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SEVERE STORMS AND REDUCING THEIR IMPACT ON COMMUNITIES

HEARING

BEFORE THE

SUBCOMMITTEE ON DISASTER PREVENTION AND PREDICTION

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

JUNE 29, 2005

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

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SUBCOMMITTEE ON DISASTER PREVENTION AND PREDICTION

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SEVERE STORMS AND REDUCING THEIR IMPACT ON COMMUNITIES

WEDNESDAY, JUNE 29, 2005

U.S. SENATE,
SUBCOMMITTEE ON DISASTER PREVENTION AND PREDICTION,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:30 p.m. in room SR–253, Russell Senate Office Building, Hon. Jim DeMint, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF HON. JIM DEMINT, U.S. SENATOR FROM SOUTH CAROLINA

Senator DEMINT. Good afternoon, everyone. I want to thank all of you for joining us at this hearing to discuss and examine the impact of severe weather on our communities, and what the citizens and government can do to lessen its impact. As we're all aware, hurricanes and tornadoes have a devastating impact on our communities. South Carolina witnessed the impact of Mother Nature most severely when Hurricane Hugo made a direct hit on Charleston in 1989. The devastation to homes, businesses, and families was widespread. Fortunately, we've learned some important lessons from these storms, we're starting to see our preparation for the storms improve, and we're seeing the accuracy of the Weather Service's predictions improve.

While we've come a long way from where we were in 1989, there's still a lot that needs to be done. Too many homes and businesses have not incorporated disaster-resistant technologies into their buildings, numerous communities have gutted out the building codes that encourage builders and developers to adopt technologies that will protect life and property when a storm rolls in. In the past few decades, the Weather Service has dramatically improved its predictions of both hurricanes and tornadoes. The hurricanes, we've seen the accuracy of landfall predictions improve significantly. Now, this is crucial for states like South Carolina where each mile of coastline evacuated can cost hundreds of thousands of dollars.

We've also seen tornado predictions increase by minutes, and a few minutes can mean the difference between getting to a tornado shelter and being stuck in your home. Each improvement translates directly into saved lives. While the improvements have been impressive, there are still places where we can do better. We need a better idea of the impact on beaches and rivers of hurricane landfall, NOAA needs to improve its forecasting of hurricane intensity. When the Weather Service estimates the intensity of the hurricane too high, they unnecessarily trigger evacuations, and this costs residences, businesses and governments money. When they forecast too low, lives are placed in jeopardy.

I'm looking forward to hearing from Mr. Mayfield, Mr. McCarthy, and Dr. Sallenger on how their agencies plan to improve the products they provide to the taxpayer, in addition to the predictions and forecasts generated by the USGS and the Weather Service. The private sector, state, and local governments play an equally important role in ensuring that our communities are prepared, and able to respond to severe storms. The engineering community and insurance industry have a crucial role to play in encouraging the incorporation of disaster-resistant technologies into homes and businesses that can provide strong incentives to businesses and individuals to become better prepared for disasters. We also need to recognize the important role that broadcast meteorologists play in communicating to our communities during disasters.

For Charleston, South Carolina, Bill Walsh is the man the community turns to when they need to know how to prepare for big storms, and after the storms when the power is down, Bill Walsh and his colleagues along with the broadcast community are often the only points of information for devastated communities. I look forward to the comments of our witnesses this afternoon. This hearing and the one earlier this month are providing valuable insights that will help inform the Committee as to how we begin to draft legislation to reauthorize the Weather Service. While the Nation has the best weather prediction in the world, we can and must do better. Our coasts are seriously exposed to the impact of major storms, and we need to improve the quality of both hurricane tracks and intensity forecasts. I will be looking at what can be done legislatively to help improve these conditions and additionally, as we consider this reauthorization, I will work proactively to assure that all the assets in America's weather prediction community, business, government and academia work together.

As the annual hurricane season shows us, weather has a profound impact on the lives and the economy of our coastal communities. I will be working to ensure that the Federal Government delivers to the taxpayer the best weather services possible.

Again, thank you for appearing before this Committee, and I will turn to Senator Vitter for his opening comments.

STATEMENT OF HON. DAVID VITTER, U.S. SENATOR FROM LOUISIANA

Senator VITTER. Chairman DeMint, thank you for holding this hearing today on the impact of severe storms on our communities. I also appreciate the very hard work of Tom Jones on your staff, as he has helped put this hearing together; and Mr. Chairman, you may be interested to know that Tom wanted such a realistic experience today, that he asked me to get hurricanes up from Pat O'Brien's in the French Quarter in New Orleans for refreshment.

[Laughter.]

Senator VITTER. For those of you who don't know, these are the high octane rum drinks served in the French Quarter.

On a more serious note, I'm afraid, if you look at some of our disaster policy in this country, it seems as if officials who put it together were sipping a lot of hurricanes, because I think it is fundamentally flawed, Mr. Chairman, in one basic way—our general policy toward disasters is reactive, instead of proactive. We spend billions of dollars after a disaster, instead of spending millions of dollars to prevent many of the harmful effects of a disaster from ever occurring.

We have some graphics here that will be put up behind me, and this isn't a simulation of World War III, or The Day After Tomorrow movie, or Atlantis—although one day it could be Atlantis—this is a real, computer-generated model of the impact of a hurricane hitting New Orleans. (The National Weather Service models have determined the following Category III storm, which as you know, is not the worst imaginable. It would place over 20 feet of water in some inland areas of Plaquemines Parish, populated areas, and 14 feet of water in the City of New Orleans.)

A Category IV storm, one step up, would put over 24 feet of water in some inland areas of Plaquemines Parish, and over 18 feet of water in New Orleans. A Category V storm, the worst case scenario, would put over 28 feet of water in some inland areas of Plaquemines Parish, and over 23 feet of water in New Orleans. And it's really not a question of "if", it's a question of "when".

The inundation of our homes and businesses would be a historic national disaster, but the full tragedy would be the loss of up to 100,000 lives, as predicted by the National Weather Service. Let me make a point again—this is not some wild speculation, this is a valid, scientific model from the National Weather Service saying that up to 100,000 lives would be lost as a result of this sort of hurricane hit on New Orleans.

To make this point even more real, I would note that the City of New Orleans had thousands of body bags ready for Hurricane Ivan last year. As we will hear today from the Director of the National Hurricane Center, Max Mayfield, and Dr. Arnold, areas like New Orleans and Key West are nearly impossible to evacuate with the advance warning technologies we have now, and the inadequate infrastructure in place in those areas today.

Director Mayfield and Mr. Sallenger correctly state in their testimony that we experience an average of 20 deaths a year and spend an average of $5.1 billion a year to respond to storms, all after the fact. In Louisiana we have plans in place to prevent much of that, to try to avoid much of that before the fact. The Southeast Louisiana Flood Control Program, Lake Pontchartrain, New Orleans to Venice, Alexandria to the Gulf, West Bank, West Shore and Louisiana Coastal Area Programs, all of these are established programs that are designed to prevent hurricane and storm damage and the loss of life. Yet, every year we fight for funds just to keep these efforts afloat and moving on inch by inch. Instead of spending those millions now, instead we're going to spend billions, literally, billions—many, many billions—after the fact, and lose up to 100,000 lives in New Orleans. Again, this is a fundamentally flawed approach to disasters, and I look forward to our witnesses talking about that today.

Finally, a number of our panelists will discuss wind damage, our lack of attention to this important issue and the effect this has had on our recovery costs, and I'm also very anxious to hear all of the witnesses thoughts and recommendations about this. Thank you, again, Mr. Chairman, for your leadership.

Senator DEMINT. Senator, excellent remarks. I would turn to Senator Nelson for his opening remarks before I introduce the panelists.

STATEMENT OF HON. E. BENJAMIN NELSON, U.S. SENATOR FROM NEBRASKA

Senator BEN NELSON. Thanks, Mr. Chairman, thanks to our panelists today, we appreciate very much your being here, obviously coming from a state that is in the Northern end of Tornado Alley. Severe weather forecasting is of great interest to me, and of great importance to my constituents in the State of Nebraska.

I would first like to recognize the efforts of NOAA and the National Weather Service in improving our forecasting abilities. It's amazing to me that only 20 years ago there was absolutely no lead time for tornado warnings, and over the last 10 years the National Weather Service has increased the warning lead time for tornadoes to an average of 13 minutes. That increase in lead time leads to a decrease in deaths and injuries from tornadoes. Earlier this year, I visited our local National Weather Service station in Valley, Nebraska just west of Omaha. I planned this trip near the 30th anniversary of a devastating tornado that hit Omaha in 1975 and killed three people. I wanted to see what advances had been made in predicting and responding to tornadoes, and I must say that I was very impressed. During my visit, I was informed that in 1975 it took 5 minutes just to process a warning before it could be issued. Now it takes under a minute, again, saving minutes means saving lives. I believe we need to continue our commitment and investment in further improving our forecasting capabilities. The exciting advances in technologies which will allow us to better forecast tornadoes, to more accurately pinpoint where a tornado is likely to touch down, and to allow longer lead time for warnings is crucial to the safety of our citizens. These advances in technologies also hold better promise for tracking hurricanes and predicting their intensity as well, again, information that is vital to protecting lives.

I applaud the collaboration between the National Weather Service, the National Hurricane Center and the media for not only warning people of impending severe weather, but also providing the information they need as to how they should respond in order to remain safe.

The education efforts you've all undertaken so that individuals can take more personal responsibility at ensuring their safety is key to reducing fatalities and injuries during severe weather. Protecting lives will always be our number one priority, and it requires keeping up with technology, which is why I stress the need for continuing investment in our forecasting capabilities. Imagine the loss of life that we would have had in Omaha, a highly populated area, during that devastating tornado back in 1975 if we had depended on the prediction and warning technology that was available in

1913, when a tornado ripped through Omaha and killed 168 people. It is worth the investment. Thank you, Mr. Chairman.

Senator DEMINT. Thank you, Senator.

Appearing before the Subcommittee this afternoon, Dr. Max Mayfield. Mr. Mayfield is Director of the National Hurricane Center, he will outline the Center's work to improve the quality of the Nation's hurricane forecast. Joining him is Mr. Dennis McCarthy, Director of Climate, Water and Weather Services at the National Weather Service. Mr. McCarthy will be discussing severe weather, and specifically the impact of tornadoes.

Finally, on this panel is Dr. Abby Sallenger, Oceanographer from the United States Geological Survey Center for Coastal and Watershed Studies. Dr. Sallenger will discuss the inland impact of hurricanes on beaches and rivers. With that, we'll start with Mr. Mayfield. I think if we're running these lights, the green will indicate you're in good shape, the yellow means you probably need to start slowing down, and red means you're out of time.

Thank you, sir, Mr. Mayfield.

STATEMENT OF MAX MAYFIELD, DIRECTOR, TROPICAL PREDICTION CENTER/NATIONAL HURRICANE CENTER, NATIONAL WEATHER SERVICE

Mr. MAYFIELD. Mr. Chairman and Members of the Subcommittee, I'm Max Mayfield, Director of the Tropical Prediction Center and National Hurricane Center. I'm pleased to be here today to discuss NOAA's role in researching, forecasting and warning the public about hurricanes. The National Hurricane Center has been the centerpiece of our Nation's hurricane forecast and warning program for 50 years. Our mission is to save lives, mitigate property loss and improve economic efficiency by issuing the best watches, warnings and forecasts of hazardous tropical weather, and by increasing the public's understanding of these hazards. Until 2004, we experienced relatively few hurricane landfalls in this country, and in particular, very few major hurricanes. Our good fortune ended last year when six hurricanes hit the United States and three of those were major hurricanes. We have already entered into a period of heightened hurricane activity. This activity in the Atlantic is cyclical with the multiple decades, and since the mid-1990s, this activity has increased sharply, and this period of heightened activity could last another 10 to 20 years.

Great progress has been made in forecasting the track of tropical cyclones over the past half century, our track forecast errors have been cut approximately in half in the last 15 to 20 years. Our 5 day forecast is as good as the 3 day forecast was just 15 years ago. These advances are largely the result of improvements made in operational, numerical weather prediction, aided by investments and increasingly sophisticated computers, and advances in satellite observations over otherwise data-sparse oceanic regions where tropical cyclones are spawned. An important part of the success story is also the Gulf Stream IV aircraft following the highly successful NOAA Hurricane Resource Division Program. Congress appropriated funds to obtain this jet in the mid-1990s. Data collected now by the Gulf Stream IV result in 36 to 48 hour forecast improvements averaging near 20 percent, when tropical cyclones threaten further gains in forecast skill through to improvements in science and technology are essential, however, enhanced hurricane information will not by itself be enough if the information is not communicated to the at-risk public in a manner that can effect the best preparedness actions, in addition to reaching out to the general public through the media, our website, and other routes. We've trained local, state, national and international emergency managers on the limitations of hurricane forecasting, and their proper use of our products through workshops. In fact, we've trained over 1,000 emergency managers in the last 14 years. Storm surge has caused most of this country's tropical cyclone-related fatalities, and represents the greatest risk for large loss of life in this country. The plans for hurricane evacuation along the Atlantic and Gulf Coast are based on our storm surge calculations, and our storm surge program and the resulting evacuation plans are credited largely with the dramatic decrease in the loss of life due to storm surge in the United States.

Now, while we have made significant progress in hurricane forecasting warnings, we have much more work to do from a scientific standpoint. The gaps in our capabilities fall into two broad categories. Number one is our ability to assess the current state of the hurricane and its environment, that's the analysis, and number two, our ability to predict the hurricane's future state, the forecast. Analysis is the starting point of the forecast process, to improve the analysis in tropical cyclones, we need to enhance our observation network. Many of the enhancements required to improve hurricane analyses, particularly over the data-sparse ocean areas will be addressed through such programs as the Global Earth Observation Systems, or GEOSS, a 10-year international endeavor, of which the United States is a member, and NOAA, a key participant. Further additional observation improvements will be realized with funding from the supplemental hurricane bill passed last year, including seven data buoys recently deployed, and the sensors to be installed on Air Force hurricane hover aircraft.

The accuracy of our tropical cyclone forecast is closely tied to improvements in computer-based, numerical weather prediction models. The United States Weather Research Program's Joint Hurricane Test Bed was recently formulated and established at the National Hurricane Center to facilitate the transfer of new technology, research results and observation, or advances for improved operational tropical cyclone analysis and prediction.

Thus far we're very pleased with the results of the Test Bed, the projects implemented have made quantifiable enhancements in our operations. In addition, the National Weather Service Environmental Modeling Center is leading development of a sophisticated, high-resolution computer model, intended to improve hurricane intensity and rainfall forecasts. This new model is scheduled to become operational in the year 2007.

In conclusion, we have come a long way in hurricane prediction to meet the challenge of reducing the risk to our Nation from tropical cyclones, we must continue to improve our forecast and warnings, and continue our public education efforts. I thank you for your support, and I will be happy to answer any questions, if I can.

[The prepared statement of Mr. Mayfield follows:]

PREPARED STATEMENT OF MAX MAYFIELD, DIRECTOR, TROPICAL PREDICTION CENTER/ NATIONAL HURRICANE CENTER, NATIONAL WEATHER SERVICE

Mr. Chairman and Members of the Subcommittee, I am Max Mayfield, Director of the Tropical Prediction Center/National Hurricane Center (TPC/NHC). The National Hurricane Center is a part of the National Weather Service (NWS), of the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. I am pleased to be here today to discuss NOAA's role in researching, forecasting, and warning the public about hurricanes.

The National Hurricane Center (NHC) has been the centerpiece of our Nation's hurricane forecast and warning program for 50 years. Our mission is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, and forecasts of hazardous tropical weather, and by increasing the public's understanding of these hazards. Today, I would like to provide some background on our hurricane program, discuss current activities, and outline some of our goals for the future.

According to a 2003 report published by the American Geophysical Union, the NHC, along with our public and private sector partners, saves the lives of close to 200 people per year in the United States alone from hurricanes, tropical storms and tropical depressions collectively known as tropical cyclones. Since our efforts began in the 1950s, we have reduced tropical cyclone mortality in the United States by about 90 percent. Saving lives is paramount, but it is also important to recognize the enormous physical and economic damage caused in our country by tropical cyclones. The impact of hurricanes in the United States alone is an average of 20 deaths and $5.1 billion in property damage each year.

Public confidence in the NHC is high. A 2003 customer satisfaction survey conducted by Claes Fornell International indicated 87 percent of the respondents approved of the quality and usefulness of our products and services. Respondents also rated our improvements over the past five years at 86 out of 100. These scores are among the highest reported among Federal Government agencies on similar questions, and reflect the significant gains we have made in analyzing and forecasting tropical cyclones. For example, our track forecast errors have been cut approximately in half in the past 15–20 years due to advances in weather forecast models enabling us to meet our Government Performance and Results Act (GPRA) performance measure every year.

