WRITTEN TESTIMONY OF
DR. RICHARD W. SPINRAD
ASSISTANT ADMINISTRATOR
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

HEARING ON WEATHERING THE STORM: THE NEED FOR A NATIONAL HURRICANE RESEARCH INITIATIVE

BEFORE THE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

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Thank you, Mr. Chairman and Members of the Committee for this opportunity to testify on the importance of increased hurricane research and preparedness. I am Dr. Richard W. Spinrad, Assistant Administrator of the Office of Oceanic and Atmospheric Research, within the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce (DOC). The Office of Oceanic and Atmospheric Research conducts and sponsors the scientific research, environmental studies, and technology development needed to improve NOAA's operations and applications, and broaden our understanding of the Earth's atmosphere and oceans.

We thank the Committee for its continuing interest in addressing the complex issues of hurricane research, prediction, planning and response, and for its critical role in protecting lives and property from these serious weather events.

INTRODUCTION

More than 50 percent of the U.S. population is living within 50 miles of the coast,[1] and roughly 180 million people visit the coast annually. The coastal population explosion over the last half-century translates to increased risks for these coastal communities. Annual U.S. hurricane losses average about $10 billion and a recent historical analysis of hurricane damages from 1900 to 2005 suggests that every ten years economic losses sustained from land falling hurricanes doubles.[2] While NOAA has a very good record of forecasting and tracking hurricanes, because of the importance of these functions there is still a great need to improve. Advancement in these areas is a key priority for NOAA. Improvement in NOAA's ability to forecast hurricane track and intensity will support our partners in the emergency management communities at the national, regional and local levels, who depend on these forecasts to make decisions on how to secure their

[1] http://www.ofcm.noaa.gov/p36-isrtc/fcm-p36.htm; http://coastalmanagement.noaa.gov/partnership.html
[2] Pielke, R. A., Jr., J. Gratz, C. W. Landsea, D. Collins, M. Saunders, and R. Musulin, 2007: Normalized Hurricane Damages in the United States: 1900-2005. Accepted for publications in the *Bull. Amer. Met. Soc.*

communities. Emergency managers need to know where a hurricane will make landfall and they need to know how strong the hurricane will be when it does make landfall, in order to make their determination on any necessary evacuation orders. Therefore, it is important our forecasts be as accurate as possible, to ensure evacuation orders are not issued unnecessarily, which is both costly and can undermine future evacuation efforts (if citizens do not trust in the forecast and do not evacuate). These forecasts, and the public's ability to rely upon them, are an essential factor in avoiding loss of life and injury and reduced property loss and economic disruption. Without accurate hurricane forecasts, it is difficult for emergency managers to take necessary decisive action to save lives and mitigate economic losses.

Action is needed to undertake an aggressive effort to improve our national hurricane forecasting capability. This effort will require the leadership of federal government, and collaborative efforts with our partners in state and local governments, and the research and academic communities. To support this need, NOAA is working with a wide variety of partners to improve observations, modeling and computing capabilities and advance our hurricane forecasts.

In addition, NOAA has been playing a role in enhancing community resilience to the impacts of hurricanes. NOAA provides products and services to help communities assess their risks and vulnerabilities, develop their plans (e.g., land use, hazard mitigation, climate adaptation), and implement their strategies to strengthen their ability to prepare for, respond to, and rapidly recover from hurricanes and other forms of coastal inundation.

NEED FOR IMPROVED HURRICANE FORECASTS

Since 1990, hurricane forecast track accuracy has increased by about 50 percent through the use of enhanced observations, improved model guidance, and increased forecaster expertise. This improvement in hurricane forecast track accuracy has led to increased lead time and, in some cases, smaller warning areas, which has allowed more time for emergency managers to coordinate their evacuation and preparedness activities. However, little progress has been made during this period to increase the accuracy of intensity forecasts and to identify rapid changes in hurricane intensity. Rapid changes in hurricane intensity (for example, a change of two-categories on the Saffir-Simpson Hurricane Scale within 24 hours or less) presents a challenge to hurricane forecasters during the life of a storm and is a serious problem for emergency managers when it occurs just prior to landfall. Recent cases of rapid intensity changes at or near the U.S. coastline have occurred with little or no warning.

