial and academic sectors in the development of advanced prediction capabilities that have potential for transition into products and services. NWS work also fosters development in the commercial sector that leads to significantly better products for specific audiences and needs. NWS could not meet its mission without the private sector, nor could the private sector be thriving without NWS.

Weather Research and Computing Partnerships

Improvements in weather forecasts and warnings all begin with an idea. Research is essential to determine the viability of the concept and then key to transition those proven ideas and concepts into operations, whether they are improvements in computer models and data, or forecast and warning techniques. Our closest partner in weather research is the Office of Oceanic and Atmospheric Research (OAR) within NOAA. The work at OAR's National Severe Storm Laboratory, its Earth Systems Research Laboratory, and at the Atlantic Oceanographic and Meteorological Laboratory has been integral to the advancements the NWS has made in prediction and forecasting over the past decade. In addition, many Federal agencies work with NOAA and conduct weather research including, but not limited to, the NASA, the Department of Defense (DOD), U.S. Geological Survey (USGS), and investigators supported by the National Science Foundation (NSF), with notable contributions from the NASA/NOAA/DOD Joint Center for Satellite Data Assimilation. Integrated and focused weather research efforts are needed, particularly in this challenging budget climate in which we find ourselves.

We are fortunate that the science and technology of weather prediction is in a period where new advances are becoming available, thanks in large part to Federal researchers working in close partnership with external partners. For example, OAR is developing concepts that apply high-resolution computer models in shorter-range forecasts to increase tornado warning lead times. An estimated 15 minutes of warning lead time was provided for the recent Washington, Illinois, tornado. With advances in observing and forecast modeling, under the Warn-On Forecast Program, NOAA is working to extend warning lead times from the current average of less than 15 minutes to a period of up to an hour, to help save lives and property. The extended lead times for severe local storms would be realized by applying an ensemble of weather forecast models to provide a measure of uncertainty with such warnings to the public, since no single model can capture the natural variability of the atmosphere, nor the sensitivity of such models to the number and quality of the observations and complexities of the model physics.

The topics of weather research and the implementation of the best research into operations are particularly timely. The NAPA study also emphasized the importance of transitioning research efforts to operations, as well as the communication of operational needs to the researchers. I can report that Acting Administrator Sullivan is making this effort a high priority of hers. NAPA summarized the need for ongoing change in NWS, such as:

> *The Panel found enormous support for the weather, water, and climate products and services provided by the NWS. However, both internal and external stakeholders see additional and ongoing change as necessary to continue to enhance NWS performance. To continue to provide the range and caliber of current products and services, the NWS, like any technologically dependent organization, will need to refresh or replace aging technology, infrastructure, and systems.*

The NAS study also makes a number of recommendations regarding weather research. This report emphasized the community enterprise that is needed to improve weather forecasts, from academic and government research, through technology transition, and with special emphasis on the connection between NOAA's weather enterprise and the U.S. commercial weather sector.

While NOAA research endeavors in both NWS and OAR include connections to academia, the Federal Government, international agencies and the commercial sector, more can be done. The U.S. Weather Research Program (USWRP) was introduced as an interagency program led by NOAA and the NSF in 1991. NOAA, NSF, NASA, and to a lesser degree DOE, were all part of the USWRP. The main purpose of the USWRP was to define outstanding weather research topics and fund these efforts both within the Federal community and, importantly, the academic community research efforts on these topics. The USWRP commissioned a series of collaborations among Federal and academic scientists that formed prospectus development teams (PDTs) in the 1990s to define outstanding weather research topics. There were 11 PDTs that published papers in the Bulletin of the American Meteorological Society throughout the 1990s and early 2000s that described important research problems that could advance the state of atmospheric science and, if addressed, would lead to improvements in weather observations, predictions, and warnings that would ultimately benefit society. Since 1999, USWRP has been a program within NOAA, and now, since FY 2009, resides NOAA's OAR. Within funds provided, efforts have focused on hurricanes, heavy precipitation, severe convection, forecast model improvements and the communication of weather predictions and warnings. All of this research aims to improve high-impact weather and air quality forecasts. NOAA is proud of its record of accurate storm forecasts and warnings.

Advanced Data Assimilation and Forecast Modeling Innovations

Forecast quality depends critically on the ability to add and retain, or assimilate, observed information on the initial state of the atmosphere, ocean, land surface, and ice regions to forecast models. Advanced data assimilation techniques, increased forecast accuracy through higher resolution and improved representation of the atmospheric, oceanic and land physical processes are each an important factor for improving operational forecasts. Recently, an advanced assimilation system originally developed by OAR and other research partners was implemented by NWS, resulting in significant improvements in our medium range predictions. While substantial data assimilation and forecast model improvements have occurred over the past five years, considerable progress is yet to be made. Over the next decade, global and regional data assimilation and model capabilities and techniques will become more integrated into a single system capable of providing forecast data from less than one hour to more than two weeks. Regional-scale forecast model ensembles will have the capability to explicitly represent convection (individual thunderstorms), which is critically important to be able to use these models to extend the tornado warning lead time to one hour.

Global weather forecast models are the basis of predictions from one day to two weeks in advance. With broader geographic coverage, global models are the key to forecasting major storms with oceanic origins, such as hurricanes and nor'easters, as well as key to predicting the precursors to longer term seasonal drought and heat waves. Global models are also critical to NWS' success in preparing the public three to eight days in advance for conditions that could lead to major tornado outbreaks, floods and fire weather conditions. By the end of the decade, the next generation of global models will run at horizontal resolutions of a few miles, with more accurate representation of physical processes. As model resolution increases, research is required to understand how to formulate and incorporate new physical processes into the models. Inevitably, when these steps have been accomplished, the forecast skill will take a big step forward. These advances can only come about through a robust research and tech transfer effort. Sustaining such an effort into the future is the surest way to continue advancing U.S. weather forecasting capability and NOAA—through OAR and NWS together—is the lynchpin to drive this work.

Trends in yearly-averaged tornado warning lead time suggest that the present weather warning process, largely based upon a warn-on-detection approach using Doppler radars, is reaching a plateau and further increases in lead time will be difficult to obtain through this method. OAR is developing new radar capabilities such as Multifunction Phased Array Radar (MPAR), which may increase our lead times and abilities to predict storms hours in advance. Additionally, a new approach, referred to as the "Warn on Forecast" paradigm in the NWS *Weather-Ready Roadmap* plan, is needed to extend warning lead time. This approach is being developed by NOAA scientists at OAR's National Severe Storms Laboratory. National scale high-resolution forecast models are needed to predict particularly the details of severe weather events such as widespread tornado outbreaks, such as the one that devastated Alabama and adjoining states in April 2011, and landfalling hurricanes undergoing rapid changes in intensity. The NSF National Center for Atmospheric Research led the initial development over the last 15 years with the creation of the regional Weather Research and Forecast (WRF) model. Based on this model, NOAA researchers working at OAR's Earth Systems Research Laboratory and partners have developed the High Resolution Rapid Refresh (HRRR) model, a key to the "Warn on Forecast" paradigm. Running in an offline experimental model, the HRRR model forecast the derecho that affected the eastern U.S. on June 29, 2012, twelve hours before the storm hit the Washington DC area. This same model forecasted nine hours in advance the dangerous conditions and general characterization of the thunderstorms that formed the destructive tornadoes that affected Alabama on April 27, 2011.

Another notable advancement, the result of major research efforts and investments, is the new hurricane prediction model that came on line for the 2013 hurricane season. The operational HWRF model represents a significant step forward in our understanding of hurricane structure and intensity forecasting. The research has been a joint effort across NOAA, notably NWS, OAR, and academic partners as part of the Hurricane Forecast Improvement Project. This advancement highlights the importance of the research (OAR) and operational (NWS) entities working hand-in-hand: as research improves, so do the forecasts. We have achieved much higher skill in recent years through improved computing capability, the ability to zoom in observationally for a "deeper look" at specific areas of storms as they form, and the ability to assimilate critical observation data from a variety of platforms.

Advances in Computing Capability

High-performance computing capacity and computer forecast modeling are indispensable requirements for extending weather warning lead times to save lives. While many nations run their own numerical weather prediction computer models, the European Centre for Medium-Range Weather Forecasts (ECMWF) model is repeatedly singled out as the "best in the world." For example, the ECMWF model was able to predict Sandy's landfall in New Jersey almost precisely at a full eight days out. Meanwhile, the NOAA Global Forecast System (GFS) eight day forecast predicted Sandy to move further offshore instead of making landfall. It was not until the five day forecast that the NOAA GFS model track became equivalent to the ECMWF track. Running at a greater resolution on nearly ten-times the computing power of the GFS, the dominance of the ECMWF model highlights the need for the very best computing capability. It is important to note that NWS forecasters used all available information, including the ECMWF, as they made their official forecasts for Sandy's track and eventual landfall in New Jersey. A version of the GFS running at higher resolution similar to the ECMWF model had Sandy tracking into New Jersey at the same time frame as the ECMWF. To address the capability gap, NOAA and its partners in the Navy and academia are working on a directed research program, called the High Impact Weather Prediction Project, to enhance our global weather prediction models during the next few years. This is another example of how the Disaster Relief Appropriations Act of 2013 funds are being rapidly applied to our mission.

As mentioned earlier, a major upgrade to NWS operational computers was completed last summer, bringing NWS operational computing a threefold hardware capability increase today. With the Disaster Relief funding, NOAA's weather computing capability will increase tenfold by 2015. We thank Congress for these investments in NWS' computing capability, which will surely save lives and property in the future. Further investments requested in the FY 2014 President's will provide a 27-fold increase in operational computing capability by 2015—an advancement that will give the NWS unmatched operational computing capability and the ability to run the latest long-range forecast models with improved resolution.

Research to Operations

NOAA is continually working to enhance the transfer of research advances into NWS operational and information services. OAR has developed the capability to provide improved longer range computer forecasts as well as short-range severe weather forecasts, but the NWS has lacked the operational computing capacity to transition these research developments to operations. The Disaster Relief Appropriations Act of 2013 not only brings funds to improve our computing capabilities, but also to implement scientific research activities into operational weather, storm surge and coastal forecast models, to accelerate weather research, and to enhance observations. The President's FY 2014 budget submission continues this trend of increasing computing capacity and pulling proven research improvements into operations. In order to improve forecast and warnings across the country, the focus is to accelerate the transition of research and technology from the broad research/technology communities into operations at the NWS.

Achieving a Weather-Ready Nation

With the destruction we have already seen this year from extreme weather and flood events, we take little solace in knowing that outcomes could have been worse without the work of NOAA and our Federal, State, local, academic, and commercial partners. There is much more that needs to be done to improve the Nation's resilience. In addition to improved forecast and warning accuracy and lead times, integrated research, education, and outreach are essential ingredients to improving preparedness. NWS is not alone at NOAA in this work. The National Ocean Service is also squarely focused on improving the Nation's resilience to extreme events along the coasts as well as OAR's Sea Grant program through their diverse network of extension agents on the ground in every coastal state. In addition, other programs within OAR, like the National Integrated Drought Information System (NIDIS), are focused on increasing resilience in the Nation's drought prone regions. For all of NOAA realizing a Weather-Ready Nation, where society is prepared for and responds to high impact weather events, is vital and the NWS is proud to lead the way.

In December two years ago, NOAA and our partners [4] initiated an ongoing dialog with the Nation's top experts to examine what can be done in the short-and long-term to improve how NOAA communicates severe weather forecasts and warnings. We've engaged leaders in broadcast meteorology, social sciences, and emergency management, as well as outreach specialists such as Sea Grant extension agents and warning coordination meteorologists, and the weather industry to focus on community response to and preparedness for severe weather. Included in this effort are 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. Social science research includes the development of new or reconfigured graphics, such as evolving the hurricane forecast cone of uncertainty, and visualization techniques to better communicate tropical cyclone risk, such as GIS enabled storm surge inundation maps. It includes the analysis of the promise and pitfalls of using Twitter in severe weather forecast operations, the assessment of how the public uses our online tools to understand and prepare for flood risk, and the identification of factors relevant to an individual's response to a tornado warning.

Most NWS offices have established Facebook pages, providing an additional medium for conducting outreach and education, as well as for highlighting information about ongoing or upcoming weather events. Additionally, the offices use NWSChat to give core external partners an invaluable opportunity to interact with NWS experts and to refine and enrich their communications to the public. And more private companies are carrying weather warnings on wireless networks (WEA), putting real-time alerts in the palm of your hand. Importantly this year we are running tests to evaluate different language to include in blizzard and severe storm warnings that may more effectively communicate the severity of the warnings. NWS is exploring ways to make its information easier to find, easier to understand, and easier to apply in operations by the public and the emergency management community, which will result in improved decision making for risk management of life and property.

Our work during the Illinois tornado outbreak, which I described earlier, is an indication of how we are beginning to address these concerns.

Evolving the NWS Service Delivery Model

Population growth, growing infrastructure threats, and an increasingly interdependent economy are creating new challenges for the Nation. At the same time, science, technology, and communications are rapidly advancing and providing potential solutions that will enable the NWS to better meet our country's needs. As the world has changed, so too has the NWS in many aspects. We have advanced our scientific and technical capabilities to better meet the needs of Americans. The result is an organization with a greater capacity to provide timely information to protect lives and property. However, more needs to be done to ensure we can change as quickly as society demands to meet its ever changing needs.

Adjusting the NWS service delivery model to reflect current demands and to meet society's evolving and future needs is essential to ensuring safety of life and property, and enhancing the economy. Recent studies by the National Academy of Sciences validated the need for improvements in numerical weather prediction, increases in decision support services, better partnerships with the private weather enterprise to advance a Weather-Ready Nation initiative and meet society's needs. NWS needs to be flexible to meet evolving needs and become second to none.

The FY 2014 President's Budget request builds on the Disaster Relief Appropriations Act of 2013: to increase our operational high performance computing capacity for improved numerical weather prediction; increase consistency in our forecasts and messaging; solidify our technical and communications dissemination infrastructure; increase research in Decision Support Services; accelerate the transition of proven research into operations; and work with our employees through the National Weather Service Employees Organization (NWSEO) to make all this happen. We believe these aims are all supported by the best advice we have from the NAS, and are consistent with the advice we received from NAPA. We are also sure there is much more that needs to be done and we are committed to working with Congress, the weather enterprise, and ultimately the entirety of U.S. society, to create the agile and effective NWS required to build a Weather-Ready Nation.

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[4] "Weather Ready Nation: A Vital Conversation on Tornadoes and Severe Weather." This activity was co-supported by NOAA/NWS and the National Science Foundation. A follow-up meeting in April 2012 in Birmingham, AL—"Weather Ready Nation: Imperatives for Severe Weather Research" was also jointly supported by NOAA/NWS and NSF. *http://www.nws.noaa.gov/com/weatherreadynation/workshops.html*

Given the rapid rate of change, NWS needs to be quick, flexible and agile to meet society's rapidly changing needs. NWS is looking ahead to a broader, end-to-end and comprehensive strategy that creates an organization capable of change. This is essential as we move toward a more fully integrated field office structure issuing improved and consistent forecasts and warnings, especially for extreme events. The discussion will focus on what services the U.S. needs from NWS and how best to provide these. Streamlining and refocusing of the NWS budget structure by aligning the budget to function and linking to performance and transparency may be another element of change.

This strategy will enable us to transform the NWS into an agile, responsive organization that can adapt quickly to new missions and integrate new science and technology without a large Federal investment. NWS must have orderly, deliberate, continuous and transparent mechanisms to explore new operating concepts, tools to inform decision on changes, and safeguards to ensure no degradation of services while implementing changes to operations. Both headquarters and field operations cannot be realigned simultaneously. NWS is analyzing current headquarters functions to ensure capabilities will be in place to support and lead field operations. This must include the capacity to redesign and implement service delivery model improvements for the NWS that prioritizes our ability to meet the evolving demands for our products, services and forecaster expertise. We are planning to have a NWS headquarters designed for the new, more agile NWS. The National Weather Service plans to begin its transformation in FY 2015 by engineering NWS Headquarters functions to align with current operations and meet the evolving needs of the future. This includes such functions as implementing a fully integrated field structure with consistent national products, resourcing dissemination properly and sharing the best practices of our forecasters and field structure to speed innovation; all the while running a transparent and accountable budget formulation and execution process.

For the Modernization and Associated Restructuring (MAR), the NWS used extensive test and evaluation of new technology and service delivery concepts. It was strictly internal to NWS with limited stakeholder input and participation. For the future NWS, all programs and office types are included—WFOs, RFCs, national centers—and we expect full stakeholder participation in the development, testing and evaluation stages with a strong focus on evaluation to determine the viability of implementing the "tested" technology or services into operations.

NWS will follow the recommendations from both NAS and NAPA and develop a deliberate process that engages all stakeholders, users and partners, including NWSEO. What we know is that the status quo will not do and for the future, with whatever service delivery model is developed, NWS needs to operate in a new paradigm. NWS will choose what to develop and test, with no presupposition of a larger or smaller agency. We will employ a stringent evaluation that informs investment choices—with the appropriate level of investment determined by Congress and the Administration. The outcome is: NWS tests and demonstrates possible changes in services and operations, and that testing and demonstration is fully open to stakeholders, encouraging and soliciting their participation. The results, rather than unfounded assertions, drive change toward a Weather-Ready Nation.

Conclusion

NWS forecasts, warnings, and community-based preparedness programs are vital in enhancing the economy and saving lives and property. It all starts with a commitment to environmental observations, to research and improved forecasting and warnings, to our people—forecasters, modelers, technicians and managers and it ends with a Weather-Ready Nation in which businesses, governments, and people are prepared to use those forecasts to mitigate impacts. In spite of our best efforts, severe weather events still cause loss of life and significant damage. We recognize that there is always room for improvement. I am proud of the NWS especially our people who are on the front lines delivering critical products and services every day to help keep our citizens safe. We are government at its best. But I need each of you to know that we can do better. Even more of these impacts could be mitigated with more timely, accurate, and focused forecasts, watches, and warnings. The impacts and lives lost from the disasters experienced over the past year alone would have been far worse without NOAA's observations, research, forecasts, people and the extensive work of our Federal, non-federal, state, local, academic and commercial partners to improve the Nation's preparedness for these events through education and outreach.

The protection of the people of the U.S. from the devastation that weather can bring is a sacred trust and duty given to the NOAA. Together, we must ensure NWS services and operations lives up to this trust and duty. We have come a long way,

but there is more we need to do to become a Weather-Ready Nation—to be ready for the event, to be responsive, and to be resilient.

Senator BEGICH. Thank you very much, Dr. Uccellini.

Let me say that the vote just started, so what we might be able to do with four of us here is get through our questions, and then maybe we might pause and then do the two votes, and then come back and hear from the next panel. We might be able to double it.

But let me ask you. I want to ask you first on the—we'll have 5 minutes. On the rebalancing issue and kind of restructuring, you had said it's kind of on schedule or on time. So let me ask you, do you have—when you say that, is there a timetable that you're kind of working under? Is there something that you could maybe produce for the Committee, unless you know it now, that you could say here is the time schedule that we're on and how we're meeting our metrics?

Dr. UCCELLINI. The two items that I referred to is the restructuring of our National Weather Service budget—we have been working this through the Executive Branch and through the Department up to OMB. We are working toward a schedule of implementation in the 2015 timeframe.

Senator BEGICH. So that would be reflected in your budget for 2015?

Dr. UCCELLINI. That is the plan.

Senator BEGICH. OK.

Dr. UCCELLINI. And with respect to the headquarters restructuring, that is an activity that's working in parallel, so that the headquarters process will be in full alignment with the new budget structure.

Senator BEGICH. Let me ask you the issue we briefly talked about yesterday, but you mentioned close to your closing there, on the U.S. weather research program. Remind me. That is authorized but nothing has been added to it money-wise or other aspects; is that correct?

Dr. UCCELLINI. Yes. The U.S. weather research program is a program developed in the 1990s. It's authorized within NOAA. It represents a partnership of NOAA, National Science Foundation, NASA. It involved researchers from around the country in the academic community, in the private sector. It developed plans. We had trouble executing according to those plans because of budget limitations.

Senator BEGICH. Let me ask you another issue, on the Arctic operations. As you know, a lot of activity is certain to occur up there for oil and gas exploration. Also, the Bering Sea has a lot of movement. More ships are going through the area. Can you give me kind of a sense what more needs to be done with regards to the work you need to have up there for the National Weather Service? Not only for the Coast Guard, but for the private sector that's going to be critical for oil and gas development, but also all the transportation going through the Bering Sea and the Arctic. Could you give me a little sense on that?