We were honored last year to have President Bush visit our facility to thank our staff for their work during the very active 2004 hurricane season. I would like to express our appreciation to the Administration and Congress for their continuing support, highlighted by the Supplemental Hurricane Bill passed last year. The supplemental appropriation provided funding for additional observing systems (data buoys and observing sensors to be installed on U.S. Air Force hurricane reconnaissance aircraft), computer model development and supporting research, and is already beginning to pay dividends. The new weather buoys we were able to deploy because of the supplemental funding helped define the early characteristics of Tropical Storm Arlene.

The combination of improved forecasting, better communications, advanced emergency management practices, and an aggressive education program have contributed to a period of relatively few tropical cyclone related deaths in this country. However, with more than half of the U.S. population residing in coastal watershed counties, we are more vulnerable to a hurricane catastrophe today than at any time in our Nation's history. Despite our progress in tracking and forecasting storms, we have much work still to do. To meet the challenge of reducing the risk to our Nation from tropical cyclones, we must continue to improve our forecasts and warnings, and continue our outreach and public education efforts.

Our Challenge

Until 2004 we experienced relatively few hurricane landfalls in this country in recent decades and, in particular, very few "major" hurricanes—those of Category 3 or higher on the Saffir-Simpson hurricane scale (Category 1–5). Our good fortune ended last year when six hurricanes hit the United States, and three of those were major hurricanes.

We have entered a period of heightened hurricane activity. On average, ten tropical storms form during the Atlantic hurricane season, with 6 becoming hurricanes and 2–3 becoming major hurricanes. However, tropical cyclone activity in the Atlantic is cyclical, with a time period of multiple decades. During the 1940s through the 1960s, we experienced an above average number of major hurricanes, and during the period from the 1970s into the mid-1990s we experienced fewer hurricanes than average. Since the mid-1990s, activity increased sharply and this period of heightened activity could last another 10–20 years. In fact, there have been more hurricanes during the past ten years than in any other ten-year period since records began in 1851.

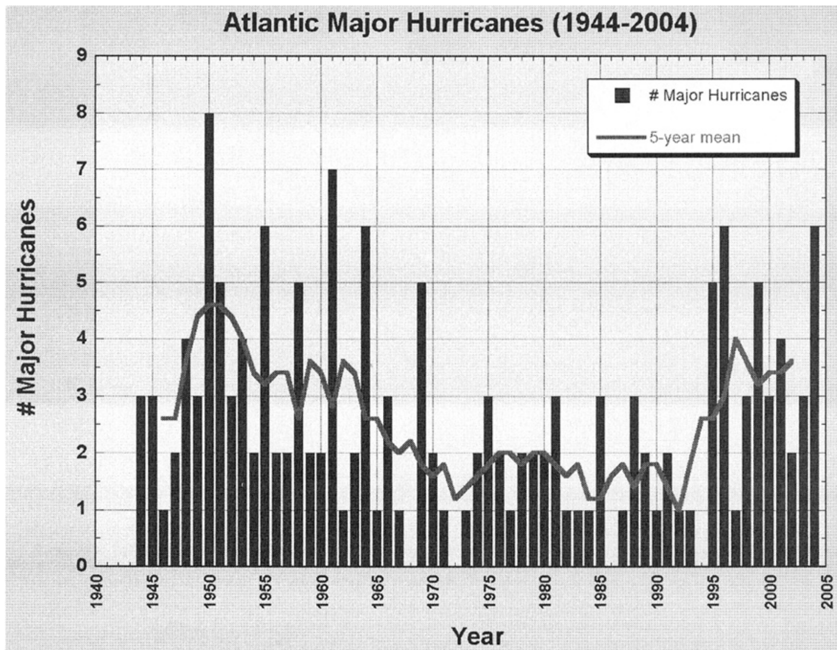

Figure 1. Number of Atlantic basin major hurricanes for the period 1944–2004.

This increased level of hurricane activity is occurring against a backdrop of a large and rapidly growing coastal population in this country as identified by the 2000 Census conducted by the DOC Census Bureau. Coastal populations are directly threatened by tropical cyclones, and are largely unfamiliar with the devastating impacts of these storms. About 85 percent of coastal residents have never experienced the core of a major hurricane. Population growth increases the overall risk by stressing the already crowded, and in some places overwhelmed, evacuation routes.

NHC Structure and Support

The NHC has a staff of 41, including six hurricane forecasters and support staff. Our area of responsibility encompasses the Atlantic Ocean, Gulf of Mexico and Caribbean, as well as the Eastern Pacific Ocean east of 140° W. The central Pacific from 140° W to the international dateline is monitored by the NWS Central Pacific Hurricane Center located in Hawaii. The NHC staff is extremely dedicated and, in 2004, worked tirelessly to provide the forecasts necessary during the very active hurricane season. Some individuals worked for many weeks without a day off to ensure forecasts and warnings were issued and our mission was upheld.

The NHC depends on numerous critical research and operational activities inside and outside NOAA, including NWS' Environmental Modeling Center (EMC), the Geophysical Fluid Dynamics Laboratory (GFDL) and the Hurricane Research Division (HRD) in NOAA's Office of Oceanic and Atmospheric Research, as well as the NWS's Central Operations, which is responsible for the computing infrastructure to run the forecast models. We also rely on the Department of Defense—in particular the U.S. Air Force Reserve Command's 53rd Weather Reconnaissance Squadron "Hurricane Hunters." These reconnaissance flights make the storm penetration flights and provide essential data about the structure of the storm. NOAA's Office of Marine and Aviation Operations conducts further reconnaissance missions when hurricanes approach land. The Office of Marine and Aviation Operations also pilots the Gulf Stream IV, which provides data from the large area surrounding a hurricane.

In the international arena, under the auspices of the World Meteorological Organization (WMO), a United Nations' Specialized Agency, the NHC is designated as a Regional Specialized Meteorological Center (RSMC). As an RSMC, NHC's forecasts provide guidance to two dozen countries in the Atlantic, Eastern Pacific and Caribbean. For their part, these countries provide the United States valuable weather observations that help in our forecasts for them and for us.

The NHC has strong ties to the meteorological research community as well as others in academia, international meteorological services, emergency management agencies, the media, amateur radio operators, the American Red Cross, and the private meteorological sector. It takes a true team effort to make the hurricane program work.

Our Products and Services

NHC tropical cyclone forecasts are issued every six hours and include text messages as well as a suite of graphical products depicting our forecasts and the accompanying probabilities and "cone of uncertainty," as it has become known. This information is available through many sources, including the media and the Internet. The media is an essential partner and helps us get the information to the public. Without the media, it would be very difficult to get the information as widely distributed. The Internet has also become an excellent vehicle to provide our information to the public. NOAA websites recorded over 9 *billion* "hits" during the peak of the 2004 hurricane season.

Even with the majority of users saying they are "very satisfied" with our current products and services, we continue to develop new experimental products for the 2005 hurricane season to meet user needs. One of these products is a depiction of tropical cyclone surface wind speed probabilities at specific locations, and is available in both text and graphical formats. These new and expanded products help us better convey forecast uncertainties and have the potential to provide users with information that enhances their ability to make preparedness decisions specific to their situations. In accordance with the NOAA Partnership Policy, we consult with our users and partners to determine the usefulness of our products to ensure the products further the public-private enterprise as a whole and help us better meet our mission.

The NHC coordinates with many other agencies, both domestic and abroad, on tropical cyclone forecasts and watches/warnings. Forecast coordination calls occur one hour before each advisory release deadline. The calls include the U.S. Navy, the U.S. Air Force Weather Agency, the Federal Emergency Management Agency (FEMA), and NWS regional headquarters and local Weather Forecast Offices (WFO) of the affected area. NHC then constructs and disseminates the final advisory products within the hour after this coordination call is initiated.

Our Region Hurricane Operational Plan provides procedures for coordinating watches and warnings with other countries. This coordination, which is a challenging and important task for NHC, can involve up to six or more weather services at one time. While NHC provides forecast information and often initiates the coordination, it is ultimately up to each country to issue watches and warnings for their area(s) of responsibility.

The FEMA/NWS Hurricane Liaison Team (HLT), which I usually activate at NHC a few days in advance of a potential U.S. landfall, coordinates communications between NOAA and the emergency management community at the Federal and State levels. After consulting with our local weather offices and our center, emergency managers make evacuation and other preparedness decisions. The HLT provides an excellent way to communicate with the large number of emergency managers typically impacted by a potential hurricane.

Our Performance

Great progress has been made in forecasting the track of tropical cyclones over the past half-century. Our average 48-hour track error, which was near 300 nautical miles in the early 1970s, is now near 100 nautical miles. Today's 5-day forecasts are as accurate as our 3-day forecasts were 15 years ago. These advances are largely the result of improvements made in operational numerical weather prediction, aided by investments in increasingly sophisticated computers and advances in satellite observations over the otherwise data-sparse oceanic regions where tropical cyclones are spawned.

An important part of this success story is the NOAA Gulf Stream IV jet aircraft. Following a highly successful HRD research program, Congress appropriated funds to obtain this jet in the mid 1990s. Data collected by the Gulf Stream IV now result in 36–48 hour forecast improvements averaging near 20 percent when tropical cyclones threaten land.

Our improvement in the accuracy of hurricane intensity forecasts has been more modest, in comparison to the progress made in track forecasts. The average 48-hour intensity forecast error has remained near 15 knots for at least the last 15 years. Anticipating rapid intensification, which occurred as Hurricane Charley made landfall last year, remains most challenging. As a result of forecast uncertainties, we advise emergency managers to prepare for a hurricane one category stronger on the Saffir-Simpson hurricane scale than what is being forecast. Improvements to the intensity forecast could substantially reduce the indirect costs of tropical cyclones by reducing the scope of evacuations and other preparations.

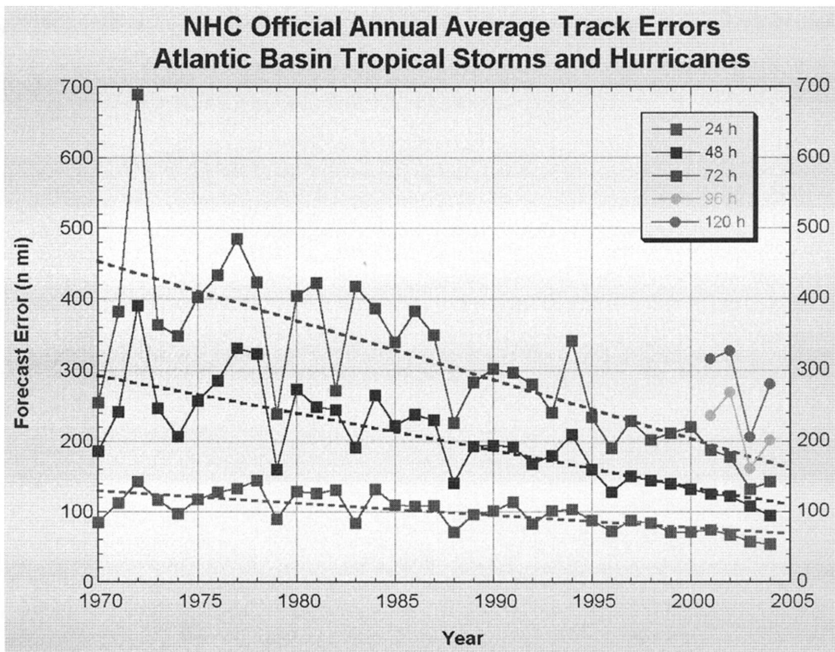

Figure 2. Annual average official track errors for Atlantic basin tropical storms and hurricanes for the period 1970-2004, with trend lines superimposed.

Outreach and Education

Further gains in forecast skill through improvements in science and technology are essential. Enhanced hurricane information will not, by itself, be enough if the information is not communicated to the at-risk public in a manner that can effect the best preparedness actions. For example, Dr. Jay Baker from Florida State University estimated that only 25–50 percent of the people who should have evacuated from last year's hurricanes did. Of those that did evacuate, a substantial number would have been safer remaining at home because their residence was well constructed and outside of a flood zone. Education and outreach events developed by NOAA, the emergency management community, and the media are essential to ensure the public has the information needed to protect lives and property.

We try to bring a "clear, calm and trusted voice" into households at risk. We conduct numerous media interviews each hurricane season. Efforts during the 2004 season reflect the magnitude of our effort. During this season NHC conducted more than 2,600 interviews with radio, television and print outlets during hurricanes Charley, Frances, Ivan and Jeanne. Bilingual meteorologists satisfy our responsibility to inform the growing Spanish speaking population.

NHC trains local, State, Federal and international emergency managers on the limitations in hurricane forecasting and proper use of our products through workshops. More than 1,000 emergency managers have been trained at the NHC in the past 14 years. These workshops extend to the international community where tropical weather forecasters from around the world come to be trained in hurricane forecasting.

The Hurricane Awareness Tours that take place along the U.S. east and gulf coasts and in the Caribbean provide opportunities to advance hurricane awareness for the public and media in vulnerable communities. Doors to the "Hurricane Hunter" aircraft are open to thousands of people each year, where they learn about aircraft missions and the team effort between forecasters, emergency managers and the media. These events encourage every individual, family, business, and community to develop a hurricane plan, and to have that plan in place before the hurricane season begins. Despite these efforts, a Mason-Dixon Research Poll released in May 2005 revealed that 47 percent of people in coastal states do not have a hurricane plan. Clearly, more needs to be done and we will continue to address this with our partners through our education and outreach efforts.

In recent years, rainfall-induced freshwater floods have taken more lives in tropical cyclones than any other threat. We are taking steps in our operational procedures, education and outreach activities, and research and development to reduce the loss of life.

Storm Surge: A Success Story—so far

Storm surge has caused most of this country's tropical cyclone fatalities, and represents our greatest risk for a large loss of life in this country, particularly in hard to evacuate areas like the Florida Keys and New Orleans. Following Hurricane Camille in 1969, which resulted in at least 100 storm surge deaths, NOAA established a group that developed and implemented a storm surge model called SLOSH (Sea, Lake, and Overland Surges from Hurricanes). The plans for hurricane evacuation programs along the Atlantic and Gulf of Mexico coasts are based on SLOSH calculations. SLOSH and the resulting evacuation plans are credited largely with a dramatic decrease in the loss of life due to storm surge in the United States. Since Camille, the total number of deaths due to storm surge in this country is less than fifteen.

The SLOSH model calculates storm surge heights resulting either from historical, hypothetical or actual hurricanes. SLOSH incorporates bathymetry and topography, including bay and river configurations, roads, levees, and other physical features that can modify the storm surge flow pattern. Thirty-eight computational domains, or SLOSH basins, cover the U.S. east and gulf coasts, Puerto Rico, the Virgin Islands, Guam, and the Hawaiian Islands of Oahu and Kauai. The SLOSH basins must be revised periodically to take into account new cuts in barrier islands, new levees or revision to older levees, waterway dredging and other significant changes to flow. NOAA recently formed a storm surge assessment team to examine our users' requirements for real-time storm surge information and products, to direct storm surge modeling within NOAA and to plan for future enhancement of, or the replacement of, the SLOSH model.

Comprehensive evacuation studies conducted jointly by FEMA, the U.S. Army Corps of Engineers (USACE), NOAA, and state and local emergency managers are based on the simulated surges computed by SLOSH. Mapping of the resulting potential surge inundations is done by the USACE as a step in determining hurricane evacuation zones.

The storm surge depends on the hurricane track and wind field. A slight difference in either can mean a huge difference in the surge. Last year's Hurricane Ivan is an example. The 12-hour forecast was off by only 25 miles, which is a very small amount. However, the difference in the predicted storm surge was large. The initial forecast called for a 14-foot surge in Mobile Bay and 5 feet in Pensacola Bay. But with the storm hitting 25 miles farther east, only a 4-foot surge occurred in Mobile Bay, while Pensacola Bay had a 12-foot surge. This is precisely why we use a mean envelope of high water for evacuation planning and training. An equally large difference is seen with the radius of maximum winds within a hurricane. When provided precise information, the SLOSH model performs well. Despite the tremendous success of the Nation's storm surge program, as our coastal regions become more populated the potential for a surge catastrophe remains.

Future Activities for the U.S. Hurricane Program

While we have made significant progress in hurricane forecasting and warnings, we have more work to do. For example, even in the areas with rapid advancement, such as track forecasting, we still cannot provide sufficient lead time to evacuate particularly vulnerable areas like the Florida Keys or New Orleans. From a scientific standpoint, the gaps in our capabilities fall into two broad categories: (1) our ability to assess the current state of the hurricane and its environment (analysis), and (2) our ability to predict the hurricane's future state (the forecast). Finally, we would like to improve public preparedness.