The sense of urgency for improved hurricane forecasts is consistent with the overarching recommendations in three recent reports: the 2006 NOAA Science Advisory Board Hurricane Intensity Research Working Group report, the 2007 report of the National Science Foundation (NSF) National Science Board (NSB): *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative*, and the 2007 report issued by the Office of the Federal Coordinator of Meteorological Services (OFCM): *Interagency*

Strategic Research Plan for Tropical Cyclones - The Way Ahead. All three reports recommend an increase in funding for hurricane and tropical cyclone research and development, and transition of research to operations. In addition, many studies and reports have shown that investments in forecasts and other warning information needed for community planners have a significant return for the nation, including the 2007 report issued by the National Hazards Review,[3] *Hurricane Forecasting: The State of the Art,* and a report from the Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences.[4]

Operational Needs

The operational goals of NOAA's tropical cyclone operation centers (National Hurricane Center (NHC), Central Pacific Hurricane Center, and the Joint Typhoon Warning Center) are to produce improved forecast information on wind speed, precipitation, and storm surge, as well as to quantify the amount of uncertainty in the forecasts, to enable emergency managers and others to make necessary decisions.

To reach these operational goals, NOAA has identified several critical steps to ensure the future success of the nation's hurricane forecast and warning program:

- Focused applied research and transition efforts to improve computer models;
- Advanced observations and observational strategies;
- Improved processing capabilities to include those data into the models;
- Expanded forecaster tools; and
- Properly applied human and infrastructure resources.

The transition of research to operations – referred to by the OFCM and defined by the Board on Atmospheric Sciences and Climate, National Research Council as "bridging the valley of death" – requires robust interaction between the research and operational communities, as well as a strong interface with the user community. Also required is a healthy infrastructure for the transition, including resources and processes for evaluation and demonstration, operational implementation and operations and maintenance.

For example, testbeds, such as the Joint Hurricane Testbed in Miami, the Developmental Testbed Center in Boulder, and the Joint Center for Satellite Data Assimilation in Maryland, are oriented toward improving operational hurricane forecasts and guidance. These testbeds provide evolutionary pathways to coordinate applied model and technology advancements to specific forecast requirements and focus on identifying and effecting the transition of research and technologies capable of providing immediate and justifiable improvements to operational hurricane forecasts.

Federal Investments

[3] Willoughby, H. et al., "Hurricane Forecasting: The State of the Art", National Hazards Review © ASCE, August 2007, p.45-49.
[4] http://www.nibs.org/MMC/MitigationSavingsReport/Part1_final.pdf

Our goal is to ensure new breakthroughs in hurricane research and technology can be accelerated into NOAA's operational forecasting systems. The importance of addressing operational forecast requirements and related research focus areas requires:

- Easy access to current and planned observing systems;
- Increased high performance computing capacity and capability to allow for higher resolution models;
- Institutionalized and transition research to operations to ensure an efficient process to incorporate demonstrated research results in modeling and observing systems;
- A plan for sufficient operations and maintenance resources; and
- Enhanced interactions with the broader science and engineering community to provide increased understanding of hurricanes while using all available resources.

Therefore, a sustained and broad hurricane research initiative would make the best use of these capabilities and improve our understanding of and ability to predict hurricanes.

As a first step in 2008, NOAA, as part of a coordinated national effort which includes the efforts of United States Navy and the National Science Foundation, started the Hurricane Forecast Improvement Project (HFIP). HFIP - described in more detail later in the testimony - is a multi-year investment designed to: significantly improve hurricane forecasts and warning accuracy for track and intensity; extend the lead-time for useful forecast information; and increase overall accuracy of coastal hurricane-related storm surges. NOAA's FY 2010 request of $17 million for HFIP supports research and development for improving forecast modeling systems for hurricanes and storm surge, as well as improving forecasting techniques at our operational Centers. The request builds on a one-time supplemental budget of $17 million, added to $4 million in base funding, received in FY 2009. HFIP activities are and can continue to be accomplished under current law.

Building off the Nation's Interagency Strategic Research Plan

We are working to build upon recent planning efforts of the NSF, NSB and OFCM[5] to engage the broader research community in improving hurricane forecasts. Our goals include improving the accuracy, reliability, and extending the lead time of hurricane forecasts and increasing confidence in those forecasts by customers and decision makers, especially those in the emergency management community. These goals were also echoed by the NOAA Science Advisory Board's Hurricane Intensity Research Working Group.