Dr. UCCELLINI. The administration and NOAA have recognized the growing strategic importance of the Arctic and commercial importance, transportation importance of the Arctic. We are working very closely with other agencies on science and service plans. I

think one of the major issues that we're working toward is the improved prediction, for example, of the ice fields both as they're created and then as they melt. So the National Weather Service in particular is working on those types of issues and also on the provision of services through the Alaska region in the forecast offices up there to serve those needs.

Senator BEGICH. This will be my last question because I want to—well, let me—when you look at the public and private sector kind of work you're doing, what is the most pressing issue that you believe is not getting the resources you need? In other words, there's a lot of stuff you're doing internally, then there's stuff that the private sector is out there kind of doing, but then there are those partnerships that, as we've talked about, are pretty critical to the long-term health of the agency.

Can you tell me, if you were to kind of prioritize, here's the one or two things that just if you had more help and more resources—and I know the OMB people are monitoring us right now, so they're watching what you might say. So I would ask you to be free and open and I will take the blame. So if you could tell me what one or two of those issues might be?

Dr. UCCELLINI. First of all, I believe that the partnership between the private and public sector is excellent and it's really been productive in the provision of services, not only to the general population, but to their tailored—how they tailor their products and services to individual customers. And we work in full partnership with them as we move forward.

One of the particular areas that they've brought to the table over the last several years is the more efficient provision of our digital data bases, especially coming out of the numerical models. We are working with folks from the private sector to explore ways that would give them ready access to our models and at model resolution. That's just turning into—it is a major technological challenge, but we are moving forward in that arena.

We'll work creative ways with them to address any of the issues between the private and public sector.

Senator BEGICH. Great. Thank you very much.

Let me pause for a second. We have just a few minutes left on the vote, so what I can do is I will say the order is Rubio, Wicker, Klobuchar, Schatz. I'm going to go vote. That gives you a sense of where you are on the list, and we'll go to Senator Rubio.

Senator RUBIO. Do you want me to filibuster?

Senator BEGICH. No, take 5 minutes.

Senator RUBIO. No, I only have—I only have a few questions.

Senator BEGICH. We got rid of that rule on filibuster.

[Laughter.]

Senator RUBIO. Even on questions? OK.

Let me just ask you—first, thank you for being here, Doctor. I appreciate it very much. What steps have you taken to implement the recommendations made by the National Academy of Public Administration, and what remains outstanding?

Dr. UCCELLINI. We have taken steps—first of all, let me just say that I came on board in this position in February 2013 and since that period of time we've had a lot of budget uncertainty, a lot of challenges that we've had to face.

What the Academy specifically emphasized is to establish a process for change and to start working through that. We certainly have had discussions along that line. Specific areas that they pointed to was the budget restructuring and the headquarters realignment, and we are working very actively in that arena. It was my highest priority coming into this position, and I believe we're making extraordinary progress along those lines.

We're also addressing what they pointed to in terms of the research to operations issues. We believe this budget restructuring will actually allow us to provide a more effective catcher's mitt to the research community.

Last but not least, we're working as best we can under the current circumstances on addressing the consistency issue with respect to our products and services that were also cited as an essential area that we had to move forward on.

Senator RUBIO. My final question, for the interest of time, is what are you doing to better leverage private sector data and satellite infrastructure?

Dr. UCCELLINI. Well, the private sector data, we—for example, aircraft, commercial aircraft data, is an area that we are adjusting. It's a critical part of our data stream to feed into the models. We also are exploring ways of commercial buys on Mesonet data, the surface data.

With respect to the satellite, we are certainly a major partner in the effort to work with the research satellite data through the Joint Center for Satellite Data Assimilation. That's a NASA-NOAA-DOD joint enterprise. We're working with all the research satellite data. We're positioning ourselves for the next generation of polar orbiting and geostationary data to be able to use those effectively, what I call at day one, when they're launched. We're really looking forward to the improvements that will be associated with those data streams.

Senator RUBIO. Thank you.

Senator KLOBUCHAR [presiding]. I'll just ask one question and then toss it over, actually two very quickly. One is the sequestration, the effect that's had on your Weather Service, and if the new budget helps at all with changing that, the proposed budget?

Dr. UCCELLINI. Well, the sequestration and when it was implemented, halfway through a Fiscal Year, had a major impact on us. We had to plan for a potential for furloughing because of the budget cuts associated with that. The reprogramming that occurred in the June-July timeframe allowed us to avoid those furloughs. But the uncertainty associated with the budget, even as we have the uncertainties today, did not allow us to effectively plan and move forward.

So what we had to do with respect to the sequestration is NOAA implement a NOAA-wide hiring freeze, which we operated under. There's a board, a review board, and we bring high priority positions to that board to ensure that we have the field structure that can provide the services.

But clearly this is a critical concern to us and the uncertainties in the budget really do not allow us to plan forward in an effective way.

Senator KLOBUCHAR. Thank you. Just with 30 seconds, are you doing more to improve the flood forecasting accuracy?

Dr. UCCELLINI. Yes. It's one of the major tasks, not only of the modernization of the Weather Service, but since. The flash flood and the river flood forecast are a major component of our efforts, and a number of these model improvements we're pointing to not only affect the atmosphere, but the hydrology as well, which is essential for improving our flood forecasts.

Senator KLOBUCHAR. I appreciate your work. Thank you.

Dr. UCCELLINI. Thank you.

Senator WICKER. Doctor, as I mentioned, after a hurricane hits it's very important to determine whether the cause of damage was wind or water. That's the purpose of the Coastal Act. I know that NOAA has begun implementing the major provisions of the Coastal Act, including the development of a storm event model. What is the status of the development of the Coastal Act storm event model and is NOAA on track to meet upcoming deadlines mandated by the Act?

Dr. UCCELLINI. First of all, we are working with the Federal, private, and academic partners. We've made progress in establishing the policy framework and the prototype coastal wind and water event data base. I have to say that the current budget environment will limit the capabilities to move forward, to test, assess, and implement the new named storm event model.

So we've met the existing milestones, but in terms of testing and executing against the new named storm event model there will be challenges with the current budget environment.

Senator WICKER. Realizing that that may slow you down, you'll still be able to proceed, though perhaps on a slower track; is that correct?

Dr. UCCELLINI. The pace at which we will proceed will be painfully slow, I'm afraid. This is a major, a major effort to implement this storm event model. So I would prefer getting back to you with details on what the impact would be and what it would do to the milestones related to the implementation of that model.

Senator WICKER. I would appreciate your getting back with a supplemental answer for the record.

What Federal agencies, private industry partners, and academic institutions are you working with?

Dr. UCCELLINI. Well, the cross-agencies have to do with the collection of the data. We're working with the Climate Center within NOAA to pull these data bases together and to implement the website. The academic community, of course, is located within the Gulf region and the coastal regions to deal with these types. Then the insurance industries themselves are knocking at the door in terms of the information aspects.

So we're being responsive to this, this consortium in a sense of groups, as we move this database forward. Obviously, the storm event model is something that we are working more internally within NOAA to bring forward.

Senator WICKER. Thank you very much.

Senator RUBIO. I think what we're going to do is we're going to go into a brief recess while the members vote on the first vote, and

then we'll vote on the second vote, which will be right after, and then we'll be right back. I think it'll take about 15 minutes.

So the Committee will stand in recess until we all return.

[Recess from 11:10 a.m. to 11:14 a.m.]

Senator BEGICH [presiding]. Thank you very much. We're trying to strategize here on what we're going to do next, but I'm glad the Senators have gotten their questions in.

Senator Schatz is next and the plan would be, just so folks know, we'll monitor the vote. If the vote, the second vote, starts, we'll pause, we'll go vote, and then Senator Schatz will take over as the Chair of the Committee, as I'm unable to stay for the full hearing. But let's go ahead, Senator Schatz.

Senator SCHATZ. Thank you, Chair Begich.

I just have one question. It has to do with the use of social media in terms of mobilizing people in the case of disasters. When I was Lieutenant Governor in Hawaii and we had two tsunami events which didn't end up being very serious, I saw the advantages and disadvantages of social media, in particular Twitter, for emerging events. And I'm wondering what kind of thinking you're doing, whether there are best practices being developed, because I see it as a tremendous asset, but also potentially problematical in terms of getting the wrong information out and possibly causing panic and dangerous situations as a result of incorrect information.

So what are we doing in terms of trying to wrestle this alligator to the ground, utilize it the best we can, but also understand that there's probably nothing we can do to prevent people from using social media, and so in my view the best thing we can do is to make sure that we get the right information out and use our friends in social media to get the word out on our behalf. But I'd be interested in your thoughts.

Dr. UCCELLINI. First of all, what we have learned over the past 10, 20 years as this way of disseminating information and way of bringing information in is changing rapidly is that we need to embrace those changes. This is not only to provide multiple means of getting our critical information out to those that are in greatest threat, but also to bring information in of what's actually going on. We're seeing this over and over again, that, whether it's the tweets, the Facebook accounts, they are providing a valuable source of information to us for what's actually happening out there in many critical situations.

We have learned through a number of meetings, conversations with social scientists, with first responders, with the emergency management community, that people will rely on multiple sources of information before they will make a decision. But what really is important to them is what's coming to them, and increasingly through cellphones. So we've been very active in making sure that we get consistent messages out through these various means of communications, and the social media aspect of that is very large.

The recent example in Washington, Illinois, where people in church were receiving warnings focused right on their area through their cell phones, is an illustration of that. They were able to take action and basically save their lives.

So we embrace it and we will continue to work with the advances associated with the social media.

Senator SCHATZ. It sounds to me as though you are aware of it, you are riding it, you are utilizing it, but that you're not quite ready to articulate best practices—which, by the way, I think we may not be ready for that because by the time we're done with a social media policy it will be obsolete. But it is I think important to kind of figure out from a staffing standpoint and from a communications strategy standpoint how to separate it out.

I saw in our emergency operations center someone who was generating press releases and handling the television media, and our civil defense Twitter feed was posting something every 90 minutes, which just wasn't going to work. So I'm just interested in making sure that we are aggressively staying on top of it. We don't have to codify anything, but I think we do need to make sure that we're actually devoting personnel to this particular proposition, because so far it's been mostly beneficial, but I saw a couple of instances where bad information was getting re-tweeted and caught fire on the Internet, and it was very, very difficult to unravel once it had been spread.

Dr. UCCELLINI. Let me assure you, whether it's within the Weather Service or how we reach out through our private sector partners and the academic community, we are very much engaged in this issue and moving forward with it. We understand exactly what you're saying. It's one of the reasons why, from a best practices perspective, we want to ensure the consistency of our products as they go through these multiple sources, to ensure that we get that message out in a very straightforward way and a very consistent way.

Senator SCHATZ. Thank you.

Senator BEGICH. Thank you very much, Doctor. We appreciate, one, your willingness to serve, public service. Thank you for being here. Thanks for giving some good information. There will probably be some questions for the record later. But again, just wanted to appreciate you being here.

I know—I think you had some foreign travel you rearranged to be here today, and we greatly appreciate it. I know the work we do is not just domestic, but we have international relationships with our weather work. So I know that's an important part. I know you had to rearrange your schedule and around the holiday season it is hard to do that and make sure you can still get a seat on the planes later.

So thank you very much for being here today, and we will dismiss you from this panel.

Dr. UCCELLINI. Thank you.

Senator BEGICH. Thank you very much.

What we'll do now is we'll ask the next panel to go ahead and set up. What we'll attempt to do while we're waiting for the second vote to start, we will have the panelists start their testimony. And we may pause you in between so we can go vote. Then what will happen is Senator Schatz will come back and be running the meeting, chair the meeting, and finish out the meeting.

So please, can we have the next panel come forward.

[Pause.]

Senator BEGICH. Thank you all again for joining us. I appreciate it.

Mr. Myers, I feel like you're like the Lone Ranger. Everyone's off to the side from you. I don't know if that means you get the hardest questions. I don't know about that.

But we want to thank you all for being here this morning. What we'll do is we'll just start going right down the row here. Like I say, we may pause you in between after one of your testimonies just so we get time to get back here.

So let me first go to Dr. William B. Gail, President-elect, American Meteorological Society. Please, Mr. Gail.

STATEMENT OF WILLIAM B. GAIL, PH.D., CO-FOUNDER AND CHIEF TECHNOLOGY OFFICER, GLOBAL WEATHER CORPORATION (GWC); PRESIDENT-ELECT, AMERICAN METEOROLOGICAL SOCIETY (AMS) AND MEMBER, COMMITTEE ON THE ASSESSMENT OF THE NATIONAL WEATHER SERVICE'S MODERNIZATION PROGRAM, NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES

Dr. GAIL. Chairman Begich and distinguished members of the Subcommittee: It is a privilege to be present here today and to testify. Thank you for the invitation. My name is Bill Gail. I am cofounder and CTO of Global Weather Corporation, a successful startup that exemplifies the growing commercial opportunities in weather. I'm also President-elect of the American Meteorological Society.

I'm speaking to you today primarily as a member of a committee chartered by the National Research Council of the National Academy of Sciences. We recently reviewed the past and future of the National Weather Service and released two reports. The first described how the Weather Service modernization of the 1990s introduced major improvements to our Nation's weather observing systems and to the Weather Service structure. This was needed to remedy inadequate modernization from several decades prior. The committee felt the Weather Service successfully learned most lessons from the modernization and it has since continued to modernize.

In the second report, titled "Weather Services for the Nation: Becoming Second to None, Look to the Future," we found that today's challenges are no less important than those of the 1990s modernization. However, the challenges today are largely external, reflecting the ever-evolving user needs and technology context.

The Committee identified three key challenges: one, keeping pace with advances in science and technology; two, meeting society's expanding needs for better weather information; and three, effectively collaborating with the larger enterprise to achieve the greatest public benefit. Meeting these key challenges will require the Weather Service to evolve its role and how it operates.

We made three recommendations. Our first was that the Weather Service should refocus on its core capabilities. These include creating foundational data sets, performing essential functions, such as forecasts and warnings, and conducting operationally-related research. All are needed for the Weather Service to perform its central role of protecting lives and property and for it to support the enterprise as a provider of additional services. Accomplishing this requires the Weather Service to prioritize those things only it can

do and avoid duplicating capabilities where viable alternatives exist.

Our second recommendation was to update Weather Service function and structure. The current structure reflects roles appropriate to the 1990s. Technology has changed much of the rationale for the present structure. We anticipated that the since-released NAPA report would add needed details in this area.

Our third recommendation addressed the need to better leverage the larger enterprise of organizations providing weather services and systems. The relationship between the Weather Service and the rest of the enterprise has improved considerably since the modernization, with praise deserved by all parties. Improved leveraging enhances the Weather Service's ability to serve the Nation and allows it to enhance its services at a time when its own resources may be constrained.

The Committee believed that meeting today's challenges will require changes at the Weather Service over as much as a decade. The result will be a more agile and effective Weather Service. In a constrained resource environment, this approach makes possible benefits to the Nation beyond what the Weather Service budget alone allows.

My personal experience starting a weather company is a testament to the report's recommendations. This is indeed a great time to be part of this community. Through ongoing technological and scientific improvements, we can serve the Nation, our citizens, and businesses far more effectively than has ever been possible before.

Why is this important? Superstorm Sandy and recent tornadoes in Illinois, Alabama, and Oklahoma remind us that we can and must do far more to protect lives and property. There is also great potential for weather information to be a growth engine for the economy. On average, weather variability alone alters economic output up to 3 percent at the State level from one year to the next.

Indeed, in every market my company enters we find opportunity for efficiency improvement. For example, Excel Energy uses 10 percent of America's wind farm capacity. Improved wind farm forecasts we provide have saved over $22 million for their ratepayers. The trucking industry lost $18 billion in 2011 to weather-related accidents and delays. Yet weather forecasts are not routinely used. A company called Telogis is about to change that using our services to offer weather and road condition forecasts for every mile of major road in the country.

The Nation will benefit from strong, visionary efforts to achieve long-term weather readiness. The weather community, built from the most dedicated people you will find anywhere, is committed to serving the Nation. We are working aggressively toward the readiness goal and welcome your support.

Thank you for the opportunity to testify and I would be pleased to answer your questions.

[The prepared statement of Dr. Gail follows:]

PREPARED STATEMENT OF WILLIAM B. GAIL, PH.D., CO-FOUNDER AND CHIEF TECHNOLOGY OFFICER, GLOBAL WEATHER CORPORATION (GWC); PRESIDENT-ELECT, AMERICAN METEOROLOGICAL SOCIETY (AMS) AND MEMBER, COMMITTEE ON THE ASSESSMENT OF THE NATIONAL WEATHER SERVICE'S MODERNIZATION PROGRAM, NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES

Chairman Begich, Ranking Member Rubio, and distinguished members of the Subcommittee: It is a privilege to be present here today and to testify. Thank you for your invitation. My name is Bill Gail. I am co-founder and Chief Technology Officer of Global Weather Corporation, a provider of precision weather forecasts to businesses within the energy, media, transportation, and consumer sectors. I am also President-Elect of the American Meteorological Society (AMS), and I was a member of the recent National Research Council study *Weather Services for the Nation: Becoming Second to None* that recommended future directions for the National Weather Service. My academic training is in physics and electrical engineering and I have over two decades of experience in the fields of meteorological satellites, weather services, and location-aware software.

Let me first commend you for the attention you are giving to the topic of U.S. weather readiness. Support for our Nation's weather infrastructure pays off many times in benefit to the nation, and legislation to accomplish that is wise. Properly crafted legislation, sufficiently comprehensive in scope and not overly prescriptive, can help achieve what I believe is a broadly supported objective of elevating the Nation's weather, water, and climate capabilities.

I'll begin by speaking to you today in my role as a member of the Committee that produced the *Second to None* report for the National Research Council (NRC). The Research Council is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology. I will conclude by providing personal perspectives based on my experience starting a company in this expanding industry. My company has been successful in today's difficult economy precisely because high quality weather information is increasingly needed by our Nation's businesses across many industries to serve their customers, improve operations, and be competitive in the global marketplace. For this statement, I draw directly on prior testimony I have given in the House on similar topics.

PART I

Background of the NRC *Second to None* report

The *Second to None* report, released in August of 2012, was the final report of a two-part assessment of the National Weather Service's Modernization and Associated Restructuring (MAR). The report's title states nicely what the Committee believed deeply and what I understand you are seeking with this hearing: ensuring world-leading capacity of the U.S. weather enterprise so as to best serve our Nation.

In the first report, the Committee was asked to perform an overall review of the MAR, which was initiated in the 1980s and completed about a decade later. During that time, major upgrades were made to the satellite, radar, and ground-based observing systems. In addition, the field offices and national centers underwent significant restructuring and major staffing realignment. Although the MAR faced many difficult lessons during this decade-long process, the Committee concluded that it was a success and worth the investment. One of the most striking results has been the improvement in the probability of detecting and issuing warnings for severe weather events. For example, the probability of detection for flash floods increased from about 40 percent to about 90 percent over the course of the MAR.

The second report, referred to widely as *Second to None,* presents forward-looking advice for the National Weather Service (NWS) on how best to plan, deploy, and oversee future improvements based on lessons from the MAR. I will focus on that report in the first half of this statement.

Identifying Today's Key Challenges

The MAR produced major improvements to our Nation's weather observing systems and to the NWS structure. It was primarily the response to an internal failure to properly modernize the technology base and organizational structure from the mid 1950s to the early 1980s. The Committee felt that the NWS successfully internalized most lessons from the MAR, and has since continued to modernize to the extent that resources have allowed. Yet today the challenges the NWS faces are no less important than those that motivated the MAR era. However, rather than internal failures, today's challenges are largely external, reflecting the ever-more rapidly evolving user needs and technology context of our society. These challenges include:

- *Keeping Pace.* The pace of scientific and technological advancement in the atmospheric and hydrological sciences continues to accelerate. As an outgrowth of public and private-sector investment, technology advancements are exceeding the capacity of the NWS to optimally utilize these technological achievements. Furthermore, enormous amounts of data generated by new surface networks, radars, satellites, and numerical models need to be rapidly distilled into actionable information to create and communicate effective public forecasts and warnings. The skills required to comprehend, manage, and optimize this decision-making process go beyond traditional meteorological and hydrological curricula. Hence, the NWS workforce skill set will need to evolve appropriately.
- *Meeting Expanding and Evolving User Needs.* Increasingly, the United States is an information-centric society. Meteorological and hydrological information in particular is central to societal security and welfare. Unlike some other industries, weather is largely an information-based enterprise. The public expects continuous improvement in public safety and property protection related to severe weather.
- *Partnering with an Increasingly Capable Enterprise*.[1] At the time of the MAR, delivery of weather information was largely synonymous with the NWS, the broadcasting sector, and those private-sector suppliers of weather data and services that supported the broadcasting sector (and a few specialized industries). Outside of this, the weather, water, and climate enterprise had limited capacity. Today, the enterprise has grown considerably, and now the NWS has many important partners. *All of these entities rely on core NWS infrastructure and capabilities to provide customized services.* Together this combination of the NWS and third parties serves the Nation better than the NWS could on its own.