Improving Analyses

Analysis is the starting point of the forecast process. Inaccurate assessments of a tropical cyclone's current position, intensity, and size lead directly to forecast errors. To improve the analysis of tropical cyclones, we need to enhance our observation network. Many of the enhancements required to improve hurricane analyses, particularly over the data-sparse ocean areas, will be addressed through such programs as the Global Earth Observation System of Systems (GEOSS), a 10-year international endeavor of which the United States is a member and NOAA a key participant. Further, additional observation improvements will be realized with funding from the Supplemental Hurricane Bill passed last year, including 7 data buoys recently deployed and the sensors to be installed on Air Force "Hurricane Hunter" aircraft. We are working with the research community to develop some of the future observation technology. Advanced operational data assimilation systems will very soon combine all of the available observational data in very sophisticated Numerical Weather Prediction (NWP) analyses.

Improving Forecasts

The accuracy of NHC tropical cyclone forecasts is closely tied to improvements in computer-based numerical weather prediction models (model guidance). Significant gains in intensity, precipitation and wind distribution forecasting await the next generation operational modeling system capable of incorporating high-resolution information from the hurricane core. Improvements will be based on state-of-the-art physics developed specifically to address these deficiencies.

We have increased our efforts to transfer research into operations. The United States Weather Research Program (USWRP) Joint Hurricane Testbed (JHT) was formed in late 2000. The mission of the JHT is to facilitate the transfer of new technology, research results, and observational advances of the USWRP, its sponsoring agencies, the academic community, and the private sector for improved operational tropical cyclone analysis and prediction. To accomplish this mission we identify promising and mature research and technology, and provide the infrastructure to test and evaluate the selected techniques in an operational setting. Federal assistance is provided to both Federal and non-federal researchers to allow them to tailor their techniques for the operational environment and to collaborate in the testing and evaluation of their techniques by operational center staff.

We are very pleased thus far with the results of the JHT. Projects implemented thus far have made quantifiable enhancements to our operations including a 35 percent improvement in the computer model 3-day track forecast and significant improvements at other time scales. These advances helped NHC to establish new records for track forecast accuracy, both in 2003 and 2004.

Much of our improvement in tropical cyclone forecasting is attributed to advances in Numerical Weather Prediction (NWP). In collaboration with many scientists and developers in the domestic and international operational NWP centers, the EMC develops state of the art numerical modeling systems and is a recognized world leader. We are now at the point in improving intensity forecasts that we were a decade ago in improving track forecasts. Through our NWP advancements, our 2005 version of the GFDL high-resolution model improved some intensity forecasts over the statistical models when run on several 2004 Atlantic storms. To advance hurricane prediction, especially hurricane intensity and size forecasts, EMC is leading the development of the Hurricane Weather and Research Forecasting (HWRF) system. The HWRF system uses a collaborative approach among the research community and will apply advanced model physics as HWRF couples the atmosphere, land, and ocean into an integrated model. EMC will also couple an advanced wave model with a dynamic storm surge model to better predict coastal impacts of waves and storm surge.

Research efforts are being coordinated across NOAA to develop new technology and applications to improve NOAA's products, and provide outreach to the public. These research efforts address issues that have direct impact upon the ability of NOAA to provide tropical cyclone weather forecasting and warning services to the public.

We are making excellent progress. NOAA has a comprehensive plan to improve intensity forecasts along with our other difficult forecast challenges. While there are no quick fixes, we are very optimistic that we will continue to make advances in operational forecasts of tropical cyclone intensity, wind structure, size, and rainfall in the near future. We are leading the Nation in a large collaborative effort through a long-term commitment to these problems.

Increase the Effectiveness of Public Preparedness

Our Nation's hurricane warning program requires more than meteorology. Mitigation of storm impacts demands an interdisciplinary approach to develop long-term policies and practices for better public safety. Such an approach requires, at a minimum, contributions from the public, private and academic sectors to address better land use, building codes, sheltering plans, identification and communication of risk, and public education. Mitigation of future storm impacts depends upon a more informed public who knows what the hazards are, how those hazards impact them, and what actions to take based on those hazards. Without this approach, our Nation is vulnerable to greater devastation from hurricanes in the coming decades regardless of forecast accuracy.

An example of how we can do more in outreach is through programs like the National Hurricane Survival Initiative. This public-private partnership includes the National Emergency Management Association, Florida Division of Emergency Management, the Salvation Army, NHC and corporate partners. Their collective aim is to educate and prepare communities at risk from hurricanes. Another example is the Federal Alliance for Safe Homes (FLASH®). FLASH® is a non-profit, 501(c)3 organization dedicated to promoting disaster safety and property loss mitigation. A current FLASH® partnership with the NOAA/NWS, the Allstate Foundation, The Southwestern Insurance Information Service and the Texas State Parks and Wildlife is bringing greater visibility to a national Public Service Campaign named by the NWS "Turn Around Don't Drown." The campaign in Texas raises flood safety awareness using billboards, bilingual handouts for state park visitors and television public service announcements across major cities. These examples demonstrate how Federal-State and public-private partnerships are critical to pre-disaster planning, and targeted dissemination of outreach, education and information about the risks of severe weather.

Conclusion

We have come a long way in hurricane prediction. Our forecasts are better than they have ever been. We have an excellent working partnership with the emergency management community. Our partners in the private weather sector and the media work with us to make sure our information is disseminated and communicated as widely and comprehensively as possible. Even with the substantive progress we have made over the last fifty years, we remain vulnerable to a hurricane catastrophe. To meet the challenge of reducing the risk to our Nation from tropical cyclones, we must continue to improve our forecasts and warnings, and continue our public education efforts.

Thank you for the opportunity to talk with you about our Nation's hurricane forecast and warning program, and for your support as we continue to provide our Nation with the highest-quality weather services.

Senator DEMINT. Mr. McCarthy?

STATEMENT OF DENNIS McCARTHY, DIRECTOR, OFFICE OF CLIMATE, WATER AND WEATHER SERVICES, NATIONAL WEATHER SERVICE

Mr. McCARTHY. Mr. Chairman and Members of the Committee, I'm Dennis McCarthy, Director of the National Weather Service Office of Climate, Water and Weather Services. Thank you for the opportunity to discuss NOAA's weather programs, specifically tornadoes.

In an average year in the United States, thunderstorms generate 1,300 tornadoes resulting in 58 deaths, 1,500 injuries, and $1.1 billion in property damage. Thunderstorms produce other hazards, such as lightning, hail damage and wind and flash flooding. The challenge is to determine which thunderstorms will bring which hazards. In the 1970s less than 1 of 3 tornadoes occurred in a tornado watch area, only 1 of 5 occurred in a tornado warning area. More than 80 percent of tornado warnings were based on spotter reports, meaning there was virtually no warning lead time for most tornadoes. By the end of the decade, research focused on optimizing observational data and new techniques for using weather satellite and conventional radar data began paying off. Meanwhile, Congress supported an expansion of the NOAA weather radio network, and a computer-based communication system for National Weather Service field offices, both improved warning dissemination. During the 1980s—warnings preceded one in three tornadoes, and lead time increased to more than 5 minutes. To take advantage of Doppler radar technology, NOAA incorporated a program to replace the 30 year-old weather radars with NEXRAD Doppler radars into the National Weather Service modernization. These new radars had an immediate impact on tornado warnings skill with lead times approaching 10 minutes in the 1990s.

In recent years, we've made improvements in the NEXRAD radars and the work stations used by forecasters, the Advanced Weather Interactive Processing System, or AWIPS, which integrate radar data with satellite, wind profiler and other data. These improvements, combined with forecasters' training and experience, have resulted in an increase in tornado warning lead time to about 13 minutes. Almost three-fourths of all tornadoes are now preceded by tornado warnings. Matching improvements in tornado detection and warning are improvements in education, preparedness and communication. With continued support from Congress and partners in the private sector, and all levels of government, the NOAA Weather Radio All Hazards network has grown to more than 900 transmitters across the United States. Warning dissemination, radar display and urgent safety advice for commercial media, especially television, have played a key role in reducing fatalities and injuries from severe storms. Internet websites displaying radar data and warning information are experiencing incredible growth and use. NOAA's Oceanic and Atmospheric Research and National Weather Service continue to work together to improve tornado and severe storm watches and warnings.

In the short-term, the three agencies involved in NEXRAD—NOAA, the FAA and U.S. Air Force—plan to add dual polarization capability to the radar in Fiscal Year 2008 to 2012 timeframe. Dual polarization will bring improvements not only to tornado warnings, but also warnings for floods, hail and winter storms. NOAA's Warning Decision Support System—WDSS II—uses sophisticated, artificial intelligence-based science to analyze storms for hail, wind and tornado potential. It will add efficiency to the warning decision-making process. Test and forecast offices indicated will increase warning lead times, by two to three minutes, and reduce the false alarm rate.

With all of the improvements in tornado detection and lead time, false alarms continue to be a challenge. Approximately three-fourths of all tornado warnings are followed by hail, high winds or heavy rain, but not a tornado. Advances such as dual polarization, and WDSS II, along with integration of Geography Information System, or GIS, technology for dissemination will help improve the false alarm rate. In the long term, we're exploring new technologies to upgrade or replace our NEXRAD Doppler radar system, which is approaching the mid-point of its life cycle. One likely candidate technology is phased array radar—phased arrays work by forming and steering radar beams electronically, they're very fast and agile compared to the mechanical rotating dish antennas. Their faster collection of the volumetric data, so important to warning decisions, can add 4 minutes to tornado lead times. These radars will also be less expensive to maintain since they have no moving parts.

Further into the future, high resolution observational data, including data from modern radars, can be used in sophisticated numerical weather prediction models, which will help make the leap from warning on observation to warning on forecast. This is where we would like to be in the 2020 timeframe, allowing us to push tornado warning lead time beyond 30 minutes.

In conclusion, Mr. Chairman, NOAA has made tremendous gains in providing warnings to help protect the lives of U.S. citizens from being able to detect and warn for most tornadoes, now with an average lead time of 13 minutes to getting the word to people about what to do when they hear a tornado warning, either from the media or directly from NOAA, by internet or NOAA Weather Radio All Hazards. We can continue to improve by taking advantage of emerging technologies in radar detection and numerical prediction of storm-scale weather events. Thank you for inviting me here today, and I'll be happy to answer any questions.

[The prepared statement of Mr. McCarthy follows:]

PREPARED STATEMENT OF DENNIS MCCARTHY, DIRECTOR, OFFICE OF CLIMATE, WATER, AND WEATHER SERVICES, NATIONAL WEATHER SERVICE, NOAA

Introduction

Mr. Chairman and Members of the Committee, I am Dennis McCarthy, Director of the National Weather Service Office of Climate, Water, and Weather Services, of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce. Thank you for the opportunity to appear before you today to discuss NOAA's severe weather programs, specifically tornadoes.

In an average year, there are 1,300 tornadoes resulting in 58 deaths, 1,500 injuries, and $1.1 billion in property damage. Floods account for $5.2 billion in damage annually and average over 80 deaths per year; lightning accounts for an additional 53 fatalities each year. Thunderstorm complexes can generate tornadoes, lightning, flash floods, extreme wind, and hail. The challenge to forecasting severe weather and any associated warnings is to determine which thunderstorm complexes will produce which combination of threats.

The highest frequency of tornado occurrence in the world is in the Central Plains of the United States, east of the Rocky Mountains and west of the Appalachian Mountains. While tornadoes typically occur during the spring and summer in late afternoon and early evening, they have been known to occur at any hour, on any day of the year, in every state in the United States.

Brief History of Tornado Forecasting

The National Weather Service (NWS) Tornado and Severe Thunderstorm Watch and Warning program can be traced back to two tornadoes that struck Tinker Air Force Base, Oklahoma, in March of 1948. The first tornado (March 20) was not forecasted. At the strong urging of Major General Fred Borum, who was in charge of the base, two Air Force meteorologists, Major Ernest Fawbush and Captain Robert Miller, studied weather charts from previous tornado outbreaks looking for similarities that could indicate tornado potential. On the morning of March 25, 1948, the weather charts were very similar to those that occurred with the first tornado. This similarity was reported back to Major General Borum, and a tornado forecast was issued. That evening, the second tornado within one week struck Tinker Air Force Base. After this success, weather forecasters, both civilian and military, started to seriously explore tornado forecasting. The first tornado forecast was issued by the then Weather Bureau in 1952. During this same period, other research scientists were actively exploring the use of radar to identify on-going storms that could potentially produce tornadoes, and pioneering work was being done by the Illinois Water Survey and Texas A&M University.

In 1956, Congress appropriated funds to develop radar for meteorological purposes. A network of radars was installed to provide coverage for most of tornado alley and the hurricane prone Southeastern United States in early 1959 and 1960. The National Severe Storms Research Project, in Norman, Oklahoma, expanded its mission to include radar techniques related to severe thunderstorm warnings. In 1964, a merger of the radar and tornado research programs created the National Severe Storms Laboratory.

Because of its dependence on rapid communication of weather data from all over the country, the forecasting of tornado potential remained with the National Severe Storms Forecast Center in Kansas City. Similarly, because providing alerts for existing storms required immediate access to radar data, local radar offices issued these products.

The 1965 Palm Sunday Tornado Outbreak took 266 lives, even though tornado forecasts and alerts had been issued. The National Weather Service conducted an assessment of its products and services following the outbreak and made several significant recommendations including:

- The National Weather Service began to differentiate tornado forecasts from typical weather forecasts by using the names Tornado Watch and Tornado Warning.
- The National Weather Service started to hold preparedness meetings in collaboration with Federal, State, and local government officials and news disseminators. Discussions at these meetings included the development of simple tornado safety rules.
- The National Weather Service committed itself to completing radar coverage east of the Rocky Mountains.

With these changes, the present watch and warning system was completed. However, tornado and severe thunderstorm meteorology was still in its infancy and we have made significant progress since then.

Key Research Leads to Significant Improvements in Operations

In a three-year period from 1976 to 1979, statistics indicated less than one out of three tornadoes occurred in a tornado watch area, and only one out of five tornadoes occurred in a tornado warning area. Also during that time, over 80 percent of tornado warnings were based on human spotter reports, meaning that there was virtually no lead time between when the warning was issued and when the tornado struck.

In 1976, a small group at the National Severe Storms Forecast Center (NSSFC) began developing new analyses and display techniques for meteorological data. These researchers worked with the National Aeronautics and Space Administration (NASA) and NOAA's National Environmental Satellite, Data, and Information Service to develop a computer system that allowed forecasters to collect data directly from the weather satellites to make short-range forecasts. In addition, the NSSFC research forecasters collaborated with scientists at the National Severe Storms Laboratory to develop new methods of interpreting conventional radar data and use it to issue warnings ahead of storms.

These efforts led to immediate improvements in our ability to issue accurate tornado watches and warnings. By the late 1980s, lead time for tornado warnings had increased from zero to over 5 minutes. Tornado warnings were issued for about one third of all tornadoes (compared to only one fifth in the late 1970s), and tornado watches were issued before about half of the tornadoes. Most importantly, the public was becoming more aware of tornado warnings, and the sentiment "the tornado struck without warning" was being uttered less and less.

While our scientific advances in the 1980s resulted in a marked improvement in tornado forecasting, the American public deserved more. In the late 1970s, a collaborative program had been established among NOAA, the U.S. Air Force (USAF), and the Federal Aviation Administration (FAA) to begin evaluating the value of Doppler radar for tornado detection. Tests were conducted in the Oklahoma City Weather Service Forecast Office. These tests proved Doppler radar could significantly improve tornado lead times and the detection of other measures essential for forecasting tornado warnings. A program to replace the 30-year-old weather radars with NEXRAD Doppler weather radars (the WSR–88D) was incorporated into NOAA's plan for National Weather Service Modernization. These radars, coupled with specially trained meteorologists in local National Weather Service Forecast Offices, had an immediate, dramatic impact on tornado warning skill. Following the nationwide installation of the NEXRAD network in the 1990s, tornado lead times almost doubled from 5.3 to 9.5 minutes. In addition, the probability of detecting a tornado increased from 35 to 60 percent. By 2004, tornado lead times averaged just over 13 minutes, and the probability of detection rose to 75 percent. More importantly, expected tornado deaths and personal injuries were reduced by 45 percent and 40 percent, respectively.

Similar research advances have improved long-range forecasts of tornadoes. In 1995, a National Science Foundation sponsored research project involving NOAA and several universities explored the causes of rotation in thunderstorms. This was a collaborative effort between research and operations with tornado forecasters from the Storm Prediction Center (formerly the National Severe Storms Forecast Center) and local warning forecasters from several NWS Weather Forecast Offices participating. This collaboration led to significant improvements in forecasting strong and violent tornadoes. While only 15 percent of all tornadoes are rated F2 or stronger on the six category Fujita Intensity Scale, they produce more than 92 percent of U.S. tornado fatalities.

Underlying these improved performance measures is the added benefit of increased data and expertise sharing by the National Weather Service with its partners in the media and private sectors. The Doppler radar data sets and improved computer and communication technologies have allowed broadcast meteorologists and others to better understand and communicate severe weather threats to citizens. In addition, the expansion of NOAA Weather Radio/All-Hazards remains a vital component of the National Weather Service's ability to communicate weather and non-weather hazard information. There are currently over 900 radio transmitters across the U.S., and weather radio is now a key vehicle for Federal, State and local public safety agencies to disseminate critical safety information on a variety of hazards, including man-made and natural disasters.