[5] - Office of the Federal Coordinator for Meteorology (OFCM) P-36, 2007; *Interagency Strategic Research Plan for Tropical Cyclones - The Way Ahead.*
- National Science Board, 2007; *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative.*
- National Oceanic and Atmospheric Administration Science Advisory Board, Hurricane Intensity Research Working Group Majority Report

Within the framework of operational hurricane forecast improvements, NOAA seeks a partnership among the federal and academic communities to align the broader science and engineering community with the operational community to realize the greatest benefits for the country. This broader partnership is critical to effectively address our goals and for NOAA to transition new research and technology into operations.

NOAA Strategy to Align with the Larger Community

The key to success in improving hurricane prediction is leveraging the capabilities of all partners: federal, state, local, academic, and private sector. Communication between federal partners and the external community on operational needs and associated research focus areas is necessary to achieve both immediate successes and scientific research advances that hold promise for the future. An annual interagency program review with a significant external (to NOAA) role is being planned with the Interdepartmental Hurricane Conference, as a possible venue. This conference leads up to an annual summit attended by agency, academia, and private sector research leadership.

NOAA is working with NSF to formally establish the National Hurricane Research Alliance to ensure coordination across the broad spectrum of activities from observations to data assimilation to modeling to basic research. The Alliance will include key federal agencies, including NSF, the National Aeronautics and Space Administration (NASA), and the Navy (including the Office of Naval Research). This Alliance will leverage existing federal hurricane coordination efforts, including those from the OFCM Services and Supporting Research, to manage overall roles and responsibilities to improve overall accuracy and reliability of hurricane forecasts. Through this Alliance, NOAA and NSF will work with other federal agencies to maximize the use of the considerable non-federal assets in conducting much of the hurricane research and development described in the aforementioned reports, and in developing and disseminating related products and services.

HURRICANE FORECAST IMPROVEMENT PROJECT (HFIP)

NOAA established the Hurricane Forecast Improvement Project (HFIP) to develop a national, interagency 10-year plan to improve our one to five day tropical cyclone forecasts, with an emphasis on rapid intensity change. The goal of HFIP is to improve the accuracy and reliability of hurricane forecasts and warnings and to increase the confidence in those forecasts to enhance mitigation and preparedness decisions by emergency management officials at all levels of government and by individuals.

The scope of the HFIP plan encompasses research and development:

- To improve understanding, with emphasis on the phenomena related to predictability of rapid intensity[6] change;
- To improve observations and observational strategies for the hurricane and its environment;

[6] Rapid intensification is defined at a 30 knot increase of sustained maximum surface winds in 24 hours or less.

- To uncover novel methods for data assimilation, to utilize the diverse range of existing and new observations;
- To advance high-resolution numerical prediction systems for hurricane forecast guidance; and
- To accelerate the transfer of research results into operational forecasting.

While NOAA is developing its level of involvement in the broader spectrum of issues identified in the NSB report (cited in the introduction), NOAA focused HFIP on the research and development issues identified by operational needs that will lead to improved hurricane forecast guidance and tools. HFIP aims to reduce and quantify the uncertainty in all forecast guidance, including high spatial/temporal resolution gridded wind speed, precipitation, storm surge analysis and forecast information. Our efforts will focus on improved track forecasts, improved intensity forecasts, improved rapid intensity change forecasts, and improved lead time.

Below are four examples of our metrics:

1) Reduce average track error by 50 percent

Based on input from emergency managers at all levels, forecasts of the location or track of the tropical cyclone are most important. Over the past couple of decades the hurricane community has put most of its effort and resources into reducing the track error. While the limits of predictability for track error are not fully understood, NOAA will seek to reduce the track error by 50 percent over the next decade, which is the same level of improvement as NOAA was able to achieve over the past 15 years. More accurate information on the location of the storm will allow emergency managers to focus on a more precise coastal area at landfall and avoid unnecessary evacuations.

2) Extend the lead time for hurricane forecasts out to seven days

In 2003 the NHC extended the lead time of its forecasts from three to five days. However state and federal emergency managers have expressed that five days is not enough time to prepare certain areas, due to population growth, infrastructure, resources, etc. Extending the forecast out to seven days would help address their concern and need for longer lead times to ensure those impacted (the public, businesses, etc.) have sufficient time to prepare for, and evacuate from, an approaching hurricane.

3) Reduce average intensity error by 50 percent

In July 2006, the NOAA Science Advisory Board's Hurricane Intensity Research Working Group recommended the overarching goal for NOAA Research and Development activity should be to reduce the 48-hour hurricane intensity forecast error by 10 knots, or about one-half of a Saffir-Simpson Scale category. The current hurricane 48-hour official forecast intensity error is ~15 knots or roughly the wind speed range for one category on the Saffir-Simpson Hurricane Scale. Due to the uncertainty in today's intensity (strength of storm) forecast, NHC suggests that emergency managers prepare for

one category above the NHC official intensity forecast (e.g., if NHC forecasts a Category 3 hurricane at landfall, emergency managers should prepare for a Category 4). A 50 percent reduction in intensity error will allow emergency managers to better focus their preparedness efforts. Reducing the uncertainty in the hurricane intensity forecasts will also support evacuation decisions by identifying the coastal and inland areas of greatest concern for wind and associated storm surge.

When the impacts of the 50 percent improvement in track and intensity errors are combined for the Gulf Coast, forecasts provided to the emergency managers will be a more confined area of concern with a more precise wind estimate.

4) Increase the forecast accuracy of rapid intensity change events

While improving the forecast accuracy of rapid intensity change events within 1 day of landfall is a high priority, given the uncertainty in track forecasts of landfall and the need by some to make decisions on protective actions more than one day before landfall, these improvements are needed at all lead times over the entire life of the storm. Increasing the forecast accuracy of rapid intensity change events can lead to greater confidence in forecasts. Emergency managers and the public will be able to make decisions and take appropriate action. Today, emergency planning is based on a storm one category higher than what is predicted. More accurate rapid intensity change predictions will allow for more efficient evacuations and preparedness.

KEY SUCCESSES OF HFIP

During the 2008 Atlantic Hurricane Season, NOAA research scientists, along with those associated with Texas A&M University, Pennsylvania State University, and the Naval Research Laboratory (NRL), were able to make use of National Science Foundation (NSF) computational resources at the Texas Area Computing Center (TACC). Through the use of the TACC, our scientist were able to begin accelerating research on the next generation hurricane modeling system and provide the NHC near real-time next generation hurricane model output.

Because of the NSF contribution, and the expert assistance and support of the TACC staff, the NOAA was able to demonstrate the potential benefits of new observational datasets, such as the real-time assimilation of airborne Doppler radar in a high resolution regional model to improve forecast guidance. The scientists demonstrated potential benefits to track forecasts using a high resolution global model using multiple model runs of high resolution data. This provided a range of forecast solutions to the hurricane forecast track and will help provide improved hurricane strike probabilities in the future.

NOAA'S ROLE IN ENHANCING COMMUNITY RESILIENCE TO THE IMPACTS OF HURRICANES

Increasing coastal populations, the value of the coastal economy to the Nation, and the loss of protective coastal habitats have increased the costs and risks from the impacts of

hurricanes and other forms of coastal inundation on the coast (including sea level rise related to climate change). Economic losses associated with urban expansion into flood-prone areas increase by 2 percent per year, and climate change events can increase the potential impacts of hurricanes in the future[7]. Wetland loss is significantly increasing flood damage, costing coastal states millions of dollars per year. For example, recent research shows that every wetland alteration permit in Florida costs an additional $1,000 in property damage per flood claim; all permits combined cost $30.4 million/year for the state[8].

Coastal managers are requesting tools and services from NOAA to help assess and reduce hurricane impacts. NOAA provides products and services to help communities assess their risks and vulnerabilities, develop plans (e.g., land use, hazard mitigation, climate adaptation), and implement strategies to improve their resilience to the impacts of hurricanes and other forms of coastal inundation. Observations and models are also required to ensure accuracy and effectiveness of these products.

In the 2007 Ocean Research Priorities Plan and Implementation Strategy developed by the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology, research priorities to help increase community resilience to natural hazards were identified, including the need to "Apply understanding to develop multi-hazard risk assessments and support development of models, policies, and strategies for hazard mitigation. The H. John Heinz III Center for Science, Economics and the Environment and Ceres subsequently documented the impressive return on investment from storm mitigation and community preparedness in their report, *Resilient Coasts: A Blueprint for Action*. The National Institute of Building Sciences showed that every dollar spent on mitigation saves about four dollars on recovery costs[9]. Still, efforts to increase community resilience to hazard impacts should not be confined to the built environment. Given the natural mitigation benefits, habitat protection and restoration are considered integral elements of hazard resilience. In fact, coastal wetlands in the United States are estimated to provide $23.2 billion worth of storm protection services each year[1].

The NSTC Subcommittee on Disaster Reduction (SDR) provides a Federal forum for information sharing, developing collaborative opportunities to leverage Federal research and investment, formulating science- and technology-based guidance for policymakers, and connecting with the U.S. policy community to advance informed strategies for managing disaster risks and encouraging risk-wise behaviors. The SDR recently released a series of hazard-specific implementation plans, including ones pertaining to coastal inundation and hurricanes. These plans, available from www.sdr.gov, were coordinated among Federal agencies to prioritize the Federal science and technology investment

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[7] Reducing Future Flood Losses: The Role of Human Actions, A Summary to the Disasters Roundtable. Sylves, Richard & Kershaw, Patricia Jones, The National Academies Press, Washington, DC, 2004

[8] Brody, S.D., Davis, Stephen E. III, *Highfield, Wesley E. and *Bernhardt, Sarah. (2008). A Spatial-Temporal Analysis of Wetland Alteration in Texas and Florida: Thirteen Years of Impact Along the Coast. *Wetlands* 28(1): 107-116.

[9] *Resilient Coasts: A Blueprint for Action*, The H. John Heinz III Center for Science, Economics and the Environment and Ceres, 2009

needed to foster preparedness and reduce the loss of life and property caused by natural hazards. NOAA is an active participant in the SDR.

Some examples of current NOAA hazard mitigation work include:

Assessing Risks

- The Hazard Assessment Tools (delivered via Digital Coast) help to construct websites that identify potential hazards in specific locations. Website users identify the location by address, owner name, or by clicking in the map to determine hazards zone(s) in that location. Typical users include planning and permitting departments, residents applying for building permits, hazard mitigation officials, and natural resource planners. Development of this and other Digital Coast products is guided by a partnership network, which includes the National Association of Counties, the Association of State Floodplain Managers, and others.
- NOAA and USGS are partnering to visualize the impacts of local sea-level rise and understand adaptation options. A prototype product that shows the impacts of sea-level rise on the Delaware coast has been developed and a similar effort is underway for Mississippi and Alabama, though these products are broadly applicable and transferrable to other regions

Developing Plans

- Coastal communities manage multiple, complex stressors ranging from hurricanes to economic downturns. The Mobile, Alabama Chamber of Commerce is leading long term economic development planning to help the community prepare for, and respond to, such situations. In support of this effort, NOAA and other partners are designing a planning framework using a resilience-minded development approach that accounts for the hazards posed by coastal storms, climate change, economic downturns, and other stressors.
- NOAA is developing programmatic guidelines to enable states to better adapt to the impacts of climate change. The objective is to encourage states to consider climate impacts when making investments in coastal habitat restoration, land acquisition, and facilities.

Implementing Strategies

- NOAA leverages partnerships with regional organizations, such as the Gulf of Mexico Alliance (GOMA), to understand key needs of coastal communities and ensure that NOAA's products and services meet those needs. In FY 2009, NOAA received $4 million to support cooperative agreements with GOMA states to address a variety of coastal issues, including resilience to coastal storms.

Models and Observations

- NOAA is undertaking several activities to improve how storm surge forecasts and impacts information are developed and delivered. The NOAA Coastal Storms Program is working with the Northern Gulf Institute to convene a group of surge

modelers and managers to develop a unified surge grid catalog for the Gulf. Such a tool will result in more accurate, faster, and cheaper surge analyses in the future.

CONCLUSION

NOAA appreciates the Committee's interest in hurricane impacts and research in areas including storm structure, rapid intensity change, ocean-atmosphere interactions, storm surge, rainfall and inland flooding forecasts. NOAA's HFIP efforts are currently focused on improved track and intensity forecasts, wind fields, and storm surge, as well as the accompanying need for improved observations and computing capability. The key to success in improving hurricane prediction is leveraging all available national assets and capabilities to address this national need, including social science and economic research needed to enhance our Nation's preparation and mitigation in the face of the hurricane threat.

Thank you for inviting me to testify about this challenge and we look forward to working with the Committee as this legislation moves forward.