Today's challenges are made more difficult by the external context, two areas of which are of particular importance:

- *Budget resources* are uncertain and will likely be constrained for the next decade.
- *Operational performance standards* against which NWS is measured, including those set by international weather service counterparts and private-sector entities, are increasingly high.

Additional important contextual issues include: the transformative pace of technological change; expansion of the number and type of observational data; continued concentration of infrastructure investment and population growth in vulnerable areas; the possibility of changing weather patterns arising from climate change; and ongoing evolution of international dimensions.

Responding to the Challenges

Meeting today's key challenges will require NWS to evolve its role and how it operates. The goal is for it to become more agile and effective. This report presents three main recommendations for accomplishing this: Prioritize Core Capabilities, Evaluate Function and Structure, and Leverage the Entire Enterprise.

I. Prioritize Core Capabilities

The NWS needs to prioritize those core capabilities that only the NWS can provide so as to deliver the products and services upon which the public and the entire national weather, water, and climate enterprise depend. These core capabilities include creating foundational datasets, performing essential functions such as issuing forecasts, watches, and warnings, and conducting operationally-related research.

Recommendation I: The National Weather Service (NWS) should:

1. Evaluate all aspects of its work that contribute to its foundational datasets, with the explicit goal of ensuring that those foundational datasets are of the highest quality and that improvements are driven by user needs and scientific advances. As part of this initial and ongoing evaluation effort, clear quality and performance metrics should be established. Such metrics would address the technical components of NWS operations, as well as the efficiency and effectiveness of the flow of weather information to end users.

[1] The "enterprise" includes all entities in the public, private, non-profit, research, and academic sectors that provide information, services, and infrastructure in the areas of weather, water, and climate. For the purposes of this report, "enterprise" is often used as shorthand to refer to those enterprise elements outside NOAA that it can draw on in its mission. The non-NOAA portion of the enterprise is now of equal or greater economic size compared to the NOAA portion.

2. Ensure that a similarly high priority is given to: (a) product generation and dissemination; (b) the brokering and provision of data services, and (c) development and enhancement of analysis tools for maintaining a common operating picture (COP).
3. Engage the entire enterprise to develop and implement a national strategy for a systematic approach to research-to-operations and operations-to-research.

In support of this recommendation, the NWS should:

- Continue effective technology infusion programs,
- Improve numerical weather prediction systems,
- Develop and advance observational data metrics,
- Lead a community effort to provide probabilistic forecasts,
- Develop hydrologic prediction metrics, and
- Maintain an ongoing capability for development and testing of its incremental technical upgrades.

II. Evaluate Function and Structure

The current structure of the NWS primarily reflects the functions of the weather, water, and climate enterprise in the 1990s. Technology, including improvements in communications and computer forecast models, has changed much of the rationale for the present organizational structure of the NWS. In view of the directions outlined in NWS's *Weather-Ready Nation Roadmap* for expanding the role of forecasters and other NWS staff, it would be prudent to evaluate the NWS's organizational and functional structure.

Recommendation II: In light of evolving technology, and because the work of the National Weather Service (NWS) has major science and technology components, the NWS should evaluate its function and structure, seeking areas for improvement. Any examination of potential changes in the function and organizational structure of the NWS requires significant technical input and expertise, and should include metrics to evaluate the process of structural evolution. Such an examination would include individual NWS field offices, regional and national headquarters and management, as well as the National Centers and the weather-related parts of the National Oceanic and Atmospheric Administration (NOAA) such as the National Environmental Satellite, Data, and Information Service (NESDIS) and the Office of Oceanic and Atmospheric Research (OAR).

In support of this recommendation, the NWS should:

- Broaden the scope of its post-event evaluations,
- Expand its vision of team structures and functions within and between forecast offices,
- Develop performance metrics-based approaches to assessing staff skill sets,
- Retrain service-hydrologist staff to instill an evolutionary culture.

III. Leverage the Entire Enterprise

The relationship between NWS and the rest of the enterprise has improved considerably since the MAR, with praise deserved by all parties. The Committee views further improvement of NWS-enterprise interaction as a way to enhance the NWS's capability to accomplish its mission of serving the public. This is especially important when it is seeking to enhance its service at a time when the Nation faces constrained resources. Leveraging the entire enterprise provides one means to further NWS's mission of serving the public.

Recommendation III: The National Weather Service (NWS) should broaden collaboration and cooperation with other parts of the weather, water, and climate enterprise. The greatest national good is achieved when all parts of the enterprise function optimally to serve the public and businesses. This process starts with the quality of core NWS capabilities but is realized through the effectiveness of NWS-enterprise relationships. A well-formulated enterprise strategy will also return direct benefit from the enterprise to the NWS, especially in areas of shared research, technology development, observational data sources, and improved end-user access to NWS-generated information.

In support of this recommendation, the NWS should:

- Seek to better understand the functioning of the secondary value-chain (defined as enterprise partners that provide value-added services beyond dissemination of NWS weather and warnings), and
- Strengthen its systems engineering and procurement processes for major systems.

PART II

A Revolution in Service to the Nation

Now let me turn to my personal perspective, derived from my experience starting a weather services company in this challenging economy and from my role as incoming president of the American Meteorological Society (AMS).

I have found this to be a tremendous time to be part of the weather community. We have the opportunity to serve the nation—our citizens and businesses—far more effectively than has ever been possible. The reason is simple. Our work involves three basic activities: observing the current weather, converting that information into forecasts, and getting the information to the people who need it. Over the last fifty years, this three-step process has been revolutionized. Starting in the 1960s, the advent of advanced observing systems such as satellites and Doppler radar gave us new ways to view current weather. Then in the 1980s advances in both computing power and modeling techniques began to make possible far more accurate forecasts of future weather. More recently, rapidly expanding Internet access and now smartphone ownership have allowed us to make great progress in delivering the right information to people and businesses—at the time they need it.

For us, getting to this point is a dream. After fifty years, the fruits of the weather information revolution are now within reach. We can finally start delivering on the ultimate vision: individualized weather information matched to every user's need, time, and place. With that, we in the weather industry can do phenomenal new things, not only for the Nation but also as leaders in the weather market internationally. NOAA's newly-developed strategy, the *Weather-Ready Nation,* is nicely aligned with this vision.

Why is this important? We have all been touched by the tragic tornados in Oklahoma, Alabama, and Illinois over the past few years, and by the devastation of Superstorm Sandy. With Sandy, we were successful in anticipating an unusual westward turn toward New York City—it made a huge difference in our preparedness. For Oklahoma, we forecast with over 30 minutes lead time, but more accurate track estimates and personalized communications would have helped. Getting the right information to people and businesses at the right time is critical.

A Growth Engine for the Economy

We know more can be done to protect lives and property, and we must do so. But often forgotten is the importance of weather information as a growth engine for our economy. A recent study showed that, on a state-by-state basis, variability in U.S. economic output due to weather-related supply and demand inefficiencies averages more than 3 percent. In some states, it is over 10 percent. A significant portion of this can be recovered as economic growth through improved weather information. Doing so would be a huge boost to the Nation's welfare. As we seek ways to grow our economy, better use of weather information can provide large returns from small investments. This is true across virtually all business sectors.

Many of us today, from academia to NOAA to the commercial sector, are focused on ways to accomplish this. The commercial sector is expanding because there are customers within the public and the business sector who derive real value from what we do. My startup company is a perfect example. In some cases, we are having trouble keeping up with the demand because it is growing so fast. I would like to provide three examples from my own company's experience reflecting innovative approaches to business growth through better use of weather information.

- The BH Media Group, owned by Berkshire Hathaway, has recently acquired nearly 100 small-and mid-sized newspapers. Their vision is that newspaper companies are not dying, but rather the best source of critical local information, which will be delivered by these companies increasingly over web and mobile. Accurate weather forecasts are often the most important information they provide to smaller communities. The move to web and mobile allows them to customize forecasts for each reader, creating new ways for businesses to become more efficient and individuals more productive. My company is helping them implement the vision.
- Xcel Energy is the off-taker utility for 10 percent of America's wind farm capacity. Starting in 2009, Xcel privately-funded R&D at the National Center for Atmospheric Research (NCAR), focused on improving the accuracy of wind forecasts. The resulting forecast system has since been successfully transitioned to my company. Its operational use has saved over $22 million for Xcel ratepayers.
- Telogis is a provider of information services to the commercial vehicle industry, including back office and in-cab navigation. They support nearly a million trucks in the U.S. In 2011, this industry lost nearly $18 billion to weather-re-

lated accidents and delays, yet weather information is not routinely used by trucking companies. My company is working with Telogis to change that, providing atmospheric weather and road surface conditions for every mile of major road through interfaces that can be easily and safely used by truckers.

The Remarkable Weather Enterprise

None of this could happen without a remarkable collaboration between three organizational sectors: academia, government agencies such as NOAA and the DOD weather services, and the commercial sector. We refer to this as the *American weather enterprise.* Academic and research organizations (which may involve all three of the sectors) are the foundation, providing the basic knowledge that drives innovation and the education for our workforce. Government agencies including NOAA provide the core data and forecast capabilities used across the enterprise. The commercial sector customizes information for end-users and delivers it across many channels, through what we call the secondary value-chain (direct delivery to the public by NWS is the primary value-chain). For example, though NOAA is the original source for virtually all weather information in this nation, today 95 percent of delivery occurs through this secondary value-chain via television, websites, and apps from the commercial sector. By working together, this enterprise has greatly improved the quality of weather forecasting and the ability to deliver that information effectively. Collaboration allows us to be bigger than the sum of our three parts—a key reason for our success. Barry Myers of AccuWeather, in prior testimony to the House, described the American weather enterprise as "better than anywhere on Earth", and I fully agree with his statement.

This shining example of how government works productively with the academic and commercial sectors can be held up to other industries to help them do the same. But it has not always been this way. We have worked hard at making this happen. Indeed, we are entering what might be called the third phase of our enterprise. The first phase, through the 1990s, was characterized by mistrust and competition, particularly between the government and commercial sectors. A decade ago a National Research Council report called *Fair Weather* laid out a process for fixing the situation, and the result has been dramatic. It led us into a second phase of the enterprise characterized by communication and mutual respect. We have made much progress as a result. As we enter the third phase, much deeper collaboration is needed. We are just beginning to build the mechanisms that make this possible, such as a recent AMS-led pilot effort to identify enterprise-wide priorities for forecasting improvement. We need more collaboration like this if we are to meet the Nation's growing needs.

A portion of our community put forth a proposal last fall to form a congressionally-chartered Weather Commission, similar to the successful Oceans Commission about a decade ago. This, some believed, would allow us to address policy issues at a level appropriate to their national importance. A group of community leaders, representing the commercial sector, academia, and non-profits, met in March at a summit in Dallas to consider this along with alternatives. AMS co-sponsored and facilitated the meeting. The Dallas group released last spring a proclamation in which we agreed to a two-prong approach. In the near-term, we are building an advocacy organization called the Weather Coalition and use that as a voice for the community, particularly with regard to possible legislation. For the longer-term, we will pursue options for foundational change, including the possibility of a Weather Commission. The Dallas meeting was a milestone in our ability to speak with a unified voice. You will be hearing from the Weather Coalition in the near future, and they will work with you on any legislation as it progresses.

The Weather Coalition, however, will be only the face of a much larger community-driven planning activity. Much of the planning input to guide the Weather Coalition will come from professional organizations such as AMS which have the broad membership to access and organize community thinking. For example, the AMS-led forecast improvement group, which I mentioned previously, brings together our three sectors to explore development of a joint plan for the Nation's forecast capabilities. The resulting recommendations are publicly available.

Building A Better Enterprise

We are not without flaws as an enterprise. Over the last decade and more, we have struggled with our satellite system and worked to stay competitive with our European counterparts in weather forecast models. We have labored to build mechanisms that help us collaborate across the enterprise and speak with a single voice. NOAA in particular has faced challenges in areas such as the transition from research to operations and major systems procurement. These issues have been openly

documented in reports from the National Research Council, the National Academy of Public Administration, and NOAA's own Science Advisory Board.

Such reports reflect broad input from the community and professional advisory groups. It is time to heed this advice and start implementing the changes needed to fulfill the vision, including NOAA's *Weather-Ready Nation.* Legislation that can accelerate this, and in particular motivate the cultural and organizational changes within NOAA recommended in these reports, is welcome. This must be done wisely and incrementally. Moving forward, additional planning guidance will become available from the Weather Coalition and other sources.

I have talked mostly in terms of weather for the sake of simplicity, but it is important to realize how our strength derives from a breadth of disciplines. For example, we increasingly recognize that space weather is a fundamental counterpart to atmospheric weather. Hydrology and oceanography are key sister disciplines. Disciplines such as coastal meteorology have specific but essential roles. Inclusion and cross-disciplinary integration is something we must prioritize.

Climate is increasingly an important piece of high-quality weather forecasts, especially as the demand for longer lead-time forecasts grows. For the real world in which my company operates, weather and climate can't be separated. There just is no good place to draw a line between them. Indeed, forecasts for coming seasons are enormously valuable to companies in energy and agriculture. The travel and leisure industries take an even longer view; they can benefit directly from improved forecasts of the El Niño cycle even years ahead. Construction companies need to anticipate flood zones and coastal erosion decades out. Our commodities markets—from heating oil to orange juice—could not function without seasonal climate forecasts.

A Path Forward

The issues we must address to make progress are not simple. The problems are interlinked. For NOAA, the solutions require collaboration across many of its organizational elements. Increasingly, NOAA must extend this collaboration to include the enterprise—public, academic, and commercial—as a whole. As we seek ways to move forward, the leadership of our community, including those within NOAA, should be encouraged to innovate and to bring forth new ideas for improving how we work. Truly novel approaches to public-private partnerships that enable open data access and low-cost use of commercial data—not just the old data buy paradigm—are but two examples. Rather than prescribing specific methodologies, legislation that promotes broad innovation in response to community guidance, and provides the resources to accomplish it, would produce results.

Unlike most people who have the honor to serve as AMS president, my career has not been entirely within the field of weather or climate. In addition to weather, I have also worked in consumer software and satellite construction, serving commercial, scientific, and military customers. That gives me a bit of an outsider perspective. My experience is that the people in this field—and I enthusiastically include those in NOAA—are the most dedicated, passionate, and innovative people I have ever met. They have one focus: make the Nation safer and more productive. That commitment to integrity is a rare quality today. In your role as legislators, this can be leveraged to improve our Nation. I believe organizations need to change and progress, and that NOAA would benefit from further focus on modernization. The people within our community can be the foundation for that change.

Success for the Nation

The recommendations in our NRC report *Second to None,* along with those from other advisory reports, provide a sound basis for moving forward. My personal view is that Congress can help make U.S. readiness in weather, water, and climate a reality, and ensure our ongoing leadership of the world community, by focusing on five simple yet fundamental principles:

- *Put Forth Visionary Framing.* Frame the goal of U.S. weather readiness as a core national priority, at the level of national security, through appropriately visionary legislation
- *Rely on Expert Advice.* Build on the excellent existing community advice, including formal advisory reports
- *Define a Path for Change.* Work with us to define a path for successful change, involving all three enterprise sectors and built on transparent processes
- *Include All Enterprise Elements.* Ensure that this change enables all three enterprise sectors and all needed disciplines to best serve the Nation and position the U.S. as a global leader in weather, water, and climate services
- *Allocate Effective Authority.* Provide the right authority and direction to those in government and across the enterprise who are committed to making such

changes and achieving the goal of U.S. weather readiness so they can move forward effectively in its pursuit.

Thank you, once again, for the invitation to testify. I am happy to answer any questions the Subcommittee might have.

Senator BEGICH. Thank you very much.

We just got notified the vote has started. So we'll do, if we can—thank you for being patient—we'll just pause here for enough time for us to go there and vote, and when Senator Schatz comes back here he'll chair the meeting and continue the panel. So if you can just hang tight and relax. I almost said have a drink, but I meant have water.

But please be patient while we go do our vote here.

Thank you very much.

[Recess from 11:28 a.m. to 11:29 a.m.]

Senator SCHATZ [presiding]. Thank you very much, Dr. Gail.

Mr. Young, please proceed. Mr. Young, thank you.

STATEMENT OF A. THOMAS YOUNG, CHAIR, SATELLITE INDEPENDENT REVIEW TEAM, NOAA

Mr. YOUNG. Thank you very much, Mr. Chairman. I'm pleased to have the opportunity to present the results of an independent review of the United States civil weather satellite enterprise. I had the privilege to chair the initial independent review in 2012 and a follow up review in 2013. The findings and recommendations are documented in publicly available reports dated July 20, 2012, and November 8, 2013.

Data provided by NOAA satellites in geosynchronous and polar orbits are mandatory to have accurate, reliable weather forecasting and severe storm warnings. Without accurate, reliable forecasts and warnings, lives, property, and the United States economy are at risk. For more than four decades, the United States has had a robust satellite program that has provided the data to support our incredible weather forecasting system. We have come to take for granted this exceptional capability that has become a critical element of the fabric of our society.

Today this robust capability continues with the geosynchronous system. Current operating systems and future systems under development, namely GOES–R, will serve our Nation well. The GOES–R series is dependent upon funding to maintain schedule to assure there is no gap in the continuity of data.

The status of the polar-orbiting system is more precarious. Currently our weather and severe storm forecasting capability is dependent upon satellites that are operating beyond their design life and a research and development satellite whose data is now used operationally.

Future capability is dependent upon the Joint Polar-orbiting Satellite System, called JPSS, which is under development. JPSS is the only approved future United States polar-orbiting weather satellite program.

Numerous previous decisions have resulted in a fragile, non-robust, polar-orbiting architecture. Current plans for JPSS will result in several years of operation that is one failure from a gap providing data for weather and severe storm forecasting. This is an unacceptable position for data so critical to lives, property, and the

economy. There is an unacceptably high probability of a gap in JPSS polar-orbiting data that could have a duration of months or years. The severe implications of such a gap make it mandatory that a gap-filler satellite program be initiated immediately and urgent changes in the JPSS program be implemented to establish a robust program with a "two failure to have a gap" criterion.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Young follows:]

PREPARED STATEMENT OF A. THOMAS YOUNG, CHAIR,
SATELLITE INDEPENDENT REVIEW TEAM, NOAA

I am pleased to have the opportunity to present the results of an independent review of the United States civil weather satellite enterprise.

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Data provided by National Oceanic and Atmospheric Administration (NOAA) satellites in geosynchronous and polar orbits are mandatory to have accurate/reliable weather forecasting and severe storm warnings. Without accurate/reliable forecasts and warnings lives, property and the U.S. economy are at risk.

For more than four decades the United States has had a robust satellite program that has provided the data to support our incredible weather forecasting system. We have come to take for granted this exceptional capability that has become a critical element of the fabric of our society.

Today, this robust capability continues for the geosynchronous system. Current operating systems and the future system under development, the Geostationary Operational Environmental Satellite (GOES)–R series, will serve our Nation well. The GOES–R series is dependent upon funding to maintain schedule to assure there is no gap in the continuity of data.

The status of the polar orbiting system is more precarious. Currently, our weather and severe storm forecasting capability is dependent upon satellites that are operating beyond their design life and a research and development (R&D) satellite whose data is now used operationally. Future capability is dependent upon the Joint Polar-orbiting Satellite System, JPSS, which is under development. JPSS is the only approved future United States polar-orbiting weather satellite program. Numerous previous decisions have resulted in a fragile, non-robust polar-orbiting architecture. Some of the decisions were made with the best of intentions but resulted in negative unintended—some highly adverse—consequences. Current plans for JPSS will result in several years of operation that is one failure from a gap in providing data for weather and severe storm forecasting. This is an unacceptable position for data so critical to lives, property, and the economy.