The success of the close collaboration between operational forecasters and research scientists, coupled with the advent of new communication systems, led to a move of the Storm Prediction Center from Kansas City to Norman, Oklahoma, in 1996 to collocate with the National Severe Storms Laboratory. This move spurred NOAA to establish the Hazardous Weather Testbed, in which NWS forecasters and NOAA research scientists collaboratively test, develop, and operationally implement new forecast and warning techniques and technology on a regular basis.

Research conducted at the Hazardous Weather Testbed has led to dramatic improvements in the quality of severe thunderstorm services provided by the Storm Prediction Center. The length of severe thunderstorm forecasts has been extended from 2–3 days, and forecasts now provide specific probabilities for the occurrence of tornadoes, large hail, and damaging thunderstorm winds. Experimental products currently being tested at the Storm Prediction Center include severe weather forecasts out to eight days, and additional forecast details in tornado and severe storm watches such as probabilities for each type of severe weather and the anticipated degree of severity. In addition, trials are being conducted that break down the daily outlooks into shorter time intervals that are of great interest to the aviation community.

The 122 NWS Forecast Offices located throughout the U.S. are experimenting with improvements to the tornado and severe thunderstorm warning process. The county currently issues these warnings, however, a real threat often exists for only a portion of a given county. A number of NWS Forecast Offices are experimenting with a "warning-by-polygon" method. In this method, the polygons are derived by assessing the threat from the latest radar observation and modeling a projected path for the most threatening portion of the storm. The polygons can easily be incorporated into geospatial display technology for satellite-based or other systems. This method would allow local emergency managers to sound sirens in the high threat areas of the county only.

Strategies for the Future

The NOAA Office of Oceanic and Atmospheric Research works in partnership with the National Weather Service to substantially improve the lead times and accuracy of tornado and severe storm watches and warnings. These efforts can be classified as short (0 to 5 years) and long term (5 plus years).

Short Term Efforts

The three agencies involved in NEXRAD—NOAA, the FAA, and the USAF—plan to add dual polarization capability to the radar system in the FY 2008 to FY 2012 timeframe. Dual polarization will provide information on the size and shape of the precipitation particles in clouds. Snow can be distinguished from rain, hail size can be estimated, and most importantly, rainfall amounts can be accurately obtained. This will lead to improvements in flash flood warnings and forecasts, as well as enhanced warnings for hail. The dual polarization radar data will be "cleaner," which should better identify precursors to tornadoes and the tornadoes themselves even before they descend to the ground. Dual polarization data also will allow for unique detection of debris lofted by tornadoes, giving additional valuable information on likely tornado intensity. Other improvements to the current network of weather radars include more rapid and enhanced sampling of the storm environment, and inclusion of FAA weather radars. NOAA's Warning Decision Support System—Integrated Information (WDSS–II) is the second generation of a suite of algorithms and displays for severe weather analysis, warnings and forecasting incorporating observational data from multiple sources. WDSS–II uses sophisticated artificial intelligence-based science to analyze storms for hail, wind, and tornado potential. The idea behind WDSS–II is to provide the forecaster with critical information that is easy to understand, resulting in a timely decision in the tornado and severe storm warning process. Tests in NWS Forecast Offices indicate WDSS–II will increase lead times for tornadoes and severe thunderstorms by 2 to 3 minutes and reduce the false alarm rate.

This past spring, NOAA's Storm Prediction Center and National Severe Storms Laboratory worked closely with the Norman Forecast Office, and partnered with three external organizations to generate a unique collection of three daily experimental very high-resolution numerical weather prediction models. The predictions are made from several different versions of the Weather Research and Forecasting (WRF) model, an advanced weather prediction system being designed for use by research scientists and forecasters in the United States. One of the purposes of this Hazardous Weather Testbed exercise is to extend the lead time and accuracy of tornado and severe thunderstorm watches issued by the Storm Prediction Center. Preliminary indications are that these very high-resolution numerical weather prediction models are quite useful in predicting rotating, severe thunderstorm complexes.

Long Term Efforts

NEXRAD Doppler radar is the key observation tool used by forecasters to warn the public of tornadoes and severe thunderstorms. The NEXRAD network is near the midpoint in its designed lifecycle and NOAA is already exploring new technologies for a major upgrade or eventual replacement. One likely candidate technology is phased array radar (PAR) with its electronically scanning antenna. Phased arrays work by forming and steering radar beams electronically, and they are very fast and agile compared to the mechanical, rotating dish antenna radars such as NEXRAD. The military has employed phased array radars for over 30 years in tactical systems.

NOAA is partnering with the U.S. Navy, the FAA, the University of Oklahoma, and several private companies to explore the capability of PAR for weather surveillance. The Navy has loaned NOAA a battle spare PAR antenna for testing at NSSL in Norman, Oklahoma. Properly configured, a PAR system can complete a volume scan of the surrounding atmosphere in less than one minute. It currently takes a NEXRAD 4.1 to 6 minutes to perform a similar scan. This faster scan rate can improve average tornado lead times by approximately 4 minutes. Other features of PAR could lead to improved detection of tornado and severe weather precursors and provide high-quality data for assimilation into numerical weather prediction models.

In the past, PAR systems have been deemed too costly for civilian use. Advances in parallel technologies, such as cellular telephones and wireless technologies, as well as breakthroughs in materials science, may reduce the cost of a PAR system to levels comparable with mechanical, rotating dish antenna radar. In addition, a PAR system can be designed with four fixed antennae resulting in a radar with no moving parts, which is therefore less expensive to operate. Such a PAR system may be able to perform multiple functions, thus satisfying the needs of several agencies. For example, a PAR could be designed to track aircraft (FAA), perform weather surveillance (NOAA, FAA), and scan for non-cooperative aircraft (Department of Homeland Security), all at the same time. Several agencies (NOAA, FAA, DHS, NASA, and the Department of Defense) are working together under the auspices of the Office of the Federal Coordinator for Meteorology to assess PAR capability, develop a multi-agency research and development plan, and to examine costs.

The potential exists to make significant long-term improvements to tornado and severe storm performance metrics. Presently, warnings are based on detecting certain precursors to tornado formation. Tornado watches and forecasts from several hours to several days are based, in large part, on numerical weather prediction models run at NOAA's National Centers for Environmental Prediction in Camp Springs, Maryland. The current upper limit on tornado lead times (based solely on detection) is about 20 minutes, perhaps 30 minutes for very strong tornadoes. Crossing this threshold will require reliance on forecasts from very high-resolution, detailed numerical weather prediction models capable of predicting the level of cloud formation.

The warning paradigm must shift from "warn on detection" to include "warn on forecast."

Very high resolution, cloud resolving numerical models exist in the research community to better understand storm science and cloud processes. Some limited experimentation with forecasting applications has produced mixed results. One approach being explored is to run many different models and combine them into an "ensemble" forecast that yields probabilities of high consequence events occurring. Other improvements will come from more detailed observations in space and time (dual polarization, PAR, surface networks, and next generation satellite data), new science, faster and higher capacity computing, and improved numerical techniques. Improvements in forecast skill in the 0.5 to 12-hour range has the potential to improve tornado and severe storm watches and warnings, improve forecasts of heavy precipitation, contribute to better routing of aircraft enroute and at airports, and to assist local emergency managers in protecting life and property in their area of responsibility.

Over the past 50 years, NOAA has made tremendous gains in providing warnings to help protect the lives of U.S. citizens—from being able to detect and warn for most tornadoes, now with an average lead time of 13 minutes, to getting the word to people about what to do when they hear a tornado warning, either from the media or directly from NOAA via Internet or NOAA Weather Radio/All-Hazards. We can continue to improve by taking advantage of improved scientific understanding and emerging technologies to upgrade and refresh tornado and severe weather forecast products and information. The trend is clearly toward providing more detail in location and time coupled with probabilistic information allowing customers to better assess their particular risk prior to taking appropriate action. Ongoing NOAA-led efforts in radar enhancement (dual polarization and phased array) and improvements in the numerical prediction of storm scale weather events hold particular promise.

We envision a future in which the National Weather Service issues warnings at least 30 to 45 minutes before tornadic thunderstorms develop. Storm Prediction Center Watches will run from about an hour in the future out to 12 hours, and extended range forecasts are valid out to several weeks. These forecasts will allow Emergency Managers and Homeland Security to plan for severe thunderstorms and tornadoes far enough in advance to pre-position resources before a storm. Even more dramatic will be the economic impact of improved severe thunderstorm forecasts. For example, energy companies can configure their grids to ensure continuous power flow in regions impacted by storms, the transportation sector can reroute trains, trucks and airplanes away from areas that will experience significant thunderstorms, and local emergency managers can better alert the public, saving lives and mitigating property damage.

Senator DEMINT. Thank you. Dr. Sallenger?

STATEMENT OF ASBURY H. SALLENGER, JR., OCEANOGRAPHER, U.S. GEOLOGICAL SURVEY CENTER FOR COASTAL AND WATERSHED STUDIES

Dr. SALLENGER. Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to speak to you on behalf of the U.S. Geological Survey on coastal change impact from extreme storms.

Each year, natural hazards in the United States, such as earthquakes, fires, floods, hurricanes, landslides and volcanoes result in hundreds of lives lost and cost billions of dollars in disaster aid, disrupted commerce and destroyed public and private properties.

At USGS it is our goal to provide scientific research and analysis to help citizens, emergency managers and policymakers decide how to react to each hazard, and how to safeguard society. In regard to hurricanes, we improve understanding of coastal erosion and deposition that can destroy infrastructure and permanently change the coastal landscape. There are two major objectives.

The first is to improve predictive capabilities, so that as a hurricane approaches, the United States assessment can be made on how the threatened coast will change at landfall. The second is to provide the knowledge to assess vulnerability of our coastlines to extreme storms so that buildings and infrastructure can be sited away from hazardous areas.

For landfalling hurricanes in 2004, we were able to make significant advances toward reaching these objectives. In a cooperative effort between USGS, NASA and U.S. Army Corps of Engineers, the impact zones of all four storms were surveyed with the airborne lidar, a laser mapping system, both before and after each landfall, to detect the patterns of erosion and deposition that resulted from the storms. The most extensive coastal change occurred during Hurricane Ivan on the Alabama and Florida panhandle coast, where the shoreline retreated 40 feet during the storm. Storm surge completely inundated low-lying barrier islands, its strong currents flowing across the islands carved new inlets. Where sand dunes were well-developed, they eroded landward, and in places underlying five story buildings collapsed, some of the largest buildings to fall during the hurricane in U.S. history. Forty-eight hours prior to Ivan's landfall, the USGS posted on its extreme storm website an experimental product that showed the vulnerability of the threatened coast to change. These vulnerability assessments were based on a ratio of worst-case storm surge, to our high resolution coastal elevations, acquired with airborne lidar, and were consistent with our subsequent measurements of what actually happened.

As our research progresses, we hope to be able to improve these assessments, for example, by identifying the specific locations along the U.S. barrier island coast, subject to breaching by waves and surge. Such breaching can sever evacuation routes, as occurred on the North Carolina outer banks in Hurricane Isabel in 2003. The unusual failures of the large ocean-front buildings during Hurricane Ivan may be a warning about the future. Ocean front communities in the Southeast U.S. have not been severely tested by hurricanes until very recently.

Between 1966 and 1990, when Southeast coastal developments grew dense, only two major hurricanes made landfall along the East Coast, or the peninsula of Florida. Most developments survived this unscathed. However, recent climate research on decadal scale changes in hurricane activity suggests that the Atlantic Basin has re-entered an active hurricane period similar to the 1941 to 1965, when there were 17 major hurricanes that made landfall in the United States or along the East Coast and the peninsula of Florida. This active period may persist for decades, hence the loss of multi-story buildings during Hurricane Ivan may occur more frequently in the future. USGS research is focused on predicting coastal areas that are vulnerable to severe erosion, so that new buildings like those that fell during Ivan can be sited away from hazardous areas. During the present hurricane season, we'll be extending our results from the 2004 hurricanes by using improved models and by testing them with coastal change data for any major landfalling hurricane.

Mr. Chairman, thank you for the opportunity to appear before you today, and I'm happy to answer any questions that you and the Members of the Subcommittee may have. I might also note that in your packets I understand you have some before-and-after photographs of at least one of these buildings that went down.

[The prepared statement of Dr. Sallenger follows:]

PREPARED STATEMENT OF ASBURY H. SALLENGER, JR., OCEANOGRAPHER, U.S. GEOLOGICAL SURVEY CENTER FOR COASTAL AND WATERSHED STUDIES

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to speak with you on behalf of the U.S. Geological Survey (USGS) on inland flooding and coastal-change impacts of extreme storms. Each year, natural hazards in the United States such as earthquakes, fires, floods, hurricanes, landslides, and volcanoes result in hundreds of lives lost and cost billions of dollars in disaster aid, disrupted commerce and destroyed public and private properties. At USGS, it is our goal to provide scientific research and analysis to help citizens, emergency managers, and policy makers decide how to react to each hazard and how to safeguard society. By collecting long-term data and information assessing past and present hazards events and by providing continuous monitoring and data collection, we hope to arrive at the place where we are able to predict these natural events and mitigate their potential impacts, providing precious time to save lives and property. By conducting research on coastal change that occurs during extreme storms, and by improving understanding of erosion and deposition that can destroy infrastructure and permanently change the coastal landscape, USGS will assist in efforts to reduce the impact these severe storms have on lives and communities.

There are two major objectives of this USGS research effort. The first is to improve predictive capabilities so that, as a hurricane approaches the United States, assessments can be made of impacts to the threatened coastal setting prior to landfall. The second major objective is to provide the information and knowledge required to assess the changing vulnerability of our coastline to hurricanes for longer-term hazard planning and mitigation so that new buildings and infrastructure, particularly those being rebuilt following a storm disaster, can be sited away from hazardous areas. The 2004 Atlantic hurricane season was one of the busiest and most destructive in history. For example, Hurricane Ivan caused severe beach and dune erosion that undermined five-story oceanfront condominium towers, some of the largest buildings to fail during a hurricane in United States history. Today, after giving an overview of the USGS research program on severe storms, I will focus on lessons learned from the coastal change impacts observed last year.

Research Program on Extreme Storms

As part of USGS National Assessment of Coastal Change Hazards, impacts of extreme storms have been intensively investigated since the 1997–98 El Nino when severe winter extratropical storms ravaged much of the U.S. west coast, causing extensive erosion of beaches and sea cliffs and resulting in loss of property. The USGS worked cooperatively with National Aeronautic and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA) to acquire airborne lidar surveys of the coast both before and after the El Nino. These data were used to test models of the interaction between storms and coasts. Since the 1997–98 El Nino, USGS has continued to work with NASA, focusing primarily on hurricane impacts in the southeast U.S., again using airborne lidar to survey the coast before and after storm impact. Airborne lidar survey systems utilize the Global Positioning System (GPS) and a laser mounted in an aircraft to measure ground topography. If the water is clear enough, some lidar systems can penetrate the ocean and measure shallow seafloor bathymetry. The before- and after-storm surveys gathered as part of USGS research are compared to detect changes in the elevation and configuration of the ground, changes that occur during a storm due to erosion and deposition.

These data are used to test and validate predictive models that can forecast coastal change prior to hurricane landfall. The data are also used to develop a quantitative means to assess the vulnerability of U.S. coasts to future extreme storms. Currently, USGS is developing the means to assess:

The location of potential breaches that sever barrier islands and evacuation routes during hurricanes. Most of the East and Gulf of Mexico mainland coasts of the United States are protected from the open ocean by a nearly continuous string of barrier islands. These long, thin strips of sand are, in places, low-lying (less than 9 feet in elevation) and subject to being inundated and cut during extreme storms. In fact, most of the present inlets through barrier islands in the southeast United States, which allow boats and ships to transit between ocean and mainland ports, were cut naturally during hurricanes. Most recently, breaches severed barrier islands during Hurricane Isabel on the North Carolina coast in 2003, on the southwest coast of Florida during Hurricane Charley in 2004, and during Hurricane Ivan on the Alabama and Florida panhandle coasts in 2004. Results of USGS research indicate that these catastrophic island breaching events occur where storm processes intersect with low-lying topography. USGS research also suggests that the underlying geology may contribute to the vulnerability of barrier islands to inlet formation.

Extreme beach and dune erosion that lowers the elevation of barrier islands, making the islands, and the back bays they shelter, more suceptible to inundation by storm surge. During extreme storms, wind can push water against the coast, raising sea level in a storm surge. This allows waves to attack beaches and dunes that are normally beyond their reach. During Hurricane Ivan, Santa Rosa Island, offshore of Pensacola, Florida, was reduced in elevation an average of approximately 3 feet; however, in places, the reduction was as much as eight feet where new breaches opened. This reduction in elevation allows more water to be driven across the island during a severe storm, raising the storm surge in the back bays higher than would have been possible had the dunes remained intact. Thus, up-to-date and accurate information of coastal elevation, and understanding of the coastal response to storm processes, is critical to providing accurate forecasts of hurricane impacts.

The 2004 Hurricanes: Charley, Frances, Ivan and Jeanne. In a cooperative effort between USGS, NASA, and U.S. Army Corps of Engineers, the impact zones of the four Atlantic hurricanes that made landfall in the United States in 2004 were surveyed with airborne lidar and photography both before and after landfall of each storm. Initial results for each hurricane can be found on the USGS World Wide Web site *http://coastal.er.usgs.gov/hurricanes*. Pre-storm surveys were combined with models of storm processes and coastal response to assess vulnerability of the threatened coast prior to landfall. After landfall, pre- and post-storm surveys were compared to quantify change and showed that coastal response was unique for each storm, depending on characteristics of both the storm and the shoreline setting impacted.

For example, the swath of hurricane-force winds associated with Hurricane Charley was narrow. Major coastal-change impacts were limited to several tens of miles of shoreline near landfall, where a breach, 1,500 feet wide, opened through North Captiva Island, Florida. In contrast, Hurricane Frances was a larger, weaker storm that caused moderate coastal erosion extending for nearly 100 miles along the Florida south-central east coast. However, Hurricane Frances' greatest legacy may have been in making the coastline more vulnerable to erosion from Hurricane Jeanne, which followed the same storm track several weeks later. Surviving structures left exposed on the brink of eroded dunes following Hurricane Frances in Vero Beach and Floraton, Florida, were later destroyed during Hurricane Jeanne.

The most extensive coastal change observed during the 2004 Atlantic hurricane season occurred during Hurricane Ivan on the Alabama and Florida Panhandle coasts. On average, the shoreline retreated 40 feet during the storm. In Gulf Shores, Alabama, where the storm's strongest winds made landfall, the relatively low-lying barrier islands were completely inundated by storm surge. The sea-level difference between the Gulf of Mexico and back bays drove a strong landward current that transported sand across the island and opened a new inlet. In contrast, several miles to the east in Orange Beach, Alabama, where land elevations were higher, the response was dune erosion. In places, the vertical scour associated with dune retreat approached nine feet and undermined structures including several five-story condominium towers that had been built on top of the dunes. These are some of the largest buildings to be destroyed by hurricane impact in United States history.

Assessments of Storm Impacts Prior to Hurricane Landfall

Forty-eight hours prior to Hurricane Ivan's landfall, the USGS posted on its extreme-storm website an experimental product that showed the vulnerability of the threatened coast to change. This assessment was based on the difference between worst-case storm-surge elevations, calculated by NOAA using computer models, and high-resolution coastal elevations, measured with airborne laser mapping. For each location along the coast, the posted maps showed where Ivan's worst-case storm surge would exceed coastal elevations and submerge barrier islands as if they were shoals. At these locations, water level differences would drive strong currents across the islands, changing their form and undermining buildings and infrastructure. The coastal change during Hurricane Ivan measured with airborne lidar was later found to be consistent with USGS assessments of coastal vulnerability made prior to the storm's landfall.

The Future

The unusual failures of large, oceanfront buildings during Hurricane Ivan may be because southeast U.S. coastal communities have not been severely tested by hurricane-induced erosion until recently. Between 1966 and 1990, when southeast coastal developments grew dense, only two major hurricanes made landfall along the east coast or the peninsula of Florida—most developments survived unscathed. However, recent research on decadal scale changes in hurricane activity suggests that the Atlantic Basin has re-entered an active hurricane period similar to that of the period 1941–1965 when seventeen major hurricanes made U.S. landfall. It is likely that this active period will persist for decades. Hence, the loss of multi-story buildings during Hurricane Ivan may be a warning of what is to come along our hurricane threatened coasts.

The USGS, working with our partners, will continue to develop extreme storm vulnerability assessment methodologies and provide these assessments of coastal change to user agencies. Several weeks ago when Tropical Storm Arlene threatened the Alabama and Florida panhandle coasts—the same area where Hurricane Ivan made landfall nine months before—USGS provided NOAA storm surge modelers with assessments of dune erosion within the forecast impact zone. The modelers were concerned that barrier island elevations had been lowered during Hurricane Ivan, which would allow more water to be driven across the islands, resulting in higher surge in estuaries than their models would account for. The USGS provided dune erosion data and assessments that were incorporated into NOAA storm-surge models and were used to help forecast potential flooding from Tropical Storm Arlene.

Ongoing data collection efforts, combined with existing models, provide the basis for a collaborative effort with other Federal partners, such as National Weather Service (NWS), to assess the likely impacts of coastal storms. Both pre-storm assessments of dune and beach erosion and post-storm damage assessments, provided in a timely manner, support the efforts of Federal and local emergency planners and responders. These activities are also an integral part of persistent research efforts to better understand and assess the vulnerability of U.S. shorelines to coastal change impacts from extreme storms. Integration of scientific information and coastal change models developed by USGS with the meteorological models of impending storm processes from NWS will support more timely and accurate forecasts of the location and type of coastal response to severe storm events.

Inland Flooding From Excessive Rainfall

As population and development continue to increase in coastal areas, more people and property are vulnerable to hurricane threat. However, coastal residents and visitors are not the only ones vulnerable to the ravages of hurricanes and extreme storms. Hurricane winds and waves impacting the coastal zone are often accompanied by extreme rainfall that can contribute to local and regional flooding of coastal and inland areas. Flooding is the most frequent natural disaster. During the 20th century, floods arising from extreme storms, both tropical and extra-tropical, were the worst natural disaster in the United States in terms of number of lives lost and property damaged. Flooding from extreme storms can occur at any time of the year, in any part of the country, and at any time of the day. Property damage, including inundation by sediment-laden water, demolished buildings, and erosion that undermines bridge foundations and footings leading to the collapse of structures, results in approximately $5 billion in losses per year.

Hurricanes and tropical storms can be especially dangerous and destructive as they move inland from coastal areas. For example, floods from remnants of Hurricane Camille in 1969 killed hundreds of people throughout Appalachia. In 1999, eastern North Carolina endured record rainfall and two months of continuous flooding from Hurricanes Dennis, Floyd, and Irene. Notable, the 2004 Atlantic hurricane season was the most costly on record—$42 billion. Widespread rainfall amounts over 6 inches caused extensive flooding. In Florida, USGS field crews obtained some of the highest flow measurements ever recorded. This flooding was compounded by the remnants of Hurricane Ivan less than 2 weeks later.

The USGS, in cooperation with NWS River Forecast Centers and others, is making significant progress in development of new tools and techniques to address flood risk. The following are examples of USGS research and modeling activities relative to inland flooding:

- Prioritizing Streamgaging Network investments and Improved Streamflow Information Delivery. The USGS managed streamgage network includes 3,200 gages that support NWS streamflow forecasts and flood predictions to calibrate their streamflow forecast models and make flood predictions. The USGS is working to improve delivery of streamgage information to meet this and other national needs for streamflow information. As part of that effort, USGS is installing new high data rate transmitters to improve real-time data access, flood-hardening streamgages critical to the National Weather Service for flood predictions, and building a robust data storage and processing system to ensure reliable and timely streamflow information delivery to users of the information.

- Development of a real-time flood inundation mapping capability using forecasts from the NWS River Forecast Centers. Emergency managers need to know what is (or shortly will be) under water when a flood is occurring. Inundation maps help emergency managers plan evacuation routes, deploy critical resources, understand the magnitude of events, and, in general, respond quickly to save lives and property. In creating real-time inundation maps, forecast flood hydrographs are routed through lidar-derived elevation models of reaches of a river with multi-dimensional flow models that allow predictions of the timing, depth, velocity, and impact of flood waters for any location in the mapped floodplain. These inundation forecast maps can be posted on the worldwide web hours to days prior to the arrival of the flood. Near-real-time simulation and internet-based delivery of forecast-flood inundation maps using two-dimensional hydraulic modeling has been developed through a pilot study of the Snoqualmie River, Washington (see USGS Water-Resources Investigations Report 02–4251, 36p.)
- Development of a map-based Web application, "StreamStats," to obtain streamflow and flood statistics. "StreamStats" provides streamflow information for all locations in the Nation, and specifically for ungaged sites, by using statistical models and established hydrological relationships. This application results in major cost savings by reducing the time needed to obtain streamflow estimates for a site from an average of about a day to only a few minutes. "StreamStats" is currently available for 6 states. By the end of Fiscal Year 2005, information from 12 states will be included in "StreamStats."
- Development of new technologies to measure flood water levels that heretofore were too dangerous or practically impossible to measure. Accurate determination of the magnitude of floods is essential for establishment of flood-frequency relationships, required for long-term hazard assessment and design of critical infrastructure. These technologies include hydroacoustic current profilers and totally non-contact methods to measure river discharge from the ground or the air (see *http://or.water.usgs.gov/hydro21/index.shtml*). These technologies keep personnel out of high flowing streams and increase the margin of safety when taking streamflow measurements in hazardous conditions.

USGS will continue to work with partners at the Federal, State, and local level to assist in efforts to reduce the impact that severe storms have on lives and communities. Natural hazards, such as hurricanes and inland flooding, will always be with us and may be difficult to predict. With USGS science, however, we are striving to prevent these natural hazards from becoming natural disasters. Our efforts in hazards monitoring and long-term data and information collection from past and present hazard events is not simply a scientific research endeavor—it is a matter of public safety.

Mr. Chairman, thank you for the opportunity to appear before you today. I am happy to answer any questions that you and Members of the Subcommittee may have.

Senator DEMINT. Thank you, panel, I would just ask a couple of quick questions and then turn to the Ranking Member.

Mr. Mayfield, on the Hurricane Center you've done some amazing things, I know you're working hard to improve forecasts and get more products out to the public. My concern is that even if the Center could produce perfect forecasts 10 days out, it still might not make a difference for some people. What I'm saying is that at the end of the day, some of this comes down to personal responsibility to make sure you have a disaster plan, you don't make foolish decisions like trying to cross a flooded bridge. You work on these issues day to day—can you comment on what you believe families need to do to be protected?

Mr. MAYFIELD. Absolutely, Mr. Chairman, and you really hit the nail on the head here. I learned a long time ago that it really doesn't matter if you even make a perfect forecast, if you don't get people to respond, it's all for nothing. As you have accurately stated here, it really comes down to that individual taking that personal responsibility to develop their own hurricane plan, and make no mistake about it—the battle against the hurricane is won outside the hurricane season—you can't afford to wait for a hurricane to be knocking at your door before you develop that plan. People need to know in advance, and I know very well now that the National Hurricane Center can't do this alone.

I think one good example of how we are addressing this—there is a public/private partnership called the National Hurricane Survival Initiative. We have gotten together with the National Emergency Management Association, the Florida Division of Emergency Management, the Salvation Army and some private sector folks, and you'll be seeing, this coming hurricane season, several public service announcements on television stations up and down the coastline—they also did a survey, a Mason-Dixon poll that was released in May, and I guess the really disturbing thing to me in spite of all of this outreach and all of this education we've done for so long, this poll from Texas to Maine told us that 47 percent of people did not have a hurricane plan, and that is not acceptable.

Now, they just released a new poll in Florida alone, in fact, I just got the results last Friday, and all but 18 percent of the people in Florida have a hurricane plan—that is understandable after the season we had last year—but you don't want to wait for a hurricane to come and cause all of this damage before you get prepared. In fact, there's some very simple things to do, in fact, we have some excellent ideas on our website. The number one thing to do is when anybody develops a hurricane plan, is to determine if you're in a hurricane storm surge evacuation zone or not, if you are, you need to know exactly where you're going to go to seek safe shelter, even if you're out of that storm surge evacuation zone, you still need to have the hurricane plan, the storm shutters, the drinking water, the batteries, flashlights and batteries, the most important thing is to have that plan done now before the hurricane comes.

Senator DEMINT. Is that information on your website? If I lived in a particular area, I could go find out exactly where the storm surge was, which bridge I should take on the way out?

Mr. MAYFIELD. That varies with the state. You can do that in some states, you can in Florida, I'm not sure that everybody does that yet.

Senator DEMINT. Who's responsible for making sure that's on the website?

Mr. MAYFIELD. Well, I would think that probably the local community. Of all the studies I'm familiar with, they are very consistent in saying that people, most people, respond really to what local officials tell them to do. And so it is really important that people listen and heed the advice of the local officials. And so my vision would be for each local community to have the storm surge zones depicted and most importantly, the shelters depicted.

Senator DEMINT. If someone went to your website, they couldn't get information as to where to go to find out that information?

Mr. MAYFIELD. Not on a community-by-community basis, there are so many communities out there from Texas to Maine, plus the Caribbean that that would be a little overwhelming for us to do.

Senator DEMINT. You can tell them they should have a hurricane plan, but they can't get the specifics from you?

Mr. MAYFIELD. But we do work very, very closely with all of the emergency management, we talked about training, and in fact, Mr. Chairman, we actually made a very conscious decision years ago—I really think that if I had time to sit down over a cup of coffee with the 50 some-odd million people living in coastal communities and talk to them about hurricanes and the hazards of the hurricanes and the uncertainties in forecasting, I'm sure I could convince people to develop their own hurricane plan—I can't do that, so we made a conscious decision to work with these emergency managers from the local communities.

Senator DEMINT. Right now, as far as you know, NOAA doesn't have a link with state departments of transportation about evacuation routes so people have to figure out separately to go to another site.

Mr. MAYFIELD. That is correct, Mr. Chairman, we don't do that for the entire coastline, I would guess that most communities do have something like that on a local website.

Senator DEMINT. Thank you, Mr. Mayfield, just a quick question for Mr. McCarthy, and then I'll turn to my Ranking Member here.

You mentioned that the phased array radar is the next generation, it could add as much as 4 minutes to lead time—could you give us some idea how much this costs as compared to Doppler? And do you think there is a cost-benefit relationship?

Mr. MCCARTHY. Well, the big benefit would be in the ongoing operation and maintenance, exactly what it costs to deploy. It is a little down the road yet, and there is a group that is actually exploring what the cost would be, because you know how technology is, things generally, the price kind of comes down. This is a system that we're actually integrating from the Navy, it is a system that the Navy has been using for some time, and so the first system that we have for testing and development that is in Norman, Oklahoma, actually came from the Navy, so now the National Severe Storms Lab in Norman, Oklahoma is using that system to adapt it to weather applications, especially storm detection, so as they figure out what it will take to develop a network of those for weather applications, and as the group who is looking into what it will take to actually do that, they can develop the unit cost, which isn't quite there yet, I'm fairly certain that later this year we can get that information to you.

Senator DEMINT. Very interesting, thank you.

Senator Nelson?

Senator BEN NELSON. Thank you, Mr. Chairman.

Mr. McCarthy, the testimony that was submitted to the Committee suggests that the area of responsibility assigned to any particular service office may be quite large, and expectations may be greater than the reality of being able to serve, and in your own written testimony, you suggested that issuing tornado warnings by county itself may be too broad. What effort is the Weather Service making to try and correct these two areas that need to be dealt with?

Mr. MCCARTHY. Well, actually sir, our areas of responsibility as we've referred to it, like the Valley office that you visited, we did, when we did our modernization and restructuring in the 1990s, we looked at the area of responsibility and feel pretty comfortable that those areas work out pretty well with the radar coverage that we have. A lot of offices have their own radar, and then they have access to their neighbor's radars now through the work stations that we use. And it's a pretty good, pretty well-oiled operation. What we're talking about with the counties, and this gets a little bit into the false alarm rate issue, currently in some areas, you know in Nebraska you have some—well, we all have interestingly shaped counties that have to do with rivers and things like that for boundaries—some of the counties geographically are a little bit large, we have issued, ordinarily we issue county-based warnings, and there's reasons for that, partly because of the emergency management network that is out there, and partly because when we issue a warning, we use the codes that are assigned for each county for automated distribution, it is called a FIPS code, which I think is Federal Information Processing System, but what we're trying to do now with GIS technology, is we're trying to narrow the area that we warn for, we have a good idea from our radars, obviously, where the storm is and where it's going. And actually, when we outline the warned area, we actually do it on our computer screen, and we outline this area and when we do that, the computer can take over and assign latitude and longitude points. Lots of people can use that polygon, as we call it, to actually transmit that as the warned area.

We have private sector partners now that are actually using that polygon area, so we can limit the geographic area that the warning is issued for, and we have a really great experiment going on out in parts of the Midwest, parts of Tornado Alley, along those lines this severe weather season, and its been very successful.

Senator BEN NELSON. Well, certainly to the extent you can get them more narrowly focused for warning, the better the warning is going to be, and more people will be well-served by fewer false alarms and more credibility.

Now I want to ask you a couple of issues on the budget—there was a bunch of downsizing that occurred in the 1990s, many of the Weather Service offices, and now the House recently proposed a cut of 7.6 percent in your budget, which would come on top of the $37 million cut that the MWS received between Fiscal Year 2004 and 2005. If enacted, how would these cuts—if you project them through your operation—how would they affect your ability to continue to do what you're doing, as well as what you would like to do?

Mr. MCCARTHY. Well, you know, sir——

Senator BEN NELSON. I'm sure the answer is, it's not going to improve, but maybe you can give us some idea of what kind of cutting or what kind of reductions you may be faced with.

Mr. MCCARTHY. Actually, when we did our modernization back in the 1990s, the offices that we phased out, there was actually a pretty strong scientific and technology reason. We had as many field offices as we had in the past because we were kind of tied to manual observations. Our systems that were used for observing certainly weren't what they are today, so we are able to do a better job with modern technology, such as the NEXRAD radar, and as was mentioned in opening statements about how long it took to generate a tornado warning back in those days, in the teletype era, before we moved into computer technology——

Senator BEN NELSON. Are you going to be able to tell me the increasing technology in the next several weeks, or months or years will help you overcome a 7.6 percent reduction, as well as the other? If you're able to tell me that, I'm not looking to put money where we don't need to.

Mr. MCCARTHY. Well, we certainly, basically, sir, we do the best we can with the budget that we're given, and we feel we do very well with that. Sometimes we have to defer some things, and sometimes there are things we would like to do that we maybe have to do next year or the year after, but what we do focus on more than anything is tornado warnings, the impacts from hazardous events, we will always do that, that is our highest priority.

Senator BEN NELSON. Well, living in Tornado Alley, I want you to be as accurate as you can possibly be, with the greatest technology that's available, and I want to make sure that those cuts don't impair your ability to do that, because I spend a fair amount of time out there, and if I didn't care about my constituents, I certainly care about my family and myself, and so I hope that you're able to continue the progress that you've made in spite of cuts, and not be impaired because of it.

Mr. MCCARTHY. Well, I can tell you for certain that every National Weather Service forecaster, as I told people in a community where we did close an office during the modernization, that I put the same effort into their community that I put into the community where I live.

Senator BEN NELSON. Well, that's fair enough. Thank you, Mr. Chairman, thank you, Mr. McCarthy.

Senator DEMINT. Thank you, Senator.

Senator Vitter?

Senator VITTER. Thank you, Mr. Chairman.

Mr. Mayfield, your written testimony refers to the inability to provide enough time to evacuate New Orleans and Key West, specifically, from a hurricane. Could you tell us why. What is unique in those two cities, those two geographic areas, such that there is that relatively unique inability to fully evacuate?

Mr. MAYFIELD. Senator Vitter, those are two of the areas that we have the most concern with anywhere in the Gulf of Mexico, in fact, the number one area of greatest concern for the Gulf is Southeast Louisiana, the Florida Keys is a very close second there. They are so vulnerable, the areas, I think that the greatest loss of life will occur in one of those areas due to the storm surge flooding as you've described in your graphics behind you here. It's really difficult to get people to understand the power of the storm surge, and the cubic yard of water weighs about 1,700 pounds, it's nearly incompressible, on top of the storm surge, you have the very dangerous waves. I like to tell people that it doesn't matter how well built your house is, if you're in the low-lying area, I mean, to make it real simple, if you're six feet tall and have ten or twenty feet of storm surge, you have a problem. I like to say you need to make friends in high places.

One of the problems is that in Southeast Louisiana and in the Florida Keys, there are no high places. The city of New Orleans is below sea level, for the most part. It's a real concern to give people enough time to evacuate to higher terrain, which is what they have to do, or they will drown from the storm surge.

Senator VITTER. So, is the biggest factor the terrain? What about infrastructure in terms of getting out?

Mr. MAYFIELD. It is not just about the forecasting, it's about the land use, and the building codes and the education, just having so many people that you have to evacuate out to higher ground. I've flown all around the Louisiana Coast and around Lake Pontchartrain with emergency managers as recently as about a year and a half ago, and I've seen the vulnerabilities, and they were pointing out to me islands that they used to go and picnic on that are now under water, and you have a very unique problem there in Southeastern Louisiana with the subsidence, it needs some attention, and again, it is not all about the meteorology there, we need to make sure people have a plan and I know people are working very hard on that. The emergency managers are doing the best they can, and it still comes down to that individual taking that personal responsibility, and making sure that they do the right thing, and in addition, a unique problem there in Southeastern Louisiana you have, I believe the last numbers I heard, 125,000 people without transportation in the New Orleans area. So, the emergency manager would be the best to answer that question, but I know they do have plans to bus them out and use other means of transportation to get them out of harms' way.

Senator VITTER. In light of all of that, what should planners and others in that area do, first and foremost to improve the evacuation picture; and specifically, how significant and useful a role do you think vertical evacuation into taller buildings, which is the only high ground we have, man-made high ground, how useful or significant could that be?

Mr. MAYFIELD. Everywhere I go I ask emergency managers what they're going to do with these high-rises, and you can go almost anywhere now, and see the development of the coastline, and when I ask them are they going to evacuate people from the many coastal areas, people living in these high rises, they always tell me yes, because they know in a major hurricane, they will know the power will be out, they will know the water systems will be inoperable, they don't want—there is no way they can take care of all these tens of thousands of people stuck in these high rises. I think that it would be, well it would be fairer to critique me here and say that this is not my area of expertise, I should stick to meteorology, but the truth is you have to care about these things, and in my opinion, and this is my personal opinion, there are some areas, like the New Orleans area, where the vertical—we like to call it vertical refuge—if you can't get people evacuated out, I don't believe you're going to have any other option other than to consider vertical evacuation, vertical refuge of last resort.

Senator VITTER. Let me switch gears for just a minute, but it is in terms of your work at NOAA.

One of your NOAA colleagues, Chris Lansy, had a difference of opinion with participants on the inter-governmental panel on climate change, which resulted in Chris Lansy resigning from the panel. The dispute apparently involved allegations that recent hurricanes were somehow attributable to climate change. Can you speak to that point?

Mr. MAYFIELD. I will do my best on that, I can't speak for Chris, but I know he is a first-class scientist, and my understanding of the issue there—and I totally agree with him—that the natural variability is far more important than the climate change that may or may not be going on related to hurricanes. The studies that I'm aware of on the climate change and the hurricane correlations, we don't really think the areas will change where the hurricanes form, we don't think that the numbers will change. There is one study from the Geo-physical Fluid Dynamics Lab in NOAA that says there could be an increase in intensity and rainfall by about 5 percent in about 80 years. The natural variability is so much larger than that in the active periods that we're in now, we average three and a half major hurricanes per year, those are the category three, four and five hurricanes on our Saffir-Simpson Scale, and the inactive periods, we only have one and a half major hurricanes, so you can go back for decades and see this natural variability.

I think that what we're doing now will serve us very well in improving the intensity of forecasting through numerical weather prediction, that will help us now and in the future. What really counts is where the hurricanes hit and how strong they are at landfall.

Senator VITTER. So, just to be clear on what happened, and I don't want to put words in your mouth, but he resigned from the project because there was a push to make more of a causal connection than he was comfortable with.

Mr. MAYFIELD. Senator, that's my understanding. And it was over the issue of the natural variability versus the climate change. By the way, there is no increase to the number of hurricanes on a global basis and I would think that no one should take one year and try to link that to climate change anyway.

Senator VITTER. Thank you, thank you, Mr. Chairman.

Senator DEMINT. Well, I want to thank the panel, this has been very helpful, I can assure you we're going to take all the information and do everything we can to assist you in your work. I will dismiss you and ask the second panel to take their seats so we can move along before the next vote.

Good afternoon, I want to thank this panel for being patient, I know you've had to wait a long time, and I think we're getting ready to lose one of our Senators here, and I wanted to make sure that Senator Vitter had an opportunity to introduce Dr. Mark Levitan.

Senator if you would like to do that, then I will handle some of the other introductions.

Senator VITTER. Thank you very much, Mr. Chairman. Mr. Chairman, Senator Nelson, I would like to introduce both of you to Mark Levitan. Not only is Mark the Director of the top hurricane center in the country, but he has an extensive background on the effect of storm winds, hurricane shelters, and evacuation and all of those issues. His work and that of the Center have been a great resource for my office, and I'm sure his testimony today will be very helpful to the Subcommittee. He is Director of the Louisiana State University Hurricane Center.

Mark, thank you for being here.

Senator DEMINT. Thank you, Senator. And I think Senator Nelson also has a guest he would like to introduce.

Senator BEN NELSON. Well, thank you, Mr. Chairman, and we're very happy to have Doug Ahlberg here today from Lincoln, Nebraska. He is the Director of the Lincoln-Lancaster County Department of Emergency Management, he was previously a captain of the Lincoln Police Department, retiring after 36 years in law enforcement, and became Director of the Lincoln-Lancaster County Department of Emergency Management in 1999. He is here today to share his expertise as someone who deals with severe weather and its aftermath on the local level, which I still believe will add a valuable perspective on this discussion on severe weather forecasting.

He has had a fairly recent and very vivid experience with severe weather that he will be able to share with us, having witnessed the aftermath of that tornado myself, I can attest to what a devastating tornado that was, it virtually destroyed an entire small town in Nebraska last summer. He made this disaster manageable because of his hard work, organization and dedication to helping the affected communities recover as quickly as possible. Everyone in Nebraska appreciates his efforts to keep our citizens safe. I might add that we have on more than one occasion hunted in Rushville County in Nebraska on the Don Forney ranch, and if Don is watching today and doesn't have anything else to do, we will both send him our regards.

Good to have you here, I appreciate it.

Senator DEMINT. Thank you, Senator, we also have Dr. Tim Reinhold. Dr. Reinhold is Vice–President for Engineering at the Institute for Business and Home Safety, and is appearing on behalf of the insurance industry. He is going to discuss the role the industry plays in reducing businesses and homes exposure to severe storms, and finally appearing before the Committee is Mr. Bill Walsh.

Mr. Walsh's official title is Director of Meteorology and Chief Meterologist for WCSC in Charleston. Really, he's known as the go-to guy in the Low Country when there is a severe storm. During his 19 years as a broadcast meteorologist in Charleston, he has seen the worst that Mother Nature has to offer, and the best that our neighbors have to give. When power was out for weeks after Hugo, it was Bill Walsh who was getting the word out to our communities on what they needed to do to recover. I'm confident he is going to provide important, helpful testimony, and with that, we will begin with you, Mr. Walsh, and as we said before, these lights will give you an indication of when you're running out of time, and I think it's about 5 minutes.

STATEMENT OF BILL WALSH, DIRECTOR OF METEOROLOGY/ CHIEF METEOROLOGIST, WCSC LIVE 5 NEWS

Mr. WALSH. Thank you, Mr. Chairman, very much and Members of the Subcommittee for inviting us up to talk here today about prevention and prediction, particularly when it comes to hurricanes, and in my view, the media—I've been a broadcast meteorologist in Charleston, South Carolina for 19 years this summer, and have guided our residents through many hurricanes, including one of the bellwethers, Hurricane Hugo in 1989, which we talked about with the 22 feet of storm surge water, in McClellanville, 135 mile per hour winds. Other noted storms include Hurricane Floyd in 1999, where hundreds of thousands were caught in a traffic jam that some called the 15 hour drive to nowhere, or the "Floyd Fiasco." And then there was last year, four hurricanes, three majors struck Florida, billions of dollars in damage and mass evacuations, South Carolina was also affected by those storms, with tornado damage in one storm, Charlie actually making a second landfall just up the road from our television station. So the threat is there, and always will be.

I want to talk today about three things—lessons learned from past storms and disasters, getting the word out, and the partnership between the media and the National Weather Service, and recommendations on what strategies are working to protect our citizens from Mother Nature's wrath.

First, lessons learned. We spent over 60 hours covering Hurricane Hugo's approach to South Carolina, but had no idea how long our coverage would have to last after the storm with no power for up to 3 weeks in some places, television and radio were the voices in the darkness. All of the stations in Charleston, ours included, dedicated 2 weeks plus of continuous coverage, commercial-free, for the aftermath of this giant, giant storm. Our simulcast on radio was key to that information flow. When people had no television, battery-powered radio was how people got their news. Radio was and is our partner when it comes to this kind of disaster, because the size of our news department and the power of the radio station are able, and were able at that time to bring people to the news they needed.

We learned that storm coverage is critical as a storm approaches for saving lives, but it is just as vital after a storm strikes, sometimes for weeks, to deliver needed information to the public from local, state and national officials. Hurricane Floyd also taught us a lesson, not only to South Carolina, but everyone in the Southeast Coast of our Nation. Evacuations are complex, and they take good planning and logistics. That evacuation was a disaster in itself because of a failed plan and poor execution, people in our state sat on our highways for literally 10 to 15 hours with no place to exit, no place to rest and were left with a bad taste in their mouths for the failure. From that, though our state learned and listened. Our new Governor, Mark Sanford, himself a coastal resident, brought together a team of people, including local officials, highway patrol officials, DOT officials, along with members of the media, including myself, to create a plan that would get people safely away from the coast, and invest in preparation. This new plan includes partnerships with local governments and the media, it includes video feeds of our states' most primary and secondary roads, car counters that measure traffic flow are also active and will be available on the web for citizens to actually look at the busy spots. One of the most important pieces of this new plan is the lane reversal operation which was drilled and actually tested before hurricane season, and actually put into effect last year for Hurricane Charlie. Also, small things, sometimes it is the small things, but small things like keeping the exits open for people to take rests or an alternate course, and pre-deployed road message signs for traffic updates, along with roadside port-a-potties for emergencies.

Information flow to the people is key to making all of this work and this partnership, which it is, with the state's media outlets gives officials a vehicle to get the word out. Floyd was a critical lesson learned, but from it, we now have new leadership and a plan that has been proven to work, and it worked last year. As a member of the Air Force Reserve, we always talk about readiness, and this crosses over to storm preparation and planning at all levels—national, state and local. Another lesson was in the slow FEMA response to Hurricane Hugo back in 1989. From that, though, FEMA has undergone many changes, and now it is a fast responder to people who may be left with nothing but their lives.

Second, getting the word out today, I'm very happy to report to you that there's no better relationship, in my opinion, between the media, and the fabulous people at the National Weather Service. The partnership between our voices carries to the citizen a word of warning when severe weather and hurricanes are going to strike. There's no place on the planet that has a better warning system for people to prepare and get ready for a possible disaster from weather. The Weather Service Forecast Offices, the National Hurricane Center and the Storm Prediction Center are vital to our national effort to defend against these killer storms. The media is also vital to get that message out and does so 24 hours a day and 7 days a week. We in the media spend millions of dollars every year on technology to protect our people and show them when danger is there. That technology includes computer models, Doppler radar systems, also owned by local media, instant crawl text systems, and so on. There's been some talk lately about fines levied by the FCC for stations that did not have closed captioning for the hearing impaired during severe weather events. It must be noted, however, that stations make a huge effort and investment in equipment to inform the public, severe weather happens in an instant and television response, along with the National Weather Service with the warnings and graphics to show where the danger is. We're responsible to all of our viewers, including the hearing impaired, and it should be recognized that while closed captioning is a wonderful tool we all use every single day, the FCC should also note that the full screen graphics and the maps, along with the crawling text at the bottom of the screen, is clearly another source for those viewers to read the information and see where the danger is, when a closed caption may be unavailable for technical or other logistical reasons.

Finally, strategies that work are rather simple—good planning, good dedicated people at all levels of government and media, as well as a citizen ready to act when the word is given. We in the media are responsible for getting the word out, our partnership with the Weather Service and state officials is just that—a partnership. We together have seen what works and what doesn't work. We in television forecast the weather and we inform the people with the best technology to back us up, and a strong partnership with the National Weather Service, together people are well-informed, and lives are saved.

Thank you so much, I'll take questions as needed.

[The prepared statement of Mr. Walsh follows:]

PREPARED STATEMENT OF BILL WALSH, DIRECTOR OF METEOROLOGY/CHIEF METEOROLOGIST, WCSC LIVE 5 NEWS

First, thank you very much for inviting me to come up and talk about disaster prevention and prediction, in particular, when it comes to hurricanes.

I've been a broadcast meteorologist in Charleston, South Carolina for 19 years this summer and have guided our residents through many hurricanes including one of the bellwethers, Hurricane Hugo in 1989 with 22 feet of storm surge water and 135 mph winds. Other noted storms include Hurricane Floyd in 1999 where hundreds of thousands were caught in a traffic jam that some call the "Fifteen Hour Drive To Nowhere . . . or The Floyd Fiasco."

Then there was last year. Four MAJOR hurricanes strike Florida, billions of dollars in damage and mass evacuations. South Carolina was also affected by those storms with tornado damage and one, Charlie, actually making a second landfall just up the road from our TV station.

So, the threat is there and will always be. I'm going to talk today about three things. Lessons learned from past storms and disasters, Getting the word out and the partnership between media and the national Weather Service, and recommendations on what strategies are working to protect our citizens from mother nature's wrath. Lessons Learned:

We spent over 60 hours covering Hurricane Hugo's approach to South Carolina, but had no idea how long our coverage would have to last after the storm. With no power for up to three weeks in some places, television and radio were the voices in the darkness.

All the stations in Charleston, ours included, dedicated two weeks of continuous coverage to the aftermath of this giant storm.

Our simulcast on radio was the key to that information flow. When people had no television, battery powered radio was how people got their news. Radio was and is our partner and with the size of our news staff and power of the radio station, we were able to bring the people the news they needed.

We learned that storm coverage is critical as a storm approaches for saving lives and that it is just as vital after a storm, sometimes for weeks, to deliver needed information for the public from local, state and national officials.

Hurricane Floyd also taught a tough lesson to everyone along the Southeast coast of our state and Nation. Evacuations are complex and take good planning and good logistics.

That evacuation was a disaster in itself because of a failed plan and poor execution. People in our state sat on highways for literally 10 to 15 hours with no way to exit, no place to rest and were left with a bad taste in their mouths for this failure.

From that though, our state learned and listened. Our new Governor, Mark Sanford, himself a coastal resident, brought together a team of people including highway patrol officials, DOT officials, along with members of the media including myself to create a plan that would get people safely away from the coast and invest in preparation.

This new plan includes partnerships with local governments and the media. It includes video feeds of our state's most primary and secondary roads. Car counters that measure the traffic flows are also active and will be available on the web for citizens to actually look at the busy spots. One of the most important pieces to this new plan is the lane reversal operation which was drilled and tested before hurricane season and actually put into effect last year for Hurricane Charlie. Also, small things like keeping exits open for people to take rests or alter their course and predeployed road message signs for traffic updates along with port-a-potties for emergencies.

Information flow to the people is key to making all this work and the partnership with the state's media outlets gives officials a vehicle to get the word out.

FLOYD was a critical lesson learned, but from it we now have new leadership and a plan that has been proven to work.

As a member of the Air Force Reserve, we always talk about readiness and this crosses over into storm preparation and planning at all levels; national, state and local.

Another lesson was the slow FEMA response to Hurricane Hugo. From that, FEMA has undergone many changes, but now is a fast responder to people that may be left with nothing but their lives.

Getting the Word Out

Today I'm happy to report to you that there is no better relationship, in my opinion, between the media and the fabulous people at the National Weather Service.

The partnership between our voices carries to the citizen the word of warning when severe weather and hurricanes are going to strike.

There is no place on the planet that has a better warning system for people to prepare and get ready for a possible weather disaster.

The Weather Service forecast offices, National Hurricane Center and the Storm Prediction Center are vital to our Nation's efforts to defend against killer storms.

The media is vital to get that message out and does so, 24 hours a day. We in the media spend millions of dollars every year on technology to protect people and show them when danger is there. That technology includes computer models, Doppler radar systems, and instant crawl text systems and so on.

There has been some talk lately about fines levied by the FCC for stations that did not have closed captioning for the hearing impaired during severe weather events.

It must be noted, however, that stations make a huge effort and investment in equipment to inform the public. Severe weather happens in an instant and television responds along with the national Weather Service with the warnings and the graphics to show where the danger is.

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We in the media are responsible for getting the word out. Our partnership with the Weather Service and state officials is just that . . . a partnership. Together we have seen what works and what doesn't work.

We in television weather focus on informing the public with the best technology to back us up and a strong partnership with our friends at the National Weather Service.

Together people are well informed and lives are saved.

Senator DEMINT. Thank you, Mr. Walsh, Dr. Levitan?

STATEMENT OF DR. MARC L. LEVITAN, DIRECTOR, LOUISIANA STATE UNIVERSITY HURRICANE CENTER/CHARLES P. SIESS, JR. ASSOCIATE PROFESSOR OF CIVIL AND ENVIRONMENTAL ENGINEERING

Dr. LEVITAN. Yes, good afternoon, and thank you for the opportunity to address the Subcommittee. I'm appearing today on behalf of Louisiana State University Hurricane Center, the American Association for Wind Engineering, American Society of Civil Engineers, and the Wind Hazard Reduction Coalition.

I was invited to provide testimony on three major areas. The role of the engineering research community in influencing building codes, the increasing exposure of coastal communities to hurricanes, and the impact of a major hurricane on the petrochemical facilities.

With regard to the role of engineering research, and influencing building codes, first and foremost we know that properly adopted and enforced building codes are very effective tools to reducing the hurricane damage. Studies underway and recently completed, even this past year from Florida, some conducted by my colleague Dr. Reinhold show that those building code changes are very effective. Also, there are some studies conducted by the LSU Hurricane Center that showed that in Florida, hurricane shelters that were built to the Florida Hurricane Shelter Enhanced Hurricane Protection Area Standard perform much better than other shelters that were not built to those standards. So, as an example of how engineering research gets into building codes and standards, let's consider the problem of wind-borne debris, and why is this important? Because wind-borne debris is one of the primary mechanisms by which windows and doors are broken out, and not only is it important to keep the windows and doors in place to keep the wind and debris out of the building or out of the home, but keeping the windows and doors in place also helps keep the roof on the structure by avoiding what we call the internal pressurization.

Several new research studies have been conducted in the past 2 years on the aerodynamics and trajectories of wind-borne debris, some of that work at LSU, sponsored by the Louisiana Sea Grant College Program. This research included wind tunnel studies, storm damage analysis after some of these storms and computational studies, and all of these studies seem to show results that the debris accelerates faster than had been previously thought. So when the roof of the neighbor's house starts coming apart, and the two by fours and the sheets of plywood are starting to come off, that those accelerate and they pick up speed much more rapidly than previously thought.

Now, why is that important? Because that goes to what are the appropriate test standards that we use for debris impact—windows, doors and shutter systems—so that information now is being translated into the building codes and standards. The first one at the moment, we're developing a national standard for the design and construction of storm shelters, which addresses tornado shelters, hurricane shelters, shelters that you would put inside of a residence, as well as community shelters, so improving, having the better knowledge of how fast and far that debris will fly will help us improve the test standards and help improve the safety and survivability of those types of structures.

On a broader scale, the American Society of Civil Engineers produces a national standard which is used for wind loads on buildings called the ASCE–7. This standard is updated every few years to reflect new research, as well as address lessons learned from previous wind storms, but one of the major problems with this is the lack of funding for the applied research necessary to take some of the work done in the laboratory and convert that into codes, standards and improved design and construction practices. With regard to the question of increasing the exposure of coastal communities to hurricanes, as the coastal populations boom and development is booming in the hurricane coast, particularly in the Southeast United States where populations are growing much faster than the evacuation capacity of the major transportation networks.

So what that means is people will be required to seek shelter locally either in their own homes, the neighbors homes, businesses or local shelters, and so how do those people know? We have to be able to provide through building codes and other methods, safe places for those people to stay during the storm.

Another important question for the emergency management community to answer is how do those people know if the building that they're in is any safer or not? During Hurricane Lilly, I live in Ascension Parish southeast of Baton Rouge, and Hurricane Lilly, the category four storm coming in, the message that came over the emergency broadcast system was, "If you live in Ascension Parish and if you don't feel safe in your own home, please go to the public shelter that we opened." Well, how does the homeowner know if he should feel safe or not in his own home? The engineering community needs to do a better job and the Weather Service communities needs to refine some of those messages, perhaps, to give the homeowners and residents more information about where they may be safest to stay.

We also desperately need to work on plans of last resort for when things go wrong. A couple of quick examples during Hurricane Isadore in 2002, rainfall flooding as the storm was still over Mexico, rainfall flooding choked off Interstate 10 westbound, the single most important evacuation route out of New Orleans, that was 3 days before the storm made landfall. From Hurricane Lilly, which was approaching Louisiana 1 week later, the storm rapidly intensified to a Category IV storm and potentially it looked like it was starting to move further east, and at that time, during that night, we were trying to work with the state to develop some last resort refuge plans of what buildings could we use for a vertical refuge, and that's obviously too late to be doing that. We desperately need to work and there needs to become a standard part of the emergency planning system is what to do when things go wrong, and have a plan of last resort.

The last issue is addressing the impact of a major hurricane on petrochemical facilities and I'm afraid that we don't have much in the way of answers for that, mostly questions. Partly the answer is, the effects on the petrochemical industry are going to be very uncertain, but generally much larger than is understood in the industry and engineering communities. As we know from some recent hurricanes, Hurricane Hugo, that devastated a major refinery in St. Croix, and Hurricane Georges in 1998, that devastated one in Mississippi, we know that hurricanes, major hurricanes do have the potential to significantly impact petrochemical facilities.

In summary, I think we need to do a better job, particularly in the engineering community of working more closely with emergency management and meteorological communities in collaboration, particularly in the hurricane preparedness and response, which oftentimes has primarily been the role of the emergency management community, and second, we need to do a better job of taking the research from the laboratory and getting it out into practice, and the major problem and the major problems there is the lack of funding for the applied type research to be able to do that, and this is one area where the National Windstorm Hazard

Reduction Program authorized last year would help provide some funding to be able to give those answers. Thank you.

[The prepared statement of Dr. Levitan follows:]

PREPARED STATEMENT OF DR. MARC L. LEVITAN, DIRECTOR, LOUISIANA STATE UNIVERSITY HURRICANE CENTER/CHARLES P. SIESS, JR. ASSOCIATE PROFESSOR OF CIVIL AND ENVIRONMENTAL ENGINEERING

Good morning and thank you for the opportunity to testify. I am Dr. Marc Levitan, I am the Director of the Louisiana State University Hurricane Center and the Charles P. Siess Professor of Civil and Environmental Engineering at Louisiana State University. I am also the elected President of the American Association for Wind Engineering and a member of the American Society of Civil Engineers.

I am appearing today on behalf of the Louisiana State University Hurricane Center, the American Association for Wind Engineering, the American Society of Civil Engineers and the Wind Hazards Reduction Coalition.

The Louisiana State University Hurricane Center. Louisiana State University is the flagship institution of the state, classified by the Carnegie Foundation as a Doctoral/Research-Extensive University. The university has a long history of research in hurricanes, coastal sciences and engineering. The LSU Hurricane Center was founded and approved by the Louisiana Board of Regents in the year 2000 to provide a focal point for this work, with a mission to advance the state-of-knowledge of hurricanes and their impacts on the natural, built, and human environments; to stimulate interdisciplinary and collaborative research activities; to transfer new knowledge and technology to students and professionals in concerned disciplines; and to assist the state, the Nation, and the world in solving hurricane-related problems. Research efforts that have been translated into practice in support of emergency management agencies include: implementation of real-time storm surge modeling; improvements in hurricane evacuation planning and operations (particularly contraflow evacuations), and improvements in hurricane shelter analysis and design methods.

The American Association for Wind Engineering (AAWE) was originally established as the Wind Engineering Research Council in 1966 to promote and disseminate technical information in the research community. In 1983 the name was changed to American Association for Wind Engineering and incorporated as a non-profit professional organization. The multi-disciplinary field of wind engineering considers problems related to wind and associated water loads and penetrations for buildings and structures, societal impact of winds, hurricane and tornado risk assessment, cost-benefit analysis, codes and standards, dispersion of urban and industrial pollution, wind energy and urban aerodynamics.

Founded in 1852, the American Society of Civil Engineers (ASCE) represents more than 125,000 civil engineers worldwide and is the Nation's oldest engineering society. ASCE members represent the profession most responsible for the Nation's built environment. Our members work in private practice, industry, government and academia. ASCE is an American National Standards Institute (ANSI)-approved standards developer and publisher of the Minimum Design Loads for Buildings and other Structures (ASCE–7), which is referenced in the Nation's major model building codes. As part of the ASCE–7 document, engineers are provided guidance in estimating the loads resulting from wind effects on structures. Thus, ASCE is at the forefront in the development of new information for engineers regarding wind and is in a unique position to comment on the status quo and our needs for the future.

The Wind Hazard Reduction Coalition currently represents 23 associations and companies which are committed to the creation of a National Wind Hazard Reduction Program (NWHRP) that would focus on significantly reducing loss of life and property damage in the years to come. The Coalition includes professional societies, research organizations, industry groups and individual companies with knowledge and experience in dealing with the impact of high winds.

Problems and Solutions

All 50 states are vulnerable to the hazards of windstorms. Just last year, four hurricanes made landfall in Florida and caused severe damage. Losses from the 2004 hurricane season are estimated to exceed $40 billion to date and are still being counted. These storms resulted in 27 Federal disaster declarations covering 15 states, the Virgin Islands and Puerto Rico. In 1998, hurricanes, tornadoes and other wind related storms caused at least 186 fatalities and more than $5.5 billion in damage. During the week of May 4–10, 2003, a record 384 tornadoes occurred in 19 states, including Kansas, Missouri, Oklahoma and Tennessee resulting in 42 fatalities. On May 3, 1999, more than 70 violent tornadoes struck from north Texas to the Northern Plains. Forty-one people died and more than 2,750 homes were damaged. In 1992, Hurricane Andrew resulted in $26.5 billion in losses and 61 fatalities, in 1989, Hurricane Hugo resulted in $7 billion in losses and 86 fatalities and in 1999, Hurricane Floyd resulted in more than $6 billion in losses and 56 deaths.

One major effort currently underway to reduce the loss of life and injuries in hurricanes and tornadoes is the development of a national standard for storm shelters. The International Code Council (ICC) and National Storm Shelter Association (NSSA), with support from the Federal Emergency Management Agency (FEMA), are currently developing the ICC/NSSA Standard for the Design and Construction of Storm Shelters. The purpose of the standard is "to establish minimum requirements to safeguard the public health, safety, and general welfare relative to the design, construction, installation, repair, operation and maintenance of storm shelters constructed for refuge from high winds associated with tornadoes and hurricanes." Scheduled to be completed next year, this consensus national standard has the potential to significantly improve shelter safety.

In tornado-prone areas, the Storm Shelter Standard could be particularly helpful with regard to assuring a minimum level of performance for manufactured residential shelters, i.e., providing a basic consumer protection. The biggest immediate impact of the standard in hurricane-prone areas will likely be for community shelters. This is because the majority of buildings currently used as public hurricane shelters are inadequately constructed to resist an intense hurricane, placing the occupants at risk. This fact was demonstrated during the 2004 hurricane season in Florida. Supported by the ICC and Louisiana Sea Grant—LSU Hurricane Center researchers spent time in the field after Hurricanes Charley and Ivan, investigating performance of hurricane shelters. Of the two dozen shelters surveyed, those built to Florida's Enhanced Hurricane Protection Area (EHPA) criteria outperformed shelters not built to those criteria. Damage to EHPA facilities was generally limited to minor water leakage. In other facilities, roof damage and water penetration serious enough to cause people to evacuate the shelter space was not uncommon.

Publication of the standard alone will not improve shelter safety though; it is just the first step in the process. Unless it is adopted and enforced by jurisdictions having authority over building construction, or voluntary compliance with the standard is requested or agreed to by the facility owners, the standard will have little impact. Therefore, a significant awareness and education campaign will be needed. It must be addressed to architects, engineers, building officials, shelter owners (e.g., homeowners, school boards, city governments) and shelter operators (e.g., American Red Cross, emergency management agencies).

One of the biggest challenges facing design of public hurricane shelters is that shelter operators are not the owners of the shelter facilities and are rarely involved in the planning and design process. When faced with tight budgets and many competing needs, spending additional construction dollars to harden the facility for use as a hurricane shelter is usually a low priority with the facility owner, even though the owner is often a public entity and tax dollars are funding the construction of the new school or municipal building. Unless able to obtain a mitigation grant from FEMA or perhaps a state agency, the local government or the school district generally has to bear the increased construction costs associated with constructing the facility for dual use as a shelter. This is an area where additional engineering research and technology transfer is crucial—improving cost-effectiveness of storm shelters.

Another hurricane sheltering issue relates to getting the message out about who should be going to shelters and who should be advised to shelter in place. Emergency managers generally only order mandatory evacuations for areas subject to significant hurricane flooding. This is done in order to make sure there is sufficient transportation system capacity available for people in the most at-risk areas. As coastal population growth continues to outpace construction of new highway infrastructure—more and more people will not be able to evacuate and need to seek shelter in their own residences or other local facilities. The National Weather Service, National Hurricane Center and television media do a comparatively good job of informing the public about the hazards they can expect with the approaching storm, but what information do people have about the relative safety of their home or business or shelter, so that they can make an informed decision about where is the safest place? If they are under a voluntary or precautionary evacuation warning, should they leave or stay? This is an area where better coordination and collaboration between the engineering community, emergency management community, and meteorology community is desperately needed.

Catastrophic hurricane planning is another area where much additional work and collaboration between the different professional communities is needed. Hurricane Georges in 1998 and Hurricane Ivan in 2004 both had the potential to drown the city of New Orleans and much of the surrounding southeast Louisiana under 10–20 feet of water. Estimates are that only 50–60 percent of the residents evacuated for these storms, meaning over half a million people were at significant risk. Warned or not, if people have not evacuated and the water comes, there will be mass fatalities. Last year the Louisiana Office of Homeland Security and Emergency Preparedness and FEMA (and many other Federal and State agencies) conducted a week-long joint planning exercise on how to respond and recover from just such a scenario. This event helped produce the first catastrophic hurricane response plan, but it also raised more questions than it answered.

Hurricane Lili in 2002 raised similar fears. As the Category 4 hurricane approached the Louisiana coast on the evening of October 2, it appeared to begin moving farther east than had been predicted, into areas that had not been as well evacuated. Frantic preparations began to start identifying buildings to serve as refuges of last resort. Fortunately the storm returned to its more westerly track and rapidly lost strength before making landfall, and Louisiana dodged another bullet. This event highlighted the importance of plans of last resort—for situations where a storm makes an unexpected turn close to shore or rapidly intensifies, as Hurricane Opal did in 1995 when it accelerated and explosively intensified overnight to unexpectedly threaten the Florida panhandle.

Hurricanes also have impacts well beyond the regions where they make landfall. Price and availability of construction materials across the country are adversely affected by major storms such as Hurricane Andrew and the Hurricanes of 2004. Hurricane Ivan significantly disrupted offshore oil and gas production and transportation in the Gulf of Mexico, impacting energy prices nationwide. Fortunately, none of last years hurricanes impacted the onshore. This is another area of significant concern.

A study of industry practices published in 1997 by ASCE found that the wind resistant design of onshore refineries and petrochemical plants varied tremendously due to the aerodynamic complexity of the types of structures involved and the lack of coverage of these types of structures in any building codes or standards. An unexplored aspect of this report is that many industrial plants do not understand how vulnerable their processing and storage facilities may be to extreme winds. Many plants specify a wind speed to which their facilities should be designed, but because of uncertainties in how the wind interacts with the complex structures, the actual wind the structure can resist might be much larger or smaller. In practical terms—the actual design strength may be more than one Saffir-Simpson Hurricane Category less than or greater than the intended design. In most cases the owners/operators of the facilities are unaware of this discrepancy, which is very important considering that decisions on whether to shut down a plant are generally based on the expected Hurricane Category at landfall. Additional study is needed to further define this problem, and cooperation with this industry and the preparedness/response community.

The problems and solutions described so far are just a few examples of areas in which more work and closer coordination is needed between industry, government, and the engineering community. The United States currently sustains billions of dollars per year in property and economic loss due to windstorms. The Federal Government's focus has been one of response and recovery, not mitigation. While there will always be a need, a sustained focus on hazard mitigation can lessen the cost in life and property of these events.

With the average annual damage from windstorms at more than $6 billion, the current $5–10 million Federal investment in research to mitigate these impacts is inadequate. In contrast, the Federal Government invests over $100 million per year in reducing earthquake losses through the National Earthquake Hazards Reduction Program, a program that has lead to a significant reduction in the effects of earthquakes. A Federal investment in wind hazard reduction would pay similar or greater dividends in saved lives and decreased property damage.

Near-surface winds are the most variable of all meteorological elements, making the prediction and control of their impacts all the more challenging. In the United States the mean annual wind speed is 8 to 12 mph, but wind speeds of 50 mph occur frequently throughout the country, and nearly every area occasionally experiences winds of 70 mph or greater. In coastal areas of the East and Gulf coasts, tropical storms may bring wind speeds of well over 100 mph. In the middle of the country, wind speeds in tornadoes can be even higher.

Unfortunately, reducing vulnerability to wind hazards is not just a question of developing the appropriate technical solution. Wind hazards are created by a variety of events with large uncertainties in the magnitudes and characteristics of the winds. The relevant government agencies and programs, as well as the construction industry are fragmented. Finally, implementation requires action by owners and the public, who may not consider hazard reduction a high priority. Solving wind vulnerability problems will require coordinated work in scientific research, technology development, education, technology transfer and public outreach.

In 1993, the National Research Council (NRC) published a report entitled "Wind and the Built Environment." The report included the recommendations of the Panel on the Assessment of Wind Engineering Issues in the United States. The panel recommended the establishment of a national program to reduce wind vulnerability. Such a program would include wind research that draws upon the expertise of both academia and industry and addresses both structural and nonstructural mitigation methods, an outreach program to educate state and local governments on the nature of the wind risks they face, a conscious effort to improve communication within the wind community and a commitment to international cooperation in wind-engineering.

A 1999 NRC study concurred with that recommendation and specifically urged Congress to designate "funds for a coordinated national wind-hazard reduction program that encourages partnerships between Federal, State and local governments, private industry, the research community, and other interested stakeholders."

In 2003, the Rand Corporation released a report entitled, "Assessing Federal Research and Development for Hazard Loss Reduction." Specific recommendations for a research and implementation program are contained in the report released by the American Association for Wind Engineering and the American Society of Civil Engineers entitled "Wind Engineering Research and Outreach Plan to Reduce Losses Due to Wind Hazards." Both reports support programs which would encompass four focuses:

- Understanding of Wind Hazards—developing a greater understanding of severe winds, quantify wind loading on buildings, structures and infrastructure and developing wind hazards maps;
- Assessing the Impact of Wind Hazards—assessing the performance of buildings, structures and infrastructure under severe winds, developing frameworks and tools for simulations and computer modeling and developing tools for system level modeling and loss assessment;
- Reducing the Impact of Wind Hazards—developing retrofit measures for existing buildings, structures and infrastructure, developing innovative wind-resistant technologies for buildings, structures and infrastructure and developing land measures and cost effective construction practices consistent with site-specific wind hazards; and
- Enhancing Community Resilience, Education and Outreach—enhancing community resilience to wind hazards, effective transfer to professionals of research findings and technology and development of educational programs and public outreach activities.

From these reports and the efforts of a number of Senators and Members of Congress, as well as the Wind Hazards Reduction Caucus, the National Wind Storm Hazards Reduction Program was born. Created by Public Law 108–360, the legislation represents five years of work in which stake holders representing a broad cross-section of interests such as the research, technology transfer, design and construction, and financial communities; materials and systems suppliers; state, county, and local governments; the insurance industry, have participated in crafting this legislation. This bill represents a consensus of all those with an interest in the issue and a desire to see the benefits this legislation will generate.

Among the potential research areas this program can explore are the numerous areas where we lack the knowledge to make informed judgments with respect to building siting and design. With data learned from research in the following areas, and others not yet foreseen, better knowledge and data will lead to cost-effective design and construction practices to mitigate the impacts of high winds.

Boundary Layer Meteorology for Landfalling Storms—We know very little about the structure of the wind in a hurricane and how it changes as it passes over land. Research is needed to better understand the nature of boundary layer transitions, turbulence, rainfall, and decay rates as storms move inland. The design wind speed and gust factors used in all building codes and standards (including ASCE 7) are based on a set of assumptions that hurricane winds have similar properties to winds from other events, which we know to be untrue. This research can lead to significant improvements in wind-loading related portions of our building codes and standards.

Rapid Damage Assessment using Remote Sensing for Improved Response and Recovery—The key to optimization of response and recovery operations is timely access to detailed information on the extent and intensity of damage throughout the effected areas. Very high resolution data can be obtained from commercial satellite-based remote sensing systems, which was previously unavailable except to intelligence and defense communities. Resolutions have improved to the point where data is available on individual buildings and vehicles. Development of computerized analysis tools that automate and map damage assessment estimates will significantly assist response and rescue and recovery operations.

Improved Connections and Framing Systems for Light Frame Construction—Much of the structural damage which occurs in severe winds is to light frame one- and two-story construction. There has been relatively little improvement in wood and other light framing technology in the past 20 years. New cost-effective construction techniques could significantly reduce structural damage to low-rise buildings.

Roof System Testing Procedures and Devices for Wind Resistance—No standardized testing procedures and devices exist to test roof cladding materials for resistance to extreme winds and debris. Development of these items is a necessary prerequisite for improved roofing performance (see next item).

New Roofing Systems—Damage to roofing is perhaps the single most common source of wind damage. Even small failures can allow the wind and rain inside the building leading to significant interior and contents damage and possible structural failure. Development of new wind-resistant roofing materials and technologies could significantly reduce wind-induced damage.

In-Residence Shelters for Hurricane Protection—In collaboration with the university research community, FEMA has conducted research and developed plans and guidelines for in-residence shelters for protection from tornadic winds. These designs provide near complete protection for occupants from even large tornadoes, but are too costly and overly conservative for use on hurricane coast. New research is needed to find more appropriate and cost effective solutions for construction on the hurricane coast.

Dual-Use Public Hurricane and Tornado Shelters—Schools are the most commonly used buildings for hurricane evacuation shelters, but they are not structurally designed to provide a safe haven. Similarly, children shelter in place while in school during tornado warnings, but these buildings too are not designed with adequate protection. Research and development of design guidelines and methodologies on how best to construct schools and other public buildings for dual function as shelters from hurricanes and tornadoes is desperately needed.

Retrofit Technologies for Wind Resistance—Although it is much easier to build wind resistance into new construction, the country has an enormous investment in existing building stock. Technologies for cost-effective retrofits to improve wind resistance of these buildings should be an important focus of any new research program.

Congress has taken action to establish a program to mitigate the impact of severe windstorms. What is needed in the immediate future is funding for the new program. I would urge Members of the Subcommittee to work with your colleagues in the Appropriations Committee to ensure that the Windstorm Hazards Reduction Program can begin the work it was designed to do. For Fiscal Year 2006 the program is authorized for $22.5 million dollars in spending, spread over four agencies. Specifically, the law authorizes:

- $8.7 million for the Federal Emergency Management Agency;
- $3 million for the National Institute of Standards and Technology at the Department of Commerce;
- $8.7 million for the National Science Foundation; and
- $2.1 million for the National Oceanic and Atmospheric Administration.

Once again, thank you for the opportunity to present the views of the many organizations I am representing here today. I would be happy to answer any questions that you might have.

Senator DEMINT. Thank you, Dr. Reinhold?

STATEMENT OF TIMOTHY A. REINHOLD, PH.D., VICE PRESIDENT OF ENGINEERING, INSTITUTE FOR BUSINESS & HOME SAFETY

Dr. REINHOLD. Thank you, Mr. Chairman, Members of the Committee and ladies and gentlemen, it's a pleasure to be here and have an opportunity to discuss some of the issues that we share in common, relative to trying to predict and to prevent the disasters that we all face when some of the natural events that will occur and can occur, do occur. And we're clearly not doing a good enough job in terms of building our homes and our businesses to provide the resiliency within our community so that they can weather these storms without the kind of distress we've seen most recently in Florida, but we have seen it in most every other state when these major events occur.

What we're seeing in the most recent events is very clearly that moving to a better building code is making a huge difference in the way people can pick up the pieces and move on after the storms. We've done a very good job in terms of improving the structural resistance of our buildings, but we've still got some serious problems in terms of water penetration and the other issues that come in when water gets in the house. When you have ceilings collapsing, people say it's great that you've helped me keep my house together, it would be really nice if I could live in it after the storm goes through, so we've got some disconnects there, we're making progress, but we've got some other issues that we really need to deal with. The insurance industry has certainly been a partner in this in trying to help move things forward, and there are several initiatives that we're involved in that I think will help along this. And it's based—the insurance industry provides a lot of that spreading of the risk and providing the resources to help communities and individuals rebuild after storms. In the previous year we had 1.7 million claims in the State of Florida, one in five homeowners had a claim in the State of Florida, and a total of $20 billion worth of insured losses, something that rivals Hurricane Andrew, and yet the insurance industry came through it in better shape in terms of being able to respond. We didn't have companies going bankrupt like we did after Hurricane Andrew, we did not have people not being able to respond in quite the same way, I think there was one company that got into trouble or went bankrupt as a result of the storms this last year, and most have been able to respond in a fairly timely fashion in closing files and reacting with the population. With that number of files, it certainly took a long time, and people are still recovering and having a difficult time finding contractors. There are people still in Port Charlotte, Punta Gordo area that are facing a year wait to get a contractor to be able to come in and rebuild their home. Next to them would be other homes and businesses built to the latest building codes that as soon as power was restored, they were up and running, and life was almost back to normal. And so as you walk through the areas, you were able to see that difference.

One of the things that we did do this last year, is we hosted a group from Louisiana, including the Insurance Commission and others to come into the State of Florida and showed them firsthand the performance and the benefits of having strong building codes. There are so many states right now in so many communities that don't have any building code, or have adopted a weakened version of our model building codes that put the residents at risk when these kind of events occur, and so consequently, one of our big initiatives and interests is in trying to incentivize the state to go to statewide building codes and to do adequate enforcement and adoption, because it is much cheaper to make that change in the new construction and to build it in to start with, rather than to come back and do it as a retrofit afterwards. A lot of my career at Clemson University over the last few years was spent in trying to develop practical ways of retrofitting homes, and I know how expensive and how difficult it can be to try to do that. So there's a challenge in trying to come up with these practical ways, there's research that is needed, there are ways that we need to make progress in terms of helping people make good decisions about, given the state of your house and the status of that, what are the most economical and most beneficial things you can do to improve your home and bring it up closer to your neighbors that have a new home built to the latest codes. I think one of the most interesting things for me in going around after the storms last year, was actually seeing how well some of the new manufactured housing units fared in the storms. In 1994 after Hurricane Andrew when a number of us who were involved in investigating the damage after Hurricane Andrew said, if you keep building manufactured housing the way you're building it today, in a storm like Andrew, you have got to consider it expendable, it's going to be gone. And we saw that widespread in Punta Gorda, Port Charlotte, where Hurricane Charlie hit and where the winds were higher than any storm since Andrew to hit the United States, we found manufactured homes built to the latest standards that were adopted after 1994 that were basically unscathed, or structurally quite sound. Some of them were beat up by the debris flying off of other homes around them, but overall, it was very clear that the codes were making a major, major difference there. And so we're interested in the Federal Government helping to incentivize the process of trying to get building codes adopted broadly across the country, we think there are opportunities in terms of providing incentives for people when they're buying a home and taking out loans to do mitigation measures then when there is possibly more dollars available than you can put on the table by rolling things into your mortgage and so forth, maybe Fannie Mae and others can help with some of that process.

[The prepared statement of Dr. Reinhold follows:]

PREPARED STATEMENT OF TIMOTHY A. REINHOLD, PH.D., VICE PRESIDENT OF ENGINEERING, INSTITUTE FOR BUSINESS & HOME SAFETY

Chairman DeMint and Members of the Subcommittee, my name is Tim Reinhold, and I am the Vice President of Engineering for the Institute for Business & Home Safety (IBHS), which is a nonprofit initiative of the U.S. property and casualty insurance industry with a mission to reduce deaths, injuries, property damage, economic losses and human suffering caused by natural disasters. We are an organization dedicated to natural hazard loss reduction, and very much involved in windstorm impact reduction in our related efforts in:

- Research
- Communications
- Outreach
- Building code development and adoption
- Data collection and analysis
- Promotion of incentives for mitigation and disaster resistant construction

It is clear that this Committee and IBHS have significant areas of common interest. Over the past decades, we have seen dramatic drops in the loss of life in hurricanes due to better warning and evacuation. However, we have also seen dramatic increases in property losses as our Nation concentrates more and more of its population and wealth along our vulnerable coastlines. With this rapid growth in population, we are certainly not immune to a large loss of life in a future event. Many experts are concerned that a fast developing and fast moving storm could produce a large loss of life among people trapped in traffic jams associated with attempts to evacuate too many people in too short a time. To counter this risk and the dramatic increases in property losses, we desperately need to build stronger and safer homes and businesses so that coastal inhabitants who are not in vulnerable structures or in inundation areas will not need to evacuate and so that the resiliency of our communities is dramatically improved. Ultimately, we are not likely to be able to provide enough evacuation capacity and warning time to handle the demands, if population growth continues unabated, and many would argue that we have already passed the point where mass evacuation is viable in a large number of vulnerable areas.

The Committee has asked me to focus my testimony on the role of the insurance industry in reducing the exposure of individuals and businesses to the impact of windstorms, IBHS's work to promote disaster resistant technologies, any barriers to the adoption of these technologies, and a discussion and presentation of any cost-benefit analysis of disaster resistant technologies.

The Role of the Insurance Industry

First and foremost, the insurance industry provides the primary mechanism for sharing risk and accumulating resources needed to help individuals and businesses recover from the impact of windstorms. It is clear from the experience of the 2004 hurricane season that the insurance industry has come a long way since the upheavals caused by Hurricane Andrew in 1992. In the aftermath of Andrew, a number of companies or at least their Florida subsidiaries were rendered insolvent and several companies were bankrupt. In 2004, despite the fact that one in five Floridians filed a claim (three times the number of claims filed after Hurricane Andrew) and total claims exceeding $20 billion (about the same insured losses as Hurricane Andrew, in 2004 dollars), only one company went bankrupt. A significant reason for this improved performance is related to the better understanding of all of the issues surrounding responding to major and widespread windstorm impacts, to better preparation of catastrophe teams, and to better modeling of the risks.

The improved modeling offers exciting possibