WRITTEN STATEMENT OF

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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 1980's 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 1950's to the early 1980's. 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.

[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.

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.
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 1960's, the advent of advanced observing systems such as satellites and Doppler radar gave us new ways to view current weather. Then in the 1980's 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 US. In 2011, this industry lost nearly $18 billion dollars to weather-related 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% 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 1990’s, 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.