There is an unacceptably high probability of a gap in JPSS polar-orbiting satellite data that could have a duration of months or years. The severe implications of such a gap make it mandatory that a gap filler satellite program be initiated immediately and urgent changes in the JPSS program be implemented to establish a robust program with a "two failure to have a gap" criterion.

Thank you.

A. THOMAS YOUNG

A. Thomas Young joined NASA in 1961. He was Mission Director for the Viking Project, Director of the Planetary Program, Deputy Director of the Ames Research Center and Director of the Goddard Space Flight Center.

Mr. Young joined the Martin Marietta Corporation in 1982. He is the former President and COO of Martin Marietta. He retired from Lockheed Martin in 1995.

Following retirement, he has been on Corporate Boards and lead numerous Committees and Review Teams associated with national security and civil space.

Mr. Young is the former Chairman of SAIC.

Mr. Young is a member of the National Academy of Engineering.

Senator SCHATZ. Thank you very much, Mr. Young.

Mr. Myers, please proceed.

STATEMENT OF BARRY LEE MYERS, CHIEF EXECUTIVE OFFICER, ACCUWEATHER, INC.

Mr. MYERS. Thank you for inviting me to speak here today.

The United States has some of the most violent and challenging weather on Earth—tornadoes, hurricanes, lightning, hail, snow, ice, and floods. In fact, we have more tornadoes than any nation and we have four times those of what Europe has.

We can and must do more relative to severe weather. People should not live in fear in America's heartland, in its cities, and along its coasts. Imagine being able to tell people an hour or two in advance to move out of the zone of danger and to have them watch a tornado from miles away.

This year marks the fiftieth anniversary of AccuWeather's creation, and I can tell you that 50 years ago weather forecasting was more art than science. A tornado might form at night in the darkness, unknown to those in its deadly path, with no radar to help a forecaster spot a hook echo. A storm like Sandy without a weather satellite would have thought to have moved way out into the ocean, only to return as a surprise. It might have been like the great Galveston hurricane of 1900 that no one knew was coming because there were not satellites in space watching.

In the United States, the National Weather Service, America's weather industry, and the academic and research communities each have important and complementary roles to play. Together they make up the American weather enterprise and that's an enterprise with a capital "E". It's a unique and special partnership for the benefit of the Nation.

Fifty years ago, if I had told anyone that a company like AccuWeather in State College, Pennsylvania, would tell a manufacturing facility in Mississippi 1,000 miles away, 21 minutes in advance, that a tornado might strike the plant and that we could save 88 lives in a single electronic message, it wouldn't have been believed, but in fact it has been done, and those and similar situations happen now routinely.

The U.S. Government collects and disseminates data from local and remote sensing platforms. It runs forecast models and prepares and makes special warnings. Weather companies and academic and research institutions use this information and also collect and disseminate data and make weather forecasts and warnings, some specific and tailored and some general public. These companies may be international media companies, such as AccuWeather and the Weather Channel, serving billions of people with instant weather information.

This joint system of public and private cooperation helps to save countless lives and prevent hundreds of millions of dollars in property damage per year here in the United States, and in fact it has the name of "public-private partnership."

It has been a transition of work from government to private industry that has occurred over decades with no letting of government contracts, no industry subsidies, and no cost to the government. It has been held up as a model by other Federal agencies and even a recent Executive Order by President Obama. Even the Weather-Ready Nation program now specifically endorses the role of America's weather industry.

Recently, the National Academy of Sciences report "Second to None" and the National Academy of Public Administration report have been published, and in a nutshell I really read them to say that growing the secondary value chain in the weather enterprise is not a choice; it is a market reality which benefits the Nation and needs to be supported and accelerated.

The government is uniquely positioned to ensure and enhance the provision of weather data and the issuance of warnings for the public aimed at the protection of life and property. We all need to protect this core functionality and the research that keeps the entire American enterprise in the weather field, and that's "Enterprise" with a capital "E," ahead of the curve.

A special focus during Superstorm Sandy was the ECMWF, the so-called European model, which did a better job only at some points in the storm track than the U.S. models did. The gap, though, presents issues from an economic, safety, and national security standpoint. Relying on other countries for better weather models, for satellite data, or for other information exclusively and not with regard to ones that we can rely on in America as the best places us in a weak and subservient position.

If America is to remain, the world weather leader, if the American weather industry is to remain the envy of the world and the carrier of American weather brands' value and prestige abroad and here at home, the core of the best public weather access of any nation, and a creator of jobs, weather research and development and creation and operation of core infrastructure remain a matter of national government concern and urgency.

Thank you for your time.

[The prepared statement of Mr. Myers follows:]

PREPARED STATEMENT OF BARRY LEE MYERS, CHIEF EXECUTIVE OFFICER, ACCUWEATHER, INC.

Chairman Begich, Ranking Member Rubio, and distinguished members of the Subcommittee: I appreciate the opportunity to testify today on this important issue.

My name is Barry Lee Myers and I have been with AccuWeather since it was founded by my older brother in 1962.

I served as Executive Vice President and General Counsel for many years and in 2007 became the Chief Executive Officer.

The 50 year odyssey from the founding of AccuWeather until today's hearing is a study in the evolution; and a story whose pages continue to be written daily.

On average, the United States experiences 100,000 thunderstorms annually, resulting in more than 1,200 tornadoes. The tornado is the most violent storm on Earth.

The United States has more tornados than any nation; in fact, we have four times the number in all of Europe.

We also report more violent EF4 and EF5 tornadoes than anywhere else.

When hit by a powerful tornado, often entire buildings are destroyed . . . sometimes literally wiped off the face of the earth.

We saw the devastating and heart sickening results again in 2013.

The Magic of Weather Forecasting

Meteorology is a rewarding field and also, like the job of first responders, one often filled with gratitude and horror, all at the same time.

Those in the field of meteorology have the ability to tell, with significant accuracy, what the future will hold.

We can tell *what* the temperature will be tomorrow or next week and whether it will be sunny or cloudy.

We can tell *whether* in the next 30 minutes, people are likely to be killed if they continue to stand where there are—in the path of a tornado or tsunami.

Based on seeing the future, one can decide whether to start planning to move the Sunday wedding indoors or under a tent. One can decide to take shelter, or leave town, and save a life.

We have a Crystal Ball that allows us to know the future. It is a privilege to have it. And it is a responsibility to continually improve the tools we have, and might develop, to improve the clarity of that crystal ball, to save lives and help people prosper.

The crystal ball in am referring to is not actually round and clear; and when it is seen, one may not realize they saw it.

But there is a magic in meteorology.

From Government Operation to a Partnership Enterprise

This year marks the 50th Anniversary of AccuWeather's creation. That is interesting in light of how far the weather enterprise, and especially the weather industry, has come.

I will tell you that when the first customer of the company that would grow to be AccuWeather signed up for $50 a month in 1962, meteorology was still in relative infancy.

And what would become the American Weather Enterprise—consisting of the U.S. Weather Bureau (later NOAA's National Weather Service), academic and research organizations, and America's weather industry—was not a full concept in 1962.

TIROS–1 was launched just two years earlier and had operated for 78 days. And the first recorded weather radar observation occurred only 9 years before.

Work building AccuWeather began around my older brother's kitchen table with a single rotary dial telephone. Joel Myers made perhaps 10,000 calls to secure the first dozen or so customers in the first two years.

So it would seem that the competitive landscape was wide open for those who would make the effort.

But that was not so.

At the time, weather forecasting was more art, than science, and even a forecast for a heavy snow storm just hours away might result in a sunny afternoon.

And a tornado might form at night and in the darkness, unknown to those in its deadly path—as no radar was there to help a forecaster spot a hook echo signature.

A storm like Hurricane Sandy, without a weather satellite, would have thought to have moved away out into the ocean and dissipated, only to return as a deadly surprise. It would have been like the great Galveston hurricane of 1900 that no one knew was coming, because there were no eyes in the sky.

In 1962, most of the weather information reaching business, industry, the media, and the public came from the United States Weather Bureau—the government.

So, the idea of starting a weather company, literally on pocket change, and competing with the government's free services, is the story of AccuWeather . . . and American's weather industry in general.

When Joel and I were thinking through the weather company concept in those early years—probably 95 percent of all the weather information reaching the public came from the government.

Government employees did the weather broadcasts on radio.

Government employees did the newspaper weather maps and charts for *The Associated Press* and many newspapers.

Government employees consulted free with anyone who called them on the phone or stopped into their offices, and provided special scheduled services to large and small companies.

At the same time, as our business struggled to grow through the 1960s and 1970s, sometimes government employees discouraged potential customers from using our services, calling them up and offering services for "free," at government expense.

It was like the Post Office and Federal Express, except it would be like the Post Office offering to carry every letter without postage, and every package for free. Why would someone use FedEx at all under those circumstances.

Despite that, it is estimated today, that 95 percent of the weather information reaching business and industry, the media, and the public comes—not from the National Weather Service—but from AccuWeather and other members of America's weather industry.

This is a complete reversal from 1962.

Basis for America's Weather Success

In 1994, I was asked to offer thoughts to the U.N.'s World Meteorological Organization about weather information and its use. What I said was, in part:

- Weather is a world-wide resource.
- In gathering weather information, time is of the essence.

- In analyzing it, and in distributing the results of that analysis of weather observations, time is critical.
- And, in getting this analysis into the hands of those who need it to protect life and property, not only is time critical, but the very nature of the message and its understandability and related action-ability needed by those receiving it, is paramount.

In the United States, the National Weather Service has a specific role to play and America's weather industry has a specific role to play. Each have important and complementary roles to play. It is a unique environment and special partnership for the benefit of the public.

The laws of the United States do not hamper or restrict the nature of the private sector. In fact, unlike many other countries, they encourage private sector and especially weather industry activities. This has been a huge benefit to the Nation.

The United States Government collects, and disseminates data from local and remote sensor platforms, runs forecast models, and prepares and makes special warnings and also general public forecasts.

Weather companies also collect and disseminate data, and make weather forecasts, some specific and tailored, prepare and make special warnings and also general public forecasts.

Weather companies also develop communication methods designed to move weather information as quickly and as understandably as possible to the end user.

Weather companies are part science company and part media and communications company.

In fact, the government and the weather industry work together, to carry out these functions.

This joint system of public and private cooperation helps to save countless lives and prevent hundreds of millions of dollars in property damage per year in the United States—in fact it has a name—The Public/Private Partnership.

This cooperative effort, better than anywhere else on earth, is dedicated to the proposition that weather information is (1) highly time sensitive and (2) a perishable scientific commodity, which, if utilized quickly and communicated to people who are in a position to act, effects real economic efficiencies, saves lives, and, results in benefit to the Nation.

Another guiding principle is that all scientists should be free to access scientific data so that they may render timely viewpoints and opinions on what future weather may be—that is create forecasts and warnings.

This freedom of access to scientific data and its free use for the benefit of society is typically American.

In the United States this "free and open access" is founded upon principles having to do with free speech and freedom of information.

These comments seem self-evident to many. In making remarks to the World Meteorological Organization, almost 20 years ago, comments about free and open access did not seem self-evident to many of the hundreds in the audience from around the world.

The weather industry in the United States was born of the concept of "free and open" availability of weather information.

It has led the world as a model of growing success, transitioning from a government agency "doing it all," at the end of World War II, to massive infusion of weather into every American's life through companies like AccuWeather—and a growing global presence by American companies as the preferred suppliers of weather to the world.

It has been a transition of work from the government to private industry involving no letting of government contracts, no industry subsidies, and no cost to the government.

In fact a tax paying industry creating perhaps tens of thousands of jobs—has been born.

It truly has built on a concept that if information is free for all, we should leave the rest to ingenious, innovative, and entrepreneurs, who would find ways to make a viable industry.

By the end of 2013, figures suggest that American Weather Companies will have weather apps and access portals on or accessible from perhaps two billion digital devices worldwide.

People who had no weather forecast of merit for 25 minutes ahead, now have forecasts, on an hour by hour basis, for 25 days ahead on *AccuWeather.com.*

People who had no warnings for severe and deadly weather, now can use at a device that looks like something they would have used to ask Scotty to beam them up, that contains more information than Star Trek creators ever imagined.

These comments seem self-evident to many today.

In speaking at the WMO in 1994 if I had told anyone that by 2008 a private weather company in Pennsylvania would tell a manufacturing facility in Mississippi, a thousand miles away, 21 minutes in advance, that a severe tornado was heading right at it and they needed to shelter their people—and that the private weather warning would save 88 lives in a single electronic message—it would not have been believed.

In 2005 the U.S. Congress Bi-partisan Committee on the review of Hurricane Katrina cited AccuWeather saying "AccuWeather issued a forecast predicting the target of Katrina's landfall nearly 12 hours before the NHC [National Hurricane Center] issued its first warning, and argued the extra time could have aided evacuation of the region."

I am not telling you this to place AccuWeather in the spotlight. My friends at The Weather Channel and at many other non-governmental organizations have this and other important capabilities.

Everywhere within the American Weather Enterprise there are meteorologists, scientists, researchers, and professionals of all kinds of equal merit.

But the government is uniquely positioned to ensure and enhance the provision of weather data and the issuance of warnings for the public aimed at the protection of life and property.

These activities also require research and development, transfer of knowledge, technologies and applications to other government agencies and the private sector.

And this is needed with regard to advanced radar technologies, aerial observing systems, high performance computing networks, advanced forecast modeling and other government-appropriate activities.

We all need to protect this core functionality and the research by the government that keeps the entire American weather enterprise ahead of the curve.

America's Unique Weather Enterprise

If we want to successfully approach the present problems the weather enterprise may face we should understand that the huge success we have had, did not occur serendipitously.

It may have followed a sometimes indirect path, but the path as supported through decades of sustained effort and shared vision in the weather enterprise.

AccuWeather's Mission Statement begins: "To save lives, protect property, and help people prosper. . . ." The mission is substantially similar to that of NOAA's National Weather Service.

In 1980 the paperwork Reduction Act was passed. The law stated its purpose was to, among other things ensure the greatest possible public benefit from information created, collected, maintained, used, shared, and disseminated by or for the Federal Government.

It also said one of its purposes was to provide for the dissemination of public information on a timely basis, on equitable terms, and in a manner that promotes the utility of the information to the public and makes effective use of information technology.

In follow up to the law, the Office of Management and Budget issued Circular A–130, which was updated over the following decades.

The Circular is lengthy, but states in part:

- The free flow of information between the government and the public is essential to a democratic society. It requires dissemination of information on equitable and timely terms.
- It states the government must avoid establishing, or permitting others to establish on their behalf, exclusive, restricted, or other distribution arrangements that interfere with the availability of information dissemination on a timely or equitable basis.
- It declares agencies shall avoid establishing restrictions or regulations, including the charging of fees or royalties, on the re-use, resale, or re-dissemination of Federal information, setting user charges at a level only sufficient to recover the cost of dissemination, but no higher.

Under Section 105 of the Copyright Act of the United States, in general, government information is not entitled to domestic copyright protection declaring it free—domestically.

The 1991 NWS Public Private Partnership Policy was an early cooperative attempt to implement concepts from the Paperwork Reduction Act, Circular A–130 and issues relating to the growing weather industry.

About ten years later the National Research Council was requested by the National Weather Service to undertake a study of the status of the enterprise and the *Fair Weather Report* was issued in 2003.

This led to the AMS Commission on Weather and Climate Enterprise.

And, the *Fair Weather Report* led to a new partnership policy issued by NOAA governing its relationship with America's weather industry.

In the main policy section, the first sentence says: "NOAA will adhere to the policies contained in the Paperwork Reduction Act, OMB Circular A–130 and other relevant laws."

The second sentence says: "These policies are based on the premise that government information is a valuable national resource, and the benefits to society are maximized when government information is available in a timely and equitable manner to all."

It goes on to endorse "Open and unrestricted access."

And further that NOAA will promote the open and unrestricted exchange of environmental information worldwide.

NOAA also states it will avoid duplication and competition in areas not related to the NOAA mission.

So today's policies trace their origins to the core nature of the republic and critical pieces of Federal legislation and rules long a part of the fabric of the country's legal structure.

Building on this, NOAA and NWS have developed formal and internal directives defining what they will do and not do and specifically stating where government personal will defer to the America's weather industry.

Even the Weather Ready Nation program now specifically endorses the role of America's weather industry and states that the requirements and activities of Weather Ready Nation participants may be fulfilled through arrangements with America's weather industry.

Recently, the National Academy of Sciences report "*Weather Services for the Nation: Becoming Second to None;*" and, the National Academy of Public Administration report *"Forecast for the Future: Assuring the Capacity of the National Weather Service*" have been published. Both support the primary tenant that reflects the reality of the state of the Weather Enterprise and the continuing robust growth of America's weather industry.

Essentially, in a nutshell, they state that growing the "secondary value chain" in the weather enterprise is not a choice for the government; it is a market reality which benefits the Nation and needs to be unconditionally supported and accelerated by NOAA's NWS.

Methods of doing this include, but are not limited to, developing, acquiring, supporting, maintaining and making available core infrastructure; data, models, warnings, and support for the public and the weather industry. This leverages government investments in high multiples.

A recent example of the recognition of this important concept is found in the Open Data Executive Order signed by President Obama on May 9, 2013, which stated:

> "For example, decades ago, the Federal Government made both weather data and the Global Positioning System (GPS) freely available to anyone. Since then, American entrepreneurs and innovators have used these resources to create navigation systems, weather newscasts and warning systems, location-based applications, precision farming tools, and much more."

Interesting, the effective use of the Nation's weather data also depends on the GPS system to assist mobile devices locate themselves to provide their users with weather information geared to their location, because all weather is local in its affect to the location of people in its greatest impact.

Nature of America's Weather Industry Success

America's Weather Industry is the most robust weather industry existing in the world today.

AccuWeather and other companies in the weather industry are out of the kitchen, and into every ones garage, home, television, radio, newspaper, Internet, and mobile device.

Weather is on the gas pump where you fuel your car or truck.

It is on the electronic signage in your doctor's office or retail store.

It is on the counter of the check-in desk at the hotel where you stay.

If products travel by rail or truck, America's weather industry helps get them to the Nation.

If food is served, the weather industry helped grow it and assisted the commodities traders who transacted in it.

In banking or financial services the industry helps customers be more efficient and better able to pay their loans and increase their deposits.

In insurance, the weather industry helps in planning for loss reserves and adjusting customers' claims after a weather-related loss.

Weather is about the national economy.

No matter the business, the weather industry can protect property, increase efficiencies, and save lives.

The weather is also the *news every day.*

It is the single most accessed piece of information watched, listened for, or selected on radio, television, the wired web, and mobile devices.

You can watch local weather channels.

You can access the AccuWeather forecast on *AccuWeather.com* from anywhere on earth.

AccuWeather and other weather sources are available on just about any mobile phone or other mobile device you carry and your friends and family might carry.

And the AccuWeather mobile website is available globally and in 48 languages and a hundred dialects.

You find it as a widget you can click on, on the screen of your new television set.

So weather is a media phenomenon, and it drives weather companies that wish to be successful—to become media companies—with weather as their core information.

While the weather may be interesting to many, and of economic importance to others, accuracy of weather information is the most important secret sauce of the weather—for businesses, government, and the public.

And the secret sauce potentiating accuracy—is communication.

The most accurate forecast or warning, not communicated in an effective and timely way, not understood and not leading to action, is merely a theoretical exercise.

As a result, many weather companies are media companies empowering all weather information to be actionable and empowering businesses and people who receive it to use it to their advantage.

So, it is estimated that over two billion electronic devices world-wide can access the information from America's weather companies. I know that AccuWeather alone serves up about one quadrillion separate "pieces" of data annually to global users.

And jobs continue to be created in this and the related device and communications sectors to support this growth. Many of these are quality American jobs.

But the fact that America's weather industry is the most robust on the world today does not mean the American Weather Enterprise has the best tools at its disposal that is possible.

There is room for enhancement, there is room for improvement.

And improvement in the field of meteorology means saving lives and property.

Success Stories from the Partnership

Often warnings are issued by the government for tornados.

Usually community-warning sirens go off.

On February 5, 2008, at about 5:37 PM, a Caterpillar company plant in Oxford, Mississippi, was bustling with activity, as 88 people were at work.

No government tornado warning extended to the location of the plant.

No warning siren was sounded.

In the winter darkness miles away, a tornado dipped from the sky, unseen by the naked eye, and began racing toward the plant.

Twenty-one minutes later the violent tornado struck the plant with a horrifying fury ripping and chewing the plant to pieces.

Steel girders twisted and collapsed, metal walls shredded.

All that debris fell in to the space people occupied inside.

The calm orderly work environment was suddenly a violent swirling mass of shrapnel, totally exposed to the monster storm.

It left a picture of a plant perhaps hit by an aerial bomb or a terrorist attack. People would be lucky to have survived.

As the monster tornado formed in the darkness that winter night and began to dip from the sky, and started its race toward the people in the Caterpillar plant, a meteorologist at our office in Wichita was at work.

He saw a tornado signature on a radar image on a computer screen. He didn't just "happen" to see it. He was looking for it.

He knew what circumstances could lead to a tornado that night.

He had cutting-edge computer tools, developed by, and proprietary to AccuWeather, that notified him to be on guard.

He had access to the government's Doppler radar system; that did not exist in 1962 when AccuWeather began.

At another time, or in another place, he might have looked on in horror wondering what humanity the monster storm would claim.

Instead, he pressed a key stroke and an AccuWeather computer sent an electronic message to another computer at the Caterpillar plant in Oxford, Mississippi.

A human at the plant was required to confirm receipt of the message.

In fact, a person-to-person telephone contact was also immediately established with the plant's safety director.

The message was clear; a tornado was forming about 30 miles southwest of the plant, and may be at or near the plant in about 22 minutes.

The first images of the destroyed plant were seen by the people who worked at the plant, not as they watched the horror around them, not as they and their coworkers were contemplating death, but as they emerged from their tornado shelter, after the tornado had done its destructive work and moved on.

Not a single person was injured, not a single person died. They all went home—shaken, but safe.

Hundreds of miles away, an AccuWeather meteorologist also went home—shaken, but safe.

He went home knowing he had just saved the lives of scores of people, and the misery that death and injury would have brought to their families.

The government/private sector collaboration worked. A government radar network and a private weather company, working together, saved lives.

Why Support the American Weather Enterprise?

Questions arise as other governments in other nations invest in improved modeling both in accuracy and timeliness.

This means others can forecast better for American shores than America itself.

Of special focus was the ECMWF (so called European Model) during Hurricane Sandy, which model did a better job at some points in the storm track, than the U.S. models did.

This gap presents issues from an economic, safety, and national security standpoint.

From an economic standpoint foreign companies and investors could potentially get the jump on Americans relative to weather events occurring on American shores.

Additionally, as America's weather industry continues to expand worldwide, restricted access to quality models could place it in a position of having second class primary information.

And interestingly, many foreign governments do not look at the weather industry as their partners, like we do here in America. And so those countries do not get to leverage the value of their government investment, like we do here. So a dollar spent on improved modeling, for example, in America, has greater value to our economy than a dollar spent by other governments.

Relying on other countries, for better weather models, places America in a weakened position in time of national and international crisis. And we cannot get full access even to the European Model from what my government sources tell me.

Weather infrastructure and related research and development, and operation of core infrastructure remain a matter of national urgency today.

They are matters of national security.

Many functions that were only government functions at the dawn of the development of America's weather industry 50 years ago—such as media weather forecasting, business targeted weather forecasting, and general public weather forecasting have been subsumed by America's weather industry.

Even some data sources such as mesonets and lightning networks have been taken under the wing of private sector entities. This is a positive trend saving government expenditures and we can expect to see privatization of other remote sensing platforms such as satellites.

The caution here is that privately developed data, in order to enter the core data set, needs to be publicly available to all those who need it in the weather enterprise, if the government is to buy it and sanction it, to secure a common data set for the whole weather enterprise, lest we fragment the very uniformity of core data that drives the whole enterprise.

Much remains, and may forever need to remain, government functionality. But much has been converted to private sector activity and much will continue to migrate there.

So I entreat you to consider joining with me to support five primary tenets:

1. To empower and facilitate the American weather enterprise to achieve its full potential

2. To define the value chain of all parts of the American weather enterprise, as stated in the recent NAPA report, to ensure the American public is served with the best possible information employing the most cost efficient combination of private and public institutions.
3. To place special focus and funding on NOAA/NWS role as the builder of the Nation's core weather infrastructure, core data sensing, core research and model development, operational modeling, public warnings for weather events that pose imminent threat to life and property, and working with and through America's weather industry, to achieve national and world-wide leadership in weather and weather media.
4. To focus Federal support to ensure a legislative and budgetary agenda which makes maximum and optimum use of all parts, public and private, of the American weather enterprise.
5. And to encourage the execution of the aligned missions and roles through public and private partnerships based on principles that will drive continuing growth of the weather enterprise.

Thank you for your time.

Senator SCHATZ. Thank you very much.
Mr. Hirn.

STATEMENT OF RICHARD J. HIRN, GENERAL COUNSEL AND LEGISLATIVE DIRECTOR, NATIONAL WEATHER SERVICE EMPLOYEES ORGANIZATION

Mr. HIRN. Thank you, Senator Schatz, Senator Blumenthal.

The Weather Service Employees Organization is proud of the fact that the operational Weather Service employees have been the primary source of most of the innovation undertaken by the Weather Service in recent years. Regrettably, however, the agency has been disinvesting in its human capital by drastic workforce reductions and the elimination of virtually all training. In so doing, the agency is placing the American people at risk and cutting off the source of future innovation. No new satellite, supercomputer, forecast model, or valued private sector partner will reduce the need for a highly trained and fully staffed workforce.

Let me provide one recent and vivid example of how the creativity and initiative of Weather Service employees have saved lives. On Sunday, November 17, six states in the Midwest experienced a dramatic late season tornado outbreak. The death toll remained remarkably low due to the lifesaving warnings issued by the men and women at nine forecast offices. But at the time the agency was suffering from a widescale communications failure. Weather Service employees were only able to communicate with emergency managers, media, and the public because employees in the field improvised emergency communication channels.

As the Acting Director of the Weather Service Central Region explained in a congratulatory e-mail to employees, "The excellence of your work has been attributed to directly saving many lives that day. I know this was accomplished despite challenges and communications problems which impeded our ability to communicate with emergency managers and media partners. In response, employees took appropriate steps to improvise other measures, such as other Internet sources, WiFi cards or telephones, and to create makeshift backup communication techniques to ensure the Weather Service got its message out."

Dr. Uccellini also sent a congratulatory e-mail to employees, writing that, "This event was another example of the important

role that social media is playing getting the message out. Forty-seven of the top 50 tweets sent by Federal Government Twitter accounts on Sunday were warnings from the Weather Service on severe weather. Your embrace of social media is a growing success story."

However, Weather Service field employees haven't just embraced the use of social media for getting warnings out; they pioneered it. Employees at local forecast offices started creating Facebook pages on their own several years ago to communicate with the Weather Service, but Weather Service headquarters made them take the pages down for about a year before realizing their full potential. Now all of the Nation's forecast offices and river forecast centers have operational Facebook pages.

Similarly, only after employees in the field started tweeting weather warnings did the agency formally embrace and sanction Twitter accounts.

Another employee initiative has transformed the way the Weather Service communicates with emergency management officials and the media. In 2004 employees at the Des Moines Forecast Office, working with the Iowa State University Environmental Mesonet, began using commercial Instant Messaging and chatroom software to communicate with Iowa television stations. Forecasters across the Nation now use what's known as NWS Chat to exchange information with emergency managers and media in real time during severe weather.

In 2011 the Weather Service implemented pilot projects at six offices to test new service delivery models, such as integrating environmental data from other NOAA agencies into Weather Service products, providing enhanced face to face decision support to emergency managers, and developing new meso-scale forecasting models and techniques that hopefully will enable the Weather Service to provide pinpoint highly localized forecasts of severe weather outbreaks hours in advance.

These pilot projects were an NWSEO initiative, which we first proposed to the Deputy Under Secretary in 2010. The field then submitted proposals for individual projects to a joint labor-management relations committee, which selected the most promising proposals, refined their objectives, and developed implementing plans.

The Weather Service will, however, require more, not fewer, employees to provide these enhanced services nationwide. But unfortunately, even before sequestration the Weather Service began shedding staff. Since 2008, the Weather Service has eliminated hundreds of positions and over 8 percent of its workforce, most of which is classified as emergency essential.

Service assessments following—conducted following eight major storms that occurred since 2008, including Hurricane Sandy, found that the agency performance was compromised due to inadequate staffing. In the service assessment of Hurricane Sandy, the assessment team gave this stark warning, "If these positions cannot be filled, the Weather Service should ensure awareness at higher levels that the vacancies may result in reduced levels of service, including potential failure on the delivery of products and services during the next significant weather event."

Thank you for inviting me to present the views of NWSEO and the 3600 employees we represent.

[The prepared statement of Mr. Hirn follows:]

PREPARED STATEMENT OF RICHARD J. HIRN, GENERAL COUNSEL AND LEGISLATIVE DIRECTOR, NATIONAL WEATHER SERVICE EMPLOYEES ORGANIZATION

Chairman Begich, Ranking Member Rubio, and Members of the Subcommittee, thank you for inviting me to present the views of the National Weather Service Employees Organization and the 3,600 National Weather Service employees it represents. Our members include the forecasters, hydrologists, technicians and other scientific and support personnel employed at 122 Forecast Offices; 13 River Forecast Centers; the various NWS national forecasting centers such as the National Hurricane Center in Miami and the Severe Storms Prediction Center in Norman, Oklahoma; the tsunami warning centers in Alaska and Hawaii; and at the NWS headquarters in Silver Spring, Maryland.

NWSEO is proud to say that the operational Weather Service employees in the field have been the primary source of most of the innovation in forecasting and service delivery undertaken by the NWS in recent years, and the primary goal of our union is to enhance the employment security of our members by developing and urging management to adopt new and better ways to protect the American public from the vicissitudes of severe weather. Regrettably, however, the agency has been disinvesting in its human capital by drastic workforce reductions and the elimination of virtually all training. In so doing, the agency is placing the American people at risk and cutting off the source of future innovation. No new satellite, supercomputer, forecast model or private sector partner will reduce the need for a highly trained and fully staffed NWS workforce.

Let me provide one recent and vivid example of how the creativity and initiative of NWS employees in the field saves lives. On Sunday, November 17, six states in the Midwest experienced a dramatic late-season tornado outbreak, involving more than 40 tornados, including several EF4 rated tornados. However, casualties remained remarkably low due to the life-saving warnings issued by the men and women from at least nine forecast offices. While the national press praised the work of the National Weather Service, what they didn't know and didn't report was that the NWS was at the time suffering from a wide-scale communications and Internet failure that began several days before. Forecasters were only able to communicate with emergency managers, media and the public during this event because NWS employees in the field improvised emergency communications channels. As the Acting Director of the NWS Central Region explained in a congratulatory e-mail message to employees:

> The excellence of your work has been attributed to directly saving many lives that day . . . I also know that this was accomplished despite challenges of communications circuit problems which impeded our ability to communicate with Emergency Management and Media Partners. In response, NWS employees took the appropriate steps to improvise other measures, such as other Internet sources, WiFi cards or telephones, to create makeshift backup communications techniques to ensure that the NWS message got out.[1]

NWS Director Uccellini also sent a congratulatory e-mail to employees after the tornado outbreak. In this message, Dr. Uccellini noted that:

> This event was another example of the important role that social media is playing in getting the message out. According to the social media tracking firm Measured Voice, 47 of the top 50 tweets sent by Federal Government Twitter accounts on Sunday were warnings from NWS on severe weather. Your embrace of social media is a growing success story.

However, NWS field employees haven't just "embraced" the use of social media to broadcast warnings—they pioneered it.

Employees at the Chicago Forecast Offices and at other local forecast offices started creating weather-related Facebook pages for their offices on their own several years ago, but NWS headquarters made them take the pages down for about a year

[1] Although the Acting Central Region Director admitted to employees that "communications circuit problems which impeded our ability to communicate with Emergency Management," existed, employees were issued official "talking points" from NWS management advising them to mislead to the press: "If asked about internal communications network issues, 'Internal communication issues did not affect provision of warning services during the outbreak.'"

before realizing their potential. Now all of the Nation's 122 Forecast Offices and 13 River Forecast Centers have operational Facebook pages through which they communicate with the public. Similarly, only after employees in the field started "tweeting" weather warnings did the NWS formally embrace and sanction Twitter accounts.

Another employee initiative involving social media has transformed the way the NWS communicates with emergency management officials and the media. Beginning around 2000, several Forecast Offices began using instant messaging to communicate with emergency managers. In 2004, employees at the Des Moines Forecast Office, working with Iowa State University's Environmental Mesonet, began using commercial instant messaging and chat room software to communicate with Iowa television stations. By 2005, seven forecast offices and 21 media outlets adopted use of this software. By 2009, the NWS assumed full control of this service, and it is now known as NWSChat. Forecasters now use NWSChat to exchange information with emergency managers and the media in real-time during severe weather events. By the summer of 2012, 3,500 members of the emergency management community had registered for an NWSChat account, as well as over 2,000 members of the media.

In 2011, the NWS implemented six pilot projects that were an NWSEO initiative, originally proposed to the Deputy Under Secretary at a meeting with the NWSEO National Council in San Francisco the year before. The plans for individual projects were then developed by a joint labor-management committee based on proposals solicited from the field. These pilot projects are now underway at NWS headquarters, at the Southern Region headquarters, and at Forecast Offices in Tampa, New Orleans, Sterling, Virginia and Charleston, West Virginia. The pilots are developing and testing new service delivery models, such as integrating environmental data from other NOAA agencies into NWS products; providing enhanced, face-to-face decision support to state and local emergency management personnel; and developing new mesoscale forecasting models and techniques that may enable the NWS to provide pinpoint, highly localized warnings of severe weather outbreaks hours in advance. As part of these pilot projects, the NWS created new positions called "Emergency Response Meteorologists" that assist local emergency managers by providing "impact-based decision support services." In other words, NWS employees will not just predict the weather and provide raw weather information, but they will assist the emergency management community in understanding how to use this information and what impact the predicted weather is likely to have on their communities in practical terms.

Hurricane Isaac provided the first real-time test of the value of the new positions. Before and during the storm, these new "ER-Mets" were deployed from the new Southern Regional Operations Center and the Tampa and New Orleans Forecast Offices to 16 different FEMA, state and local Emergency Operations Centers, as well as to the Multi-agency Communications Center at the 2012 Republican National Convention, to supply face-to-face decision support service. An official from the Secret Service Intelligence Division wrote to the NWS that:

> I found it very helpful to have someone on hand from the NWS to provide up to date information regarding the hurricane . . . It was invaluable to have you on the scene, when we all received a tornado warning on our Blackberries. You were able to say that we were in fact not in any danger because that particular storm was to the north of us.

These pilot projects build on the success of an aviation weather pilot project recently tested at New York, Chicago and Atlanta. By adding three additional forecasters at each location (one per shift) who were dedicated to providing additional weather support to the FAA, weather-related air traffic delays were reduced by 50 percent immediately.

NWSEO agreed to alter traditional staffing models in order to conduct these pilot projects. But if these pilots are successful, the NWS will require more, not fewer, forecasters to provide these enhanced services nationwide. But unfortunately, over the past several years, even before sequestration, the NWS has been shedding staff.

The National Academy of Public Administration reported earlier this year that "[w]hile staffing levels have been relatively constant over the past decade, in the last three years, the NWS has realized personnel losses at a greater rate than it has been hiring." NATIONAL ACADEMY OF PUBLIC ADMINISTRATION, FORECAST FOR THE FUTURE: ASSURING THE CAPACITY OF THE NATIONAL WEATHER SERVICE., 39 (2013). The Senate Appropriations Committee noted earlier this year that "[s]ince 2010, NWS has seen a reduction of 290 positions, or approximately 6 percent of its workforce, with many forecaster and other positions left vacant across the country." S.REP. No. 113–78, 113 Cong. 1st Sess. 38 (2013). According to NAPA, the vacancy

rate reached 8 percent by the second quarter of 2013, and warned that "[i]f this trend continues, the NWS is in danger of losing a significant segment of the workforce and will not be able to renew itself at sustainable levels unless it revises staff functions and allocations across programs and offices." FORECAST FOR THE FUTURE, at 38, 39. This problem was exacerbated when the NWS imposed a freeze on hiring on March 27, 2013. *Between July 2008 and August 2013, the NWS eliminated 331 non-managerial employees—almost all of who are classified as "emergency/essential."*

Even with a full complement, Forecast Offices are only staffed for "fair weather." The 122 Forecast Offices operate 24/7, and most of the time have just two forecasters on duty These two forecasters are responsible for issuing forecasts and severe weather warnings for an average of nearly three million people. For example, the two forecasters at the Forecast Office in Sterling, Virginia near Dulles Airport are responsible for the welfare of more than nine million people who live in DC, Maryland, Delaware and Northern Virginia. The two forecasters on duty at the Miami Forecast Office have the responsibility to protect nearly six million people, and the two forecasters on duty at the Tampa Forecast Office are responsible for protecting more than five million people in central Florida.

Thus, there is usually only the minimal number of staff on duty to be alert for severe weather and to call in the rest of the staff when it occurs. According to the National Academy of Sciences, the ability of the NWS to protect the public from the hazards of severe weather is highly dependent on the availability of this additional staff:

> The quality of the NWS's warning capability corresponds with its capacity to muster an ample, fully trained local staff at its WFOs [Weather Forecast Offices] as severe weather unfolds. With current staff levels, there are always two people working each shift, 24 hours a day, seven days a week. Though this works well in fair weather, it can become problematic in severe weather, particularly when events develop rapidly under seemingly benign conditions. While managers at individual WFOs generally plan ahead to add sufficient staff to cover forecasted dangerous weather situations, more innocuous weather scenarios that suddenly and unexpectedly "blow up" often lead to shortcomings that are directly attributed to having insufficient manpower. Several recent Service Assessments (*e.g.,* NWS, 2003, 2009, 2010) illustrate the critical role that adequately enhanced staffing (or lack thereof) plays in the success (or weakness) of NWS performance during major events. Appropriate levels of staffing, beyond normal fair weather staffing, during major weather events, are critical for fulfilling the NWS's "protection of life" mission.

National Research Council of the National Academies, The National Weather Service Modernization and Associated Restructuring: A Retrospective Assessment, 60–61 (2012)

The Service Assessments to which the NRC refers are conducted by the NWS after major storm events where there are multiple fatalities or a major economic impact, in order to evaluate its performance. Assessment teams, composed of experts from within and outside the NWS, generate a report that serves as an evaluative tool to identify and share best practices in operations and procedures, and to identify and address service deficiencies. *Service assessments conducted following eight major storms that occurred between 2008 and 2011 found that the ability of the NWS to protect lives during these major events was compromised due to inadequate staffing at Forecast Offices or River Forecast Centers.*[2]

In May 2013, the NWS issued the Service Assessment on its performance last October during Hurricane/Post-Tropical Storm Sandy. The agency concluded that its performance during this event was hampered by vacancies in critical positions. Eight vacancies at the NWS's Eastern Region Headquarters "limited the ability of the Acting ERH Director to help offices provide DSS [Decision Support Services] and to staff the Regional Operations Center." This assessment revealed that the Upton, NY, Forecast Office (which services New York City and Northern New Jersey) could not provide numerous forecast products, such as tropical storm wind speeds at skyscraper heights, because the Information Technology Officer position was (and still

[2] Central U.S. Flooding of June 2008; Southeast U.S. Floods, September 18–23, 2009; Record Floods of Greater Nashville: Including Flooding in Middle Tennessee and Western Kentucky, May 1–4, 2010; Historic Tornadoes of April 2011; Missouri/Souris River Floods of May-August 2011; Middle and Lower Mississippi River Valley Floods of Spring 2011; Remnant of Tropical Storm Lee and the Susquehanna River Basin Flooding of September 6–1-, 2011; Hurricane/Post Tropical Storm Sandy, October 22–29, 2012. These reports can be found at: *http://www.nws.noaa.gov/om/assessments/index.shtml.*

is) vacant. The assessment also noted that there was a "severe staffing shortage" in the branch of the National Hurricane Center that maintains the computer systems, communication support, and software development for the Center. The Assessment made the following recommendation:

> NWS should identify and fill critical positions at operational facilities. If these positions cannot be filled, NWS should ensure awareness at higher levels in NOAA that these vacancies may result in reduced levels of service, including constraints and potential failure on the delivery of products and services during the next significant weather event.

U.S. Department of Commerce, Service Assessment: Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012, 43–44 (May 2013)

Although the agency has focused much attention on the development of more sophisticated global weather modeling and the acquisition of supercomputers to run them, investment in the refinement of global models will soon face diminishing returns. Refinement of "mesoscale" models, which predict smaller weather phenomena (such as particular storms), has both the greater potential for improvement and the greater societal pay-off. Improved mesocale models, covering smaller geographic areas, run and interpreted by forecasters and staff at the weather forecast offices, could provide more precise (in both temporal and geographic terms) forecasts of storms as well as more benign weather phenomena. Local forecasts will be more precise and certain—that is to say, more deterministic—rather than being coached in probabilities. It is well and good to know there is a 40 percent chance of rain and for day 5 or 6 of the forecast that is great information. However, if you are pouring concrete in your back yard or landing a plane at Dulles airport tomorrow afternoon you will want to know what time it will rain, how hard it will rain and whether there will be strong winds and lightning. To accomplish this, the NWS will not only need new mesoscale models, but also technicians stationed at local forecast offices who know how and where to site the observational equipment needed to obtain mesoscale model input, and forecasters who know the local and regional microclimates to interpret and modify model output and communicate that to local authorities.

Congress directed an outside study on the management of the NWS as part of the 2012 Commerce Department Appropriations Act. The study was conducted by the National Academy of Public Administration. Its final report released in May contained many recommendations concerning the agency's human capital assets. Unfortunately, the NWS has failed to yet act upon many of NAPA's findings and recommendations.

For example, NAPA found that the NWS has cut the amount it spends on training by more than half since 2000, and that it now spends less than 1 percent of its budget on training. Almost all training that involves travel, such as on-site training at the National Weather Service Training Center in Kansas City, has since been terminated. Advanced Warning Operations Courses for FY 14 conducted by the Warning Decisions Training Branch in Norman, Oklahoma have been defunded. These courses address science, technology, and human factors (situation awareness, decision making, team communications, and much more). The Advanced Warning Operations Course for winter weather has not been funded for three years. Follow-on training for the new dual polarization radar upgrade has also been defunded. NWS "Incident Meteorologists" who are dispatched to assist wildland firefighting crews are no longer sent to safety training at the National Interagency Fire Center in Boise, Idaho.

One of the major training programs for NWS forecasters is the COMET program run by the University Corporation for Atmospheric Research. The National Weather Service has reduced funding for the COMET Program by over $2.5M annually since FY 2010.

NAPA recommended that the NWS reexamine its entire training strategy if it hopes to successfully establish a "Weather-Ready Nation." Without increased investments in training for the National Weather Service in the very near future, the new systems resulting from the Sandy Supplemental Appropriations and the ongoing advancements in satellites, probability prediction and new decision support tools will be limited in providing improvements in national forecast and warning capabilities. These limitations will stem from a forecast staff that lacks advanced knowledge in the optimum application of the advanced technologies.

NAPA also found that a review of the NWS's current staffing model is warranted, but that "it is important to include the National Weather Service Employees Organization in this analysis process." FORECAST FOR THE FUTURE at 42. We understand from unofficial sources that this review is well underway at NWS headquarters, but

we regret to report that NWSEO has been shut out of this process. This poses a significant risk to the success of whatever plans the agency might develop, and it is not the first time that the NWS has developed plans to change field staffing and operations without the input from employees and outside user groups that is needed for success. As NAPA found:

> In reviewing the NWS's past attempts at change, many required the NWS to spend considerable staff time and resources on a proposal's development only to see that proposal challenged by an outside force. The Panel notes that many of these efforts did not justify the need for specific change or address mitigation of the impact of such change.

Forecast for the Future at 33

The NAPA Panel also found "that the NWS needs to re-frame the labor-management relationship starting at the national level." The Panel noted that:

> NWSEO involvement was crucial to the success of the MAR [Modernization and Associated Restructuring during the 1990s], and continued involvement will be crucial to future NWS successes . . . This will be accomplished by communicating early and often with union officials and ensuing that the union understands they will be viewed as a partner in change.

Forecast for the Future at 48, 49

Unfortunately, communications between NWS and NWSEO have grown even less frequent since the NAPA report was issued. Nevertheless, NWSEO and the employees it represents stand ready and willing to assist the agency in re-engineering the NWS for the future.

Senator SCHATZ. Thank you very much.

Dr. Ohanian.

STATEMENT OF LEE E. OHANIAN, PROFESSOR OF ECONOMICS, AND DIRECTOR, ETTINGER FAMILY PROGRAM IN MACROECONOMIC RESEARCH, UCLA

Dr. OHANIAN. Senator Schatz, Senator Blumenthal: Thank you for this opportunity. I'm pleased to be here.

My testimony presents recommendations to improve the future performance of the Weather Service, focusing on promoting cooperative labor relations between the Weather Service and thereby avoid some of the pitfalls that occur in some union-organization relationships. I'll begin by summarizing the economic impact of unions, discuss differences in trends between public and private sector unions, and then apply this analysis to develop recommendations.

A union is a form of a monopoly, which enables unions to drive up the cost of labor by raising compensation above market rates and by introducing work rules that increase union jobs, but sometimes at the expense of reducing productivity. Research shows that unions raise compensation by 15 percent above competitive market rates. Research on work rules indicates that they can reduce productivity by as much as 50 percent.

Private sector unionization has declined from around 37 percent in 1952 to about 6 percent today. Some workers find unions less attractive today than in the past. The enormous increase in global competition means that unions can't raise compensation significantly above market rates, nor can they implement efficient work rules, without risking substantial job loss. My research finds that about half of the job loss in the Rust Belt States that occurred after 1970 is a result of union bargaining that did not respond proactively to the increase in competition that occurred at that time.

Public sector unionization has not declined, because government organizations don't face the same type of competition as the private sector. Compensation has increased among government workers at a much faster pace than private sector workers. Compensation was roughly the same through 1980 for both private and public sectors, but has diverged since then, with public sector compensation about 20 percent higher today.

Successful labor relations in both the public and private sectors require unions and management to work productively for the common goals of enhancing productivity and providing a high level of service. Southwest Airlines is a terrific example of this principle. Most of Southwest's workers are in unions, but Southwest has a history of highly cooperative labor relations in which both management and labor focus on the same objectives of efficiency and quality. This has allowed Southwest to compete vigorously with much larger carriers and gain market share.

Let me apply these principles to the relationship between Weather Service and the NWSEO. In terms of compensation, BLS data show that Federal meteorologists receive the highest compensation, with 2012 median compensation of about $97,000 per year compared to annual private sector median compensation of about $90,000. Let me state that these data don't necessarily imply that compensation levels for Federal meteorologists are above market, but they do raise this possibility. I recommend that a compensation review process should be updated on a regular basis, particularly since the private weather industry is growing so rapidly, and which provides useful benchmarks; and that this compensation review process should take into account differences in retirement benefits between Federal sector and private sector as well.

Another recommendation is to review how the NWSEO may impact work rules and the organization of manpower. This is noteworthy for two reasons. One is that rapid technological change has significantly impacted weather forecasting and this will likely impact the deployment of labor and the structure of the organization in the future. The second reason is that private weather forecasting has expanded considerably and this will also potentially impact Weather Service organizational changes and changes in labor deployment.

To ensure that the Weather Service responds productively to these changes, it's central that the Weather Service and the NWSEO cooperatively plan future organizational and manpower changes to achieve a high level of productivity and quality. However, some actions by the NWSEO indicate that their goals stand in contrast to that of the Weather Service. My testimony lists some of these, including the fact that the NWSEO defeated plans to consolidate some forecast offices and reduce positions.

Ideally, the NWSEO will work with the Weather Service to constructively plan organizational and manpower changes and, most important, standard cost-benefit analysis should be used to assess different proposals to achieve organizational efficiency and quality. Both labor and management come up with terrific plans to improve quality and service.

A constructive relationship between the Weather Service and the NWSEO that focuses on increasing productivity and quality is the

best way to ensure that Weather Service workers are paid reasonably, have reasonable job security, and that benefits from the resources devoted to Weather Service forecasting justify the costs.

Thank you very much. I look forward to your questions.

[The prepared statement of Dr. Ohanian follows:]

PREPARED STATEMENT OF LEE E. OHANIAN, PROFESSOR OF ECONOMICS, AND DIRECTOR, ETTINGER FAMILY PROGRAM IN MACROECONOMIC RESEARCH, UCLA

Chairman Rockefeller, Senator Begich, and Committee members, thank you for the opportunity to testify today on the key importance of the National Weather Service (hereafter NWS). My testimony primarily consists of recommendations to improve the future efficiency and performance of the National Weather Service, with a focus on labor relations between the NWS and the union representing the employees of the NWS, the National Weather Service Employees Organization (hereafter NWSEO).

My focus on labor relations between the NWS and the NWSEO follows from the fact that labor costs are typically the largest component of production costs in organizations, and that there is evidence that unions have raised costs in some government agencies and in some private organizations. Moreover, technological change has had a large impact on weather forecasting and analysis, and may continue to impact the weather forecasting industry in the future. This in turn may lead to changes in manpower requirements and/or the cost-effective organization of the NWS. The productivity of future NWS operations will therefore depend on an ongoing cooperative relationship between NWSEO and the NWS as technology and the demands of the users of weather forecasts continue to evolve over time.

I will begin by summarizing the economic impact of unions, including distinctions between trends in private sector unionization and public sector unionization. I will discuss how unions can raise costs by raising compensation levels and by introducing work rules that reduce productivity and that may also interfere with organizational changes and the adoption of new technologies. I will then apply this analysis to developing a set of recommendations for the NWS in order to facilitate and foster a cooperative and productive relationship with the NWSEO.

A union is a form of monopoly. It is a single seller of labor services to an organization. This monopoly position provides unions with the opportunity to drive up the cost of labor by raising the compensation for union members above the compensation that would prevail in a competitive marketplace and by defining work rules for its members that protect jobs, which in turn increase the number of workers and thereby reduces labor productivity. In terms of their impact on costs and productivity, there has been considerable research on the effects of collective bargaining on wages, and consensus estimates are that unions raise wages by about 10 to 15 percent above the rate that would prevail in their absence (see Card (1996)). In terms of patterns over time, research by Blanchflower and Bryson (2002) indicate that union wage premia have declined in the private sector over time, but not in the public sector. There is comparatively less research on the impact of work rules on economic activity, but the cost of work rules may be much larger than the cost of higher wages. Several detailed studies indicate that union work rules, particularly in industries that face little competition, can substantially reduce efficiency and output by as much as 50 percent. In some instances, work rules impede the adoption of new technologies by requiring a minimum number of workers in production and/or by restricting how a particular job is done (see Holmes and Schmitz (2010) for a summary, and Schmitz (2005) for a detailed study). In summary, adopting inefficient work rules and raising compensation above levels that would prevail in a competitive marketplace harms consumers and/or taxpayers by raising costs and impeding the efficient allocation of society's scarce resources. My analysis with Harold Cole of the Great Depression (Cole and Ohanian, 2004) indicates that the large reduction in competition that occurred during the 1930s, including the rapid rise in unionization, prolonged the Depression for a number of years.

Union membership grew substantially following the National Labor Relations Act of 1935, and continued to expand through the early 1950s, as unions provided its members with important benefits at that time. This reflected the fact that there was much less competition in the economy for workers, which meant that some workers may not have received compensation commensurate with their productivity. Moreover, unions were considered to be important for protecting worker safety and health at that time. But both labor market conditions and worker health and safety conditions have changed considerably over time. Today, there is considerable com-

petition for workers, which means that compensation is commensurate with worker productivity, and health and safety are covered by national, state, and local laws.

These changes have made unions less attractive to workers than in the past, and this has resulted in a large decline in private sector unionization. Figure 1 shows the share of unionized employment from 1929 to the present. Union representation in the private sector began declining in the 1960s and this decline accelerated in the 1970s. Private sector unionization rates have declined from about 37 percent in 1952 to only about 6 percent today. Declining private sector unionization reflects a number of factors, including the facts that the economy is much more competitive than it was 60 years ago, that health and safety are protected through legislation, and that many of today's workers prefer to negotiate their own opportunities rather than relinquish their individual bargaining rights to collective bargaining. It is also important to recognize that declining unionization is not simply the result of the country's declining industrial base, as is often suggested (see for example Bluestone, 1990). In particular, declining unionization characterizes most of the private sector economy, including industry. As Hirsch (2008) shows, unionization rates in manufacturing and construction, two of the most heavily unionized sectors, fell from about 40 percent in the early 1970s to less than 15 percent in 2006.

Increased competition is considered by many economists to be a major factor in understanding lower private sector unionization. Competition for workers drives wages up to the level of worker productivity, which means that worker compensation is commensurate with the value of their production. And competition in product markets drives output prices down to the level that is consistent with the market return on capital. This means that in today's globally competitive world economy, union attempts to raise compensation or implement inefficient work rules would result in organizations becoming uncompetitive, which in turn would lead to substantial job loss. This is an important reason why unions have become a much smaller force in the private sector workplace and why there is relatively little new unionization among private industry. My research shows that increasing competition is a key factor in understanding why the most heavily unionized sectors of our economy, such as the auto, steel, and rubber industries, have declined so much since the 1970s. (Alder, Lagakos, Ohanian, 2013).

Today's increasingly competitive global and domestic economy indicates that there are important limitations on what unions can plausibly achieve for their members compared to what they were able to achieve in the past. Thus, workers have little to gain from union representation when unions cannot deliver better pay and working conditions than what workers can achieve on their own.

There are important lessons from the decline of private sector unionization rates and the decline of industries that were represented by traditional unions. Specifically, the historical characteristics of labor relations in which unions and management were at odds, and unions raised costs through compensation above market rates and through inefficient work rules, must change for both workers and other organization stakeholders to succeed. Successful labor relations today require unions and management to work productively for the common goal of enhancing productivity and providing a high level of service and value to the users of its products and services. An example of this is Southwest Airlines. Nearly 90 percent of Southwest's workers are in unions. Several of these unions, including Southwest's pilot union, are independent organizations, in contrast to the unions that represent pilots at other airlines. Southwest has a history of highly cooperative labor relations in which both management and labor focus on the same objectives of efficiency, customer satisfaction, and competing vigorously with other carriers. While many other air carriers have had a history of conflicted labor relations, Southwest's cooperative labor relations have been a key factor in its success, and they have allowed Southwest to compete vigorously with much larger carriers and gain market share.

I now turn to public sector unionization. Unionization trends among public sector workers are very different than the private sector trends discussed above. Figure 1 also shows unionization rates for federal, state, and local government workers since the early 1980s. The unionization rates of these public sector workers have been stable over time, at around 43 percent for local government workers, about 33 percent for state workers, and about 17 percent for Federal workers.

These very different trends reflect large differences in the impact of competition private versus public sector employees. As noted above, the very large decline in unionization in the private sector has been significantly impacted by increased competition, which has reduced the ability of unions to raise wages or change work rules. But much less competition exists in the public sector, and this means that unions have more opportunities to raise compensation above competitive levels and protect jobs, which makes union membership more attractive. In the private sector, significantly higher labor costs would result in large employment losses as firms

that attempt to pass on these higher costs would lose market share to competitors. But in the public sector, this type of competition often does not exist, so higher costs of above-market compensation or inefficient work rules can be passed on to taxpayers.

My research (Ohanian, 2010) indicates that public sector unions have been able to thrive because of limited competition. This also suggests that unions have increased compensation at a faster rate than the competitive levels noted above. In particular, compensation at all levels of government has increased by about 40 percent since 1980, compared to about a 20 percent increase in the private sector. The average public sector compensation level is now $70,000, compared to an average of $60,000 in the private sector. Moreover, job security in the public sector has traditionally been higher in the public sector, and public sector pensions are often superior to private sector pensions. Higher job security, and more attractive pensions, which is a form of deferred compensation, suggests that government workers may be willing to work at their current positions for less than private sector pay. My findings indicate that accounting for just the higher rate of public sector job security suggests that public sector employment could be competitive even with compensation that are about 10 percent lower than the private sector. The fact that average public sector worker compensation is higher than in the private sector, without taking into account pension benefits, suggests that public sector compensation levels may be above competitive levels.

There may be considerable savings from federal, state and local government reforms that systematically develop competitive compensation analyses and that also review work rule practices. Specifically, government organizations should review how they benchmark compensation, including pensions, to private sector comparison. Ideally, this would also include some allowance for the likelihood that public sector employment offers greater job security than private sector employment.

This discussion about unions also has implications for public sector union performance. These unions understandably operate in the interest of their members who pay their unions to represent them to gain the highest compensation and job security. But public sector unions must understand that taxpayers are becoming increasingly unwilling to pay for public sector services in which compensation is above market and in which there are inefficient work rules. As in the private sector, successful public sector labor relations will be ones in which unions and management broadly agree on goals of enhancing efficiency, productivity and customer service and perceived value to insure that their workers are reasonably and fairly compensated and that they have reasonable job security.

This discussion also has implications for assessing the future relations between the NWSEO and the NWS. One issue is regarding compensation. Data from the Bureau of Labor Statistics (BLS) shows that among meteorologists, public sector meteorologists receive the highest wages and salaries. In 2012, Federal Government-employed meteorologists received about $97,000 per year, compared to a median salary of about $86,000 for private sector meteorologists. While these data do not necessarily imply that compensation levels are above market for Federal Government meteorologists, these data do raise this issue as a possibility. I recommend that a review process for compensation should be updated on a regular basis, particularly since the private weather industry is growing so quickly, and this compensation review process should ideally take into account differences in pension/retirement benefits between government and the private sector.

Another recommendation regarding labor relations, and promoting the goal of high productivity, is reviewing how NWSEO may impact work rules and the organization of manpower. It is particularly important for the NWS and the NWSEO to follow current successful labor relations practices and to try to achieve a common set of goals that enhance productivity and customer satisfaction. This is noteworthy for two reasons. One is that rapid technological change has significantly impacted weather forecasting. As in other industries that adopt and adapt new technologies, the organization of the industry, including the deployment of labor and the location of production, will change.

Another reason is that private weather forecasting has expanded considerably in recent years, and debates regarding what forecasting services are to be provided by the NWS and other government agencies, and what services are to be provided by private organizations, will likely continue. While it is difficult to predict how the provision of weather forecasting services will evolve between public and private providers, it is possible that some services should be shifted from the NWS to the private sector, and this will also lead to organization changes and changes in manpower deployment and utilization.

The NWSEO will play a role in both of these processes. In the past, the NWS has negotiated with the NWSEO when an organizational change will impact working

conditions, unless the union has been involved prior to the decision. Ideally, the NWSEO and the NWS will share common goals of enhancing productivity and customer value, and the NWSEO would be involved in the planning stages of changes in the utilization of manpower to help achieve these common goals, instead of negotiating between the NWS and the NWSEO after the organization change.

I recommend that developing joint goals and working cooperatively be given high priority, and that this should be reviewed on an ongoing basis in the future. One reason to prioritize this issue is because some of the NWSEO achievements that are listed on *www.nwseo.org* may be inconsistent with the goal of achieving common objectives with the NWS. Specifically, I list below the NWSEO's main five recent achievements, all of which either involve raising compensation or expanding personnel. I have copied these from *www.nwseo.org*.

1. Saving the CWSUs (center weather station unit to forecast to FAA) from consolidation—a culmination of a five year lobbying effort by NWSEO to preserve both aviation safety and NWS employee jobs. NWSEO spent over $200,000 in this lobbying effort and obtained the support of the Senate Commerce Committee, the House Science Committee and the House and Senate Commerce, Justice and Science Appropriations Subcommittees.
2. Securing back pay for overtime for nearly 200 NWS employees. Securing FLSA (fair labor standards act) Non-Exempt status of *an additional* 165 NWS employees. The NWS has agreed to pay two years' lost overtime wages and liquidated damages for those employees, as well.
3. Winning an appeal to bargain to increase staffing at Anchorage WFO (national weather forecast service office) by 10 positions—this directs the National Weather Service to bargain with NWSEO over a proposal that would increase staffing at the Anchorage WFO by ten positions.
4. Securing special projects designed to increase aviation safety, which include increased NWS personnel at the CWSU and WFOs in New York City, Atlanta, and Chicago.
5. NWSEO secured an agreement that upgrades to a GS–8 every Administrative Support Assistant at field offices around the country. The GS–8 upgrade includes approximately one million dollars in extra pay and benefits to the lowest paid NWS employees each and every year from now on.

Note that Items 2 and 5 suggest the possibility of raising compensation above market levels. Items 1, 3, and 4 suggest the possibility of expanding staffing that may not be justified on a cost-benefit basis.

The NWSEO also has a top 20 historical achievement list that also includes items that raise the possibility of expanding staffing and impeding organization changes, and raising compensation above market. These include:

1. Defeated the agency's plans to reduce staffing and consolidate Forecast Offices (CONOPS).
2. Defeated the agency's plan to eliminate nearly 400 HMTs and instead negotiated for the creation of new promotional opportunities for HMTs (the GS–12 OPL position) and true time and one-half overtime for HMTs.
5. Won an arbitration case which requires the agency to maintain at least two employees on duty on every forecast shift.
9. Negotiated agreements that raised target grades of interns from GS–9 to GS–11 and that entitles interns to the first opportunity to apply for forecaster vacancies before outside candidates.
10. Won an arbitration case which requires the agency to make temporary promotions when forecasters cover vacant positions for 20 days or more.

Some of these items prevented organizational changes involving the deployment of manpower or the organization of the NWS that would presumably have enhanced efficiency of the NWS. Some other items raised compensation possibly above market levels.

These actions do indicate contrasting objectives between the NWSEO and the NWS. The NWSEO's mission has been to represent its members by obtaining high compensation and job security. However, these NWSEO objectives may possibly be raising costs and reducing efficiency. A cooperative relationship between the NWSEO and the NWS that focuses on increasing productivity and customer value will be central for the future success of both parties.

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Figure 1: Unionization Rates

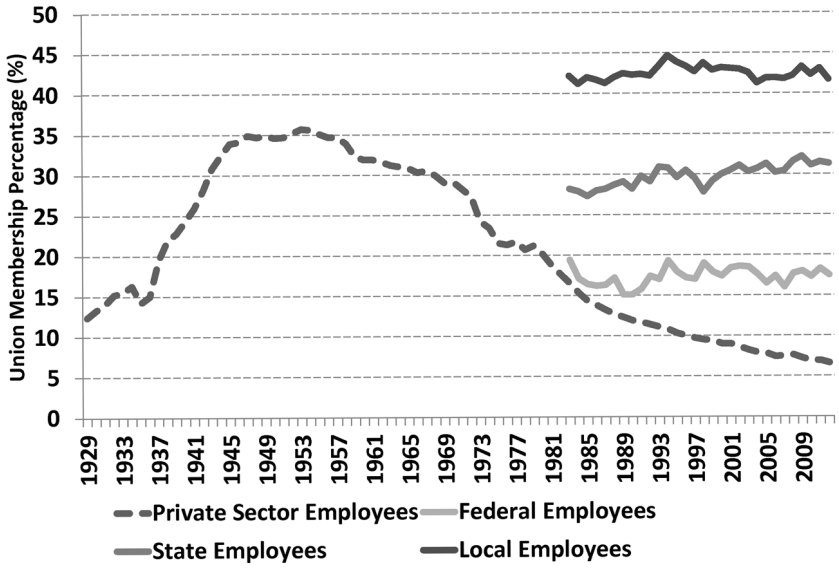
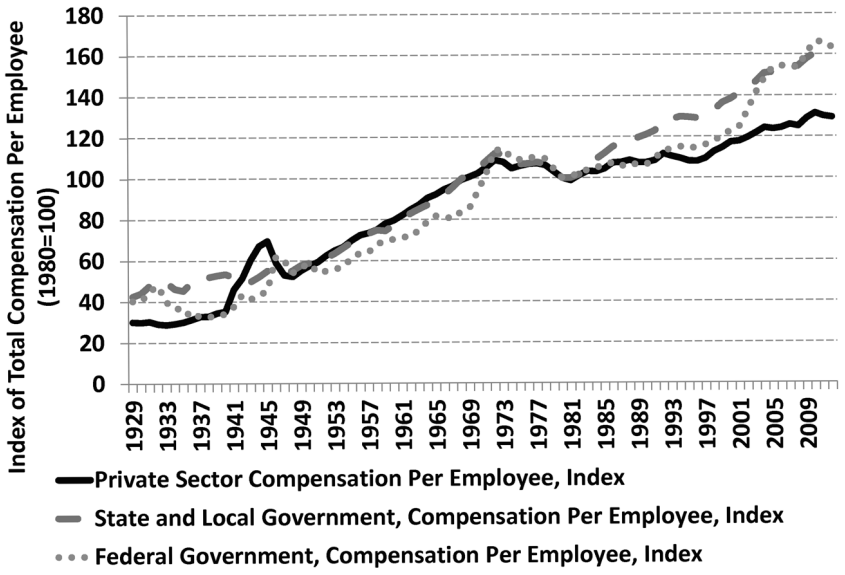


Figure 2: Compensation



Senator SCHATZ. Thank you very much.
Senator Blumenthal.

STATEMENT OF HON. RICHARD BLUMENTHAL, U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thank you, Mr. Chairman.

Thank you all for being here today on a subject that Americans truly appreciate, I think, although often they don't look beyond the immediate forecast for the day to the longer term forecast, either for the weather forecasting capability or the weather itself.

So let me begin. Mr. Gail, in your testimony—and I've been reading as well as listening to it—you make reference at various points to technology, the need to build new skills to use the technology. Is there technology available right now that the National Weather Service is not using, that it could be using, that would provide more accurate and reliable forecasts?

Dr. GAIL. There has been a lot of attention to that recently. The Sandy legislation put forth resources to help resolve some of those issues. Many of these are things that we as a community and the Weather Service in particular are directly aware of. So there is progress, particularly in the area of modeling. That's an area where we know that in some cases we have been falling behind the Europeans in particular. So resources have been put towards that and we are making substantial progress.

The technology of delivering information is, as everybody knows, undergoing rapid evolution. There was discussion earlier of Twitter and other mechanisms for communicating information. That's an area that really requires really focused attention to make best use of that and to understand when it works well and when it doesn't

work well. So those are real challenges for us as a community in general.

Senator BLUMENTHAL. Are there sources of information—I know in Connecticut, for example, a number of our academic institutions help to provide information on what's actually happening on the ground. Is that practice generally used around the country?

Dr. GAIL. There's a lot of work being done in the academic sector on these exact issues. Some of it is technological, some of it is sociological and communications science, to understand not only how to get information to people in the best manner, but how to deliver it in a form that's most useful.

Senator BLUMENTHAL. How do we attract the kinds of people—you make reference to them—who have skills, who can develop these skills?

Dr. GAIL. I think we're seeing a time where this field is becoming very dynamic and we are beginning to attract people because they see the challenges and the interest in delivering weather information in a variety of ways, to a variety of end users, whether they're businesses or the public. So we see this in terms of applications being developed for mobile phones and a large number of applications that are being developed by people even outside what we would consider our traditional community, people coming in and saying: This is a really interesting thing to do.

Senator BLUMENTHAL. Let me ask you and any of the other folks here if they care to comment: do you think there is sufficient attention given to climate disruption, global warming, that area, in terms of the forecasting of weather?

Dr. GAIL. Well, let me. That obviously is a very tricky and deep question. Let me just add that I am speaking from my own personal perspective here rather than the perspective of the Committee. When you look at extreme events, extreme events are interesting to us irrespective of the source of climate change. We're seeing more and more sensitivity to extreme events. So I think paying attention at that level to extreme events and the climate underpinnings of extreme events is important no matter your particular perspective on climate change.

Senator BLUMENTHAL. Thank you.

Anyone else care to comment?

[No response.]

Senator BLUMENTHAL. Thank you very much.

Thank you, Mr. Chairman.

Senator SCHATZ. Thank you, Senator Blumenthal.

I have a question for Mr. Young. You talked about the fragile state of the situation with JPSS and that we were one failure from a gap which would have severe implications. Can you explain in sort of plain language what that means for someone in my home state or Senator Blumenthal's home state in terms of our ability to know what's happening, in terms of our visibility into weather events? What does that mean as a practical matter if we were to have a gap?

Mr. YOUNG. If we had a gap we would have——

Senator SCHATZ. I think your microphone—thank you.

Mr. YOUNG. If we had a gap, there would be no afternoon polar-orbiting data available. No polar-orbiting data available means no

long-range forecasts. So it fundamentally means that the ability to do a lot of the things that have been presented in terms of not only weather, but severe event forecasting, we won't have the ability to provide those data in a timely manner to execute appropriate warnings.

Specifically, I think it has been referenced, but there was data denial study done for Sandy and polar-orbiting data were eliminated, and if polar-orbiting data were not part of the model it would have forecast that Sandy would have gone out to sea. So there would have been no warnings for New Jersey and New York and the small loss of life that took place obviously would not have been the result.

Senator SCHATZ. Thank you, Mr. Young. That's a perfect example, easy for all of us laymen, lay people, to understand.

I have a question about the efficacy of utilization of appropriated moneys. Obviously, we're very hopeful that we'll have a budget deal and soon after start to move forward with appropriations. I want to get the perspective of Dr. Gail and Mr. Myers very quickly, if you don't mind, on the efficacy of, say, a dollar spent in the communications, public education aspect of weather preparedness versus trying to spend another dollar on increasing accuracy, because I think that for the appropriators is going to be one of the tough questions to answer, is where are—if we are able to incrementally spend more dollars, where's the best place in this appropriation timeframe to focus?

Mr. Myers.

Mr. MYERS. I'm a believer in the fact that the National Weather Service is primarily at least a science agency, and the quality of what they do is probably the most important thing. I know at AccuWeather we look upon accuracy as critical. If forecasts are not accurate, if warnings are not accurate, people will not act, no matter what the message, no matter what methodology you use to get the message out. An example with Sandy. If the data's not there, if the satellites aren't there, you won't even know that there's a danger.

So I have some fundamental points of discussion that I constantly have with NOAA and the National Weather Service over where the money should be spent, especially in terms of social media activities that are going on. I understand the desire to do that. I also understand the cost to do that and the fact that it has to take money away from the essence of what that agency is about, which is putting out a quality warning that people can rely on. If you knew every warning was correct, you would act.

Senator SCHATZ. Thank you.

Dr. Gail?

Dr. GAIL. My personal perspective is that understanding how people use information and how it gets communicated to them is important. I believe the Weather Service should focus to some extent on that. Our committee did say very clearly that the Weather Service should focus first and foremost on those things that only they can do, and the modeling, major modeling, certainly falls within that category. So I would agree with Mr. Myers that a focus on core capabilities is primary. Communication is something that we all share across the enterprise. We all try to do that well.

Senator SCHATZ. Thank you very much.

I have a question for Mr. Hirn. It's actually a repeat of my first question for Dr. Uccellini, regarding the use of social media. You talked about it a little bit and I'm wondering what the perspective is of how social media is evolving in the work place and how you think it's going to help people to be prepared?

Mr. HIRN. Well, I would note that you're going to need—when you have a fully staffed office, this is something that can be done. There is—once you fully staff the Weather Service—and it's not fully staffed now to what it ideally should be or to what's necessary to consistently and reliably issue the forecasts and warnings. But the social media is not much of an additional, incremental cost. That's something that the employees have taken on on their own as an employee initiative in the forecast offices, that they have embraced doing.

I think it's important to keep doing that. We want to make sure that—there's a lot of social media out there, some reliable, some not. We want to make sure that the information that's being conveyed on the social media is coming from the reliable source. The Weather Service is the official source for public warnings of severe weather. If the Weather Service is not doing that and somebody unreliable is doing that or things get tweeted and re-tweeted and people start guessing what it's going to be, the public's going to get confused.

So I think it really is important to have the Weather Service be engaged there and have the social media outlet, and if you fully staff the offices I'm not sure where the additional cost comes in.

Senator SCHATZ. Thank you, Mr. Hirn. I just want to say I agree that it's very unlikely to cause incremental additional costs unless you start hiring specific positions called social media manager, digital outreach, communications coordinator. But to the degree and extent that your NWSEO employees, National Weather Service professionals, have information, most of them are on the Internet, which means that they're going to be engaged in social media whether we like it or not. So the question is how do we just make sure that they do so responsibly and in a somewhat organized fashion to the extent that it's possible.

I really want to thank all the testifiers for being so engaged in this critically important issue. The Commerce Committee and Senator Begich's subcommittee are very interested in this issue. As you can see from our membership when the hearing started, we are all passionate about weather. It is something that impacts all of our communities, both on a day to day quality of life basis, but also economically. So I appreciate your engagement and look forward to working with you.

Thank you.

[Whereupon, at 12:11 p.m., the hearing was adjourned.]

A P P E N D I X

GEOOPTICS, INC.
December 12, 2013

Hon. MARK BEGICH,
U.S. Senate,
Washington, DC.

Dear Senator Begich:

RE: Please Support—H.R. 2413—the Weather Forecasting Improvement Act of 2013

I am a 40 year Navy veteran (Vice Admiral. USN ret), then served as the Administrator of the National Oceanic and Atmospheric Administration (NOAA) from 2001–2007, and am currently CEO and Director of a satellite-based weather data company, GeoOptics. The Committee on Commerce, Science, and Transportation's Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard will soon be considering H.R. 2413 that emanates from a critical need to improve weather forecasting in the United States in response to severe weather events such as tornados and hurricanes, and other costly weather impacted events.

As a former Administrator of NOAA, I strongly support a renewed emphasis on ensuring the necessary management policies and resources are directed toward improving our ability to forecast and warn in advance of severe weather events of all types from heat waves, floods, forest fires to hurricanes and tornados. The U.S. economy, national security, and daily business demand in a competitive world that the U.S. be the leader in these critical areas. We need to support a renewed emphasis on a balance of research, observations, data gathering, modeling, high performance computing and communications to protect our economy and our people.

As the CEO of a satellite-based weather data company, I strongly support the provisions to require a commercial data buy component that will exert market influences to lower the current costs and development times resulting from the long practice of exclusive use of government developed, owned, and operated weather satellite systems. From my experiences as a DOD cost analyst, manager of the U.S. Navy program and budget, and NOAA executive, I am a strong advocate of competition to lower costs and improve value. After living with and studying the current weather satellite "business" model in government and the private sector, I am convinced that the gradual addition of a commercial data buy component can achieve what to date has been elusive—firm management control over weather satellite costs, schedules, and performance.

Firm legislative direction to ensure an immediate place for commercial data buys of operational weather data will provide the opportunity to transition the current system to a more rational and logical path both for developing satellite technology and ensuring operational weather data continuity without the current "theater" that accompanies every new generation of weather satellites.

With your support and consideration for H.R. 2413, this legislation can help NOAA save more lives; spur commercial investment in new technologies; and, bolster our economy by creating jobs and enhance our citizens' quality of life affected by severe weather.

Thank you for your consideration.

Sincerely yours,

CONRAD C. LAUTENBACHER, JR.
VADM USN ret,
CEO & Director,
GeoOptics, Inc.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARCO RUBIO TO DR. LOUIS W. UCCELLINI

Question 1. Provided that the data are subjected to the same standards of quality, reliability, and timeliness, do you have a preference whether satellite data come from government satellites versus commercial satellites?

Answer. As operational users, the National Weather Service (NWS) utilizes data from both government agencies as well as commercial vendors. The data must meet required quality, reliability, and timeliness standards.

Question 2. I understand from your testimony that you used a new hurricane prediction model for the 2013 season. The 2013 Atlantic Hurricane Season was predicted to be an above average season with 13 to 20 named storms and three to six major hurricanes. Yet, it ended as the sixth least active hurricane season since 1950. Can you explain this anomaly? What are you doing specifically to improve hurricane forecasting?

Answer. The hurricane seasonal outlook you mention is a seasonal prediction effort, and includes many large atmospheric and oceanic variables, such as Pacific Ocean sea surface temperatures, Atlantic Ocean temperatures, and an overall prediction of the high level steering winds over the tropics. This information is used by our seasonal forecasters to predict the atmospheric characteristics that foster hurricane development in general, not individual hurricanes. Our forecasters did not anticipate the high level wind shear to persist over the Atlantic Ocean throughout the entire hurricane season, and this feature contributed to the reduced number of hurricanes in the Atlantic basin. While progress has been made in seasonal hurricane prediction over the past few years, additional research is necessary to improve the skill of these outlooks.

NOAA's Hurricane Forecast Improvement Project (HFIP) is focused on the short term prediction of individual storms. The goal of HFIP is to improve hurricane track and intensity forecasts by 50 percent. The new HFIP-supported hurricane forecast model we are using predicts the track and intensity of the hurricanes and has shown significant improvement over previous models. Since the program began four years ago, we have achieved a 20 to 25 percent improvement in track prediction and 10 to 20 percent improvement in intensity prediction and expect to see continued strong improvement for FY 2014. While funding for the program is reduced in FY 2015, we still expect to make continued, albeit smaller, progress in track and intensity predictions.

Question 3. How have the labor relations at NWS impeded your efforts to make the agency work more efficiently?

Answer. Executive Order 13522: "Creating Labor-Management Forums to Improve Delivery of Government Services," issued in 2009, envisions a non-adversarial relationship between labor and management to reach consensus on common issues. E.O. 13522 prescribes using pre-decisional involvement and a non-adversarial forum that allows managers and employees to collaborate in delivering high-quality services to the public. As reported to the National Council on Federal Labor-Management Relations in May 2011, the Department of Commerce and the National Weather Service Employees Union (NWSEO) had success working together to improve efficiency, by saving money on travel expenses. However, the NWS and the NWSEO are still working together to realize the full benefits of pre-decisional involvement and interest-based bargaining.

Historically, the relationship between NWS management and the NWSEO is strained. When unresolved, particularly contentious issues may come before a third party, such as an arbitrator or the Federal Labor Relations Authority, when there are allegations that the NWS has failed to meet its bargaining obligations under 5 U.S.C. chapter 71 and the NWS/NWSEO Collective Bargaining Agreement.

But, since I have been the director of the NWS (February 2013), our leadership team has taken steps to improve our relationship and involve the NWSEO in all of our planning meetings and initial efforts. We are implementing the recommendations of the National Academy of Public Administration (NAPA) report, "Forecast for the Future: Assuring the Capacity of the National Weather Service," to develop a process for change that is deliberate, involves NWSEO up front, and will ensure any proposed changes in our organization are successful and result in no degradation of services this Nation relies upon on a daily basis. Our plan is to involve NWSEO at every stage to evolve the agency following the direction outlined in the FY 2014 CJS report language.

Question 4. In what areas has the Federal Labor Relations Authority required negotiations with the National Weather Service Employee Organization and, therefore, hampered the agency's ability to perform work effectively?

Answer. The agency's obligation to negotiate with the NWSEO is found in 5 U.S.C. chapter 71, which the FLRA is responsible for administering. The Federal Labor Relations Authority (FLRA) may require negotiations if it determines that the NWS has violated 5 U.S.C. § 7116(a)(5) by refusing to negotiate in good faith, as required by law or contract. The FLRA may also require the parties to negotiate upon request over specific proposed language where the FLRA determines in a negotiability proceeding under 5 CFR Part 2424 that the agency has a duty to bargain over that language. The FLRA typically does not hamper our ability to perform work effectively other than it may occasionally take a long time to reach a decision resolving a dispute involving an issue regarding negotiations. In this connection, delays may occur when the Authority component of the FLRA does not have a quorum and is unable to issues decisions. In regards to negotiating with NWSEO in general, the Collective Bargaining Agreement (CBA) between the NWS and NWSEO, became effective on October 25, 2001. Since that time several MOUs and associated addenda have been added to the CBA. The CBA was initially valid and in force for a period of three years from its effective date, and it is renewed automatically from year to year unless either party provides written notice of a desire to change. While the effectiveness of a negotiated agreement is not dependent on the age of an agreement, the ability to effect change could be based on the balance of management and employee rights within the cumulative agreement and its associated addenda. The NAPA study, "Forecast for the Future: Assuring the Capacity of the National Weather Service," recommended the NWS and NWSEO collaborate to reframe the relationship. Although renegotiating the October 2001 CBA may help to reframe the labor-management relationship, other key elements suggested in the NAPA study include reinvigorating the labor-management forum and involving NWSEO in predecisional discussions.

Question 5. As we will hear from Dr. Gail, the Independent Review Team has recommended that the NWS evaluate its function and structure, seeking areas for improvement. What specific actions are you taking with the NWS workforce to implement this recommendation?

Answer. (1) As part of the FY 2015 President's Budget, we requested authorization to restructure our budget lines or Programs, Projects, or Activities (PPAs) to align with our functions in the NWS—(Facilities; Observations; Central Processing; Dissemination; Science and Technology Integration; and Analyze, Forecast and Support). In parallel, NWS is exploring options to reorganize its headquarters to align with the new budget structure. Furthermore, we are developing a Budget Governance document for the NWS leadership to follow in preparing the budget and execution according to the Congressional appropriations. Once complete, our budget process will be transparent and far more effective towards executing our mission.

(2) We are developing a services baseline in our field offices to ensure any changes will not lead to degradation of service. Moreover, we have plans to conduct an agency-wide staffing analysis to ensure resources are applied strategically and optimally to meet our mission.

(3) We are also developing a process for change to plan, execute, and assess any significant changes to NWS services or operations. It is an open process and actively solicits input from our users—ranging from the emergency management community to Federal partners, and Congress, and includes university users, the private sector, and our employees.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. DAN COATS TO DR. LOUIS W. UCCELLINI

Question. The IRT report used some fairly strong words with regards to the state of NOAA's weather satellite program and the unacceptable gap in coverage we face. However, it did suggest we could help right those problems with investment in low cost small satellites without some of the costly sensors on our current polar systems. Would the NWS benefit from the data that could be provided by the sounders flown on the gap filler mission suggested by the IRT?

Answer. NOAA is taking steps to reduce the likelihood of a gap in coverage in the afternoon polar orbit. A gap-filler mission could further reduce the probability that a gap were to occur between planned JPSS missions; however, a gap filler mission is not the only way to ensure robustness. NOAA is examining all options, including a gap filler, and plans to make a recommendation with the FY16 President's Budget. NOAA has developed a contingency plan to help mitigate a gap if it were to occur and is taking steps to reduce the risk of a gap occurring. There are several projects that were funded through the 2013 Disaster Relief Appropriations Act (Sandy Supplemental) that will bring in additional non-satellite observations, en-

hance data assimilation techniques, and improve national numerical weather prediction capabilities.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARCO RUBIO TO WILLIAM B. GAIL

Question. Do you agree that some of the listed "achievements" by the National Weather Service Employees Organization directly contradicts your specific recommendations for the NWS to evaluate its function and structure in a way that would make the agency and its operations more efficient?

Answer. I do not agree that the listed "achievements" by the National Weather Service Employees Organization (NWSEO) directly contradicts the specific recommendations of the NRC "Second to None" report for the NWS to evaluate its function and structure in a way that would make the agency and its operations more efficient. The "achievements" describe how individual initiative has proved valuable to the NWS mission. In several of the cases presented, this initiative was rewarded with public endorsement by NWS management.

The "Second to None" reported noted that NWS field offices are staffed for fair weather, and can be spread thin when responding to severe weather events. It recommended that a more agile workforce—with regard to both individual skills and workforce structure—is needed for the future. Determining the nature of this agility and implementing it represents a challenge for NWS and NWSEO. Yet increased agility in no way undermines the ongoing need for human staff. In contrast, such agility can be exemplified by reliance on individual initiative to develop improved NWS services. NWSEO's list of "achievements" is consistent with the agility message of the "Second to None" report, not contradictory.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARCO RUBIO TO A. THOMAS YOUNG

Question. Did the team consider commercial options to help mitigate gaps in polar-orbiting weather satellites? If not, why not?

Answer. The IRT did discuss and consider commercial options to help mitigate data gaps from polar-orbiting weather satellites. And while the IRT is supportive of the overall growth of commercial satellite systems, the IRT believes there are very limited, if any, viable commercial options to address the data gap in the 2017 era.

First, analysis by the National Weather Service (NWS) has shown that the two atmospheric observation instruments that have the largest impact on weather prediction error, are the microwave sounder and the infrared interferometer, respectively. These are the key sensors that are needed for the gap. The IRT is not aware of any commercial vendor that can produce either of the sensors, especially in time to address a gap in 2017. [Of the handful of current commercial vendors that plan to provide atmospheric observation data, two are planning on providing GPS Radio Occultation data, and the other is providing hyperspectral sounder data collected from geosynchronous orbit.]

Second, additional analysis by NWS has shown that the atmospheric observations must be of high quality with low noise and sufficient resolution. For example, attempting to fill the gap with an older generation microwave sounder (*i.e.,* the DMSP SSMIS) actually *degrades* the weather forecast. Other than the ATMS and the CrIS which are already under contract for JPSS1, the IRT is not aware of any other high fidelity instruments that can be developed and procured in time to support a potential gap in 2017.

For these reasons, the IRT recommended to immediately procure at least three of the ATMS and the CrIS instruments. Block buys not only make the unit cost less expensive, but also can reduce schedule risk by having available spares should a component or a board fail in development or test. Once these instruments have been acquired, there may be several options to fly them in space—as hosted payloads, perhaps on a commercial satellite. However, due to the time criticality and the potential impact of a data gap, the IRT still recommends investigating the option to host these instruments (ATMS and CrIS) on a free flyer.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DAN COATS TO A. THOMAS YOUNG

The 2013 IRT report notes that with the cancellation of NPOESS and the DOD's subsequent termination of DWSS, today there is an "unacceptably high risk" of a gap in U.S. polar weather coverage. While the IRT report does mostly look at civil programs, one way to increase the robustness of both civil and DOD weather imagery would be to leverage the low cost of hosting imagery sensors in the Canadian Polar Communications and Weather satellites.

Question 1. If DOD were to take action and fund weather imagery in FY15, could this provide spinoff benefit to NOAA and our observations?

Answer. It is possible that if DOD were to take action and obtain additional weather data, that the data could provide benefits to NOAA and the NWS. These possible benefits are why the IRT recommended that NOAA have discussions with the Air Force, who was in the process of conducting an Analysis of Alternatives (AoA) study for their polar weather data needs. It is possible that some of these AoA concepts might be available before 2017, particularly to guard against a data gap from a premature S–NPP failure. Historically, there have been mutually beneficial arrangements and data sharing between the DOD and NOAA. As noted in Question 1, to mitigate the potential gap in polar data, what is critically needed are high quality microwave sounder and infrared interferometric (ATMS and CrIS level) data.

Question 2. Did the IRT look at the PCW option in particular?

Answer. The IRT did not look at Canada's Polar Communication and Weather (PCW) mission. However, the PCW mission is currently at an early stage of development, with an estimated procurement start in November 2016 and will not be available for gap mitigation in the time-frame suggested in the report (Mid FY16—Mid FY22). The IRT continues to recommend that emphasis should be placed on a short-term gap filler.

From a longer term perspective, it is possible that PCW could help bolster the robustness of the JPSS program. However, at this time the IRT cannot assess the suitability of the PCW mission orbit or data for NOAA's weather data needs.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARCO RUBIO TO BARRY LEE MYERS

Question 1. Are there any legal or regulatory issues that impede government use of private sector data for forecasting?

Executive Summary Answer. No, but the law requires the private sector data must also be made available to the public in real time and the method by which it is incorporated into the weather forecasts must be transparent and verifiable. From a practical perspective, to do otherwise, the structure of the whole American Weather Enterprise will be seriously and negatively impacted.

Full Answer. In 1994, I was asked to offer thoughts to the U.N.'s World Meteorological Organization about weather information and its use. What I said was, in part:

- Viewed broadly, weather is a world-wide resource.
- In gathering weather information, time is of the essence.
- In analyzing it, and in distributing the results of that analysis of weather observations, time is critical.
- And, in getting this analysis into the hands of those who need it to protect life and property, not only is time critical, but the very nature of the message and its understandability by those receiving it, is paramount.

In the United States, the National Weather Service has a specific role to play and America's Weather Industry, and the academic and research communities, each have important and complementary roles to play. It is a unique environment and special partnership for the benefit of the public. Together, it is known as the American Weather Enterprise, with a capital "E."

The laws of the United States do not hamper or restrict the nature of the private sector. In fact, unlike many other countries, they encourage private sector and especially weather industry activities.

The United States Government collects, and disseminates data from local and remote sensor platforms, public and private, runs forecast models, and prepares and makes special warnings and also general public forecasts.

Weather companies and academic and research institutions also collect and disseminate data, and make weather forecasts, some specific and tailored and some general public forecasts.

Weather companies also develop communication methods designed to move weather information as quickly and as understandably as possible to the end user.

In fact, the government and the weather industry work together, to carry out these functions.

This joint system of public and private cooperation helps to save countless lives and prevent hundreds of millions of dollars in property damage per year in the United States—in fact it has a name—The Public/Private Partnership.

This cooperative effort, better than anywhere else on earth, is dedicated to the proposition that weather information is (1) highly time sensitive and (2) a perishable scientific commodity, which, if utilized quickly and communicated to people who are in a position to act, effects real economic efficiencies, saves lives, and, results in benefit to the Nation.

Another guiding principle is that all scientists should be free to access scientific data so that they may render timely viewpoints and opinions on what future weather may be—that is create forecasts and warnings.

This freedom of access to scientific data and its free use for the benefit of society is typically American.

In the United States this "free and open access" is founded upon principles having to do with free speech and freedom of information.

These comments seem self-evident to many. In making these remarks to the World Meteorological Organization, almost 20 years ago, these comments did not seem self-evident to many of the hundreds in the audience from around the world.

The weather industry in the United States was born of the concept of "free and open" availability of weather information.

It has led the world as a model of growing success, transitioning from a government agency "doing it all," at the end of World War II, to massive infusion of weather into every American's life through companies like The Weather Channel and AccuWeather—and a growing global presence by American companies as the preferred suppliers of weather to the world.

It has been a transition of work from the government to private industry involving no letting of government contracts, no industry subsidies, and no cost to the government.

In fact a tax paying industry creating perhaps tens of thousands of jobs—has been born.

It truly has built on a concept that if information is free for all, we should leave the rest to ingenious, innovative, and entrepreneurs, who would find ways to make a viable industry.

By the end of 2013, figures suggest that American Weather Companies will have weather apps and access portals on or accessible from perhaps two billion digital devices worldwide.

People who had no weather forecast of merit for 25 minutes ahead, now have forecasts, on an hour by hour basis, for 25 days ahead on *AccuWeather.com.*

People who had no warnings for severe and deadly weather, now can use at a device that looks like something they would have used to ask "Scotty beam me up" that contains more information than Star Trek creators ever imagined.

These comments seem self-evident to many today.

In 1994 if I had told anyone that by 2008 a private weather company in Pennsylvania (AccuWeather) would tell a manufacturing facility in Mississippi (Caterpillar), a thousand miles away, 21 minutes in advance, that a severe tornado was heading right at it and they needed to shelter their people—and that the private weather warning would save 88 lives in a single electronic message—it would not have been believed.

In 2005 the U.S. Congress Bi-partisan Committee on the review of Hurricane Katrina cited AccuWeather saying "AccuWeather issued a forecast predicting the target of Katrina's landfall nearly 12 hours before the NHC [National Hurricane Center] issued its first warning, and argued the extra time could have aided evacuation of the region."

I am not telling you this to place AccuWeather in the spotlight. My friends at The Weather Channel and at many other non-governmental organizations have this and other important capabilities.

Everywhere within the American Weather Enterprise there are meteorologists, scientists, researchers, and professionals of all kinds of equal merit.

But the government is uniquely positioned to ensure and enhance the provision of weather data and the issuance of warnings for the public aimed at the protection of life and property.

These activities also require research and development, transfer of knowledge, technologies and applications to other government agencies and the private sector.

And this is needed with regard to advanced radar technologies, aerial observing systems, high performance computing networks, advanced forecast modeling and other government-appropriate activities.

We all need to protect this core functionality and the research that keeps the entire American weather enterprise ahead of the curve.

We also need to be cognizant of the fact that private weather data is emerging from private sources; in the weather field, if these data are restricted by taxpayer money paying for critical scientific data that needs to be kept secret, it will degrade the entire weather effort of the Nation.

Free and Open Access Drives America's Unique Success

So indulge me for a few minutes to point out that if we want to successfully approach the present problems the weather enterprise may face we should understand that the huge success we have had, did not occur serendipitously. It was well planned, thought through, and took much hard work in all sectors of the weather enterprise over many years.

In 1980 the Paperwork Reduction Act, sponsored in part by Representative William Klinger (R–PA) was passed. The law stated its purpose was, among other things to:

Ensure the greatest possible public benefit from information created, collected, maintained, used, shared, and disseminated by or for the Federal Government.

It also said one of its purposes was to provide for the dissemination of public information on a timely basis, on equitable terms, and in a manner that promotes the utility of the information to the public and makes effective use of information technology.

In follow up to the law, the Office of Management and Budget issued Circular A–130, which was updated over the following decades.

The Circular is lengthy, but states in part:

- *The free flow of information between the government and the public is essential to a democratic society. It requires dissemination of information on equitable and timely terms.* [Emphasis added]
- It states the government must avoid establishing, *or permitting others to establish on their behalf, exclusive, restricted, or other distribution arrangements that interfere with the availability of information dissemination on a timely or equitable basis.* [Emphasis added]
- It declares agencies shall avoid establishing restrictions or regulations, including the charging of fees or royalties, on the re-use, resale, or re-dissemination of Federal information, setting user charges at a level only sufficient to recover the cost of dissemination, but no higher.

Under Section 105 of the Copyright Act of the United States, in general, government information is not entitled to domestic copyright protection declaring it free—domestically.

The 1991 NWS Public Private Partnership policy was an early cooperative attempt to implement concepts from the Paperwork Reduction Act, Circular A–130 and issues relating to the growing weather industry.

About ten years later the National Research Council was requested by the National weather Service to undertake a study of the status of the enterprise and the *Fair Weather Report* was issued in 2003.

This led to the AMS Commission on Weather and Climate Enterprise.

And, the Fair Weather Report led to a new partnership policy issued by NOAA governing its relationship with America's weather industry.

In the main policy section, the first sentence says: "NOAA will adhere to the policies contained in the Paperwork Reduction Act, OMB Circular A–130 and other relevant laws."

The second sentence says: "These policies are based on the premise that government information is a valuable national resource, and the benefits to society are maximized when government information is available in a timely and equitable manner to all."

It goes on to endorse "Open and unrestricted access."

And further that NOAA will promote the open and unrestricted exchange of environmental information worldwide.

NOAA also states it will avoid duplication and competition in areas not related to the NOAA mission.

So today's policies trace their origins to the core nature of the republic and critical pieces of Federal legislation and rules long a part of the fabric of the country's legal structure.

Building on this, NOAA and NWS have developed formal and internal directives defining what they will do and not do and specifically stating where government personal will defer to the America's weather industry.

Even the Weather Ready Nation program now specifically endorses the role of America's weather industry and states that the requirements and activities of Weather Ready Nation participants may be fulfilled through arrangements with America's weather industry.

And, the Open Data Executive Order signed by President Obama just this month on May 9, 2013 stated:

> "For example, decades ago, the Federal Government made both weather data and the Global Positioning System (GPS) freely available to anyone. Since then, American entrepreneurs and innovators have used these resources to create navigation systems, weather newscasts and warning systems, location-based applications, precision farming tools, and much more."

Question 2. How can we better leverage resources in the private sector, particularly as the threat of data gaps increases?

Executive Summary Answer. Data from the private sector is available to both the government and the American Weather Industry and others. The effect of government licensing such data under licensing arrangements that makes the data available in real time as part of the data flow from the government to the public will guarantee the suppliers of a floor which will encourage investing in new data sources. Experience suggests such arrangements do little to impede private companies from also securing license for the data source originator because by direct access nano-seconds are saved and such speed is a competitive and lifesaving effect. Data wants to be free and it will leak out and artificial markets damages the flow of data where it is needed. Supporting data providers in restricting data, costs lives. We see various models at present in the United States including in the lightening field, in the agricultural field, and emerging in the launching of satellites (interestingly some of these satellite companies appear to agree with this model).

Full Answer: See Full Answer to *Question 1.* for more background.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARCO RUBIO TO LEE E. OHANIAN, PH.D.

Question. You point out several areas where the priorities of the National Weather Service Employees Organization often contradict direct measures we could take to make the National Weather Service more efficient. How can we better address these contradictions?

Answer. Achieving a more efficient relationship between the National Weather Service (NWS) and the National Weather Service Employees Organization (NWSEO) requires aligning the incentives of the NWS and NWSEO to achieve more efficient work rules and deployment of workers, and requires benchmarking compensation levels to private sector counterparts.

The NWSEO identifies the following compensation and work rule changes on their website (*www.nwseo.org*), all of which raise questions regarding the impact of these changes on the efficiency and cost of the NWS:

1. Saving the CWSUs (center weather station unit to forecast to FAA) from consolidation—a culmination of a five year lobbying effort by NWSEO to preserve both aviation safety and NWS employee jobs. NWSEO spent over $200,000 in this lobbying effort and obtained the support of the Senate Commerce Committee, the House Science Committee and the House and Senate Commerce, Justice and Science Appropriations Subcommittees
2. Securing back pay for overtime for nearly 200 NWS employees. Securing FLSA (fair labor standards act) Non-Exempt status of *an additional* 165 NWS employees. The NWS has agreed to pay two years' lost overtime wages and liquidated damages for those employees, as well.
3. Winning an appeal to bargain to increase staffing at Anchorage WFO (national weather forecast service office) by 10 positions—this directs the National Weather Service to bargain with NWSEO over a proposal that would increase staffing at the Anchorage WFO by ten positions.

4. Securing special projects designed to increase aviation safety, which include increased NWS personnel at the CWSU and WFOs in New York City, Atlanta, and Chicago.
5. NWSEO secured an agreement that upgrades to a GS–8 every Administrative Support Assistant at field offices around the country. The GS–8 upgrade includes approximately one million dollars in extra pay and benefits to the lowest paid NWS employees each and every year from now on.

Compensation

In terms of insuring that compensation levels are competitive, the NWS should routinely gather data on pay and fringe benefits from the private weather forecasting services and from other employers of meteorologists and weather-related occupations for comparable jobs. Some of these data are available from the Bureau of Labor Statistics, which publishes data on pay for both private and public sector weather forecasters on "Occupational Employment Statistics" website: *http://www.bls.gov/oes/current/oes192021.htm.*

This website does not, however, include fringe benefits, which is important because benefits may be greater in the public sector. Moreover, any compensation comparison should try to account for differences in job security, which may be higher in the public sector. If this is not being done currently, it should be a high priority item.

Work Rules and Deployment of Labor

Work rules and the deployment of labor and of other resources at the NWS must achieve a higher level of efficiency. Ideally, the NWS and the NWSEO should work cooperatively to achieve a common set of goals aimed at improving efficiency and productivity, and maximizing the value of the NWS to its main users. This cooperative approach is becoming more common in the private sector, as increased global competition is making achieving high productivity much more important than in the past.

In the public sector, this is more difficult to achieve because there is so much less competition and the users of public sector services often do not pay user fees. A top priority for the NWS and the NWSEO is to work cooperatively to improve work rules and in particular identify changes at CWSUs and any other NWS offices that can improve productivity.

Note that increasing productivity will in some cases go against the NWSEOs previous efforts to save jobs and to save NWS offices. To deal with this tension, cost-benefit analyses should be used to determine the economic viability of NWS offices. If the NWS identifies a particular office as not providing sufficient value, then the NWSEO should provide analysis that can demonstrate how to improve efficiency and value in order to enhance the economic viability of an office. *Saving NWS offices or jobs must be justified on the basis of economic value in terms of the benefits must exceed the costs of providing the services.*

Summary

In summary, the NWS needs to routinely compare compensation to peer organizations in order to insure that NWS compensation is justified, and the NWS and NWSEO need to jointly acknowledge the fact that work rules and the number of workers, and the location of workers, must be guided by the principle of productivity and economic viability. The guiding principle is that NWS jobs and NWS offices must be justifiable on a cost-benefit basis. More broadly, the NWSEO must recognize that saving jobs and weather offices cannot be done just to benefit NWSEO members, but rather, must enhance productivity and the cost efficiency of providing NWS services.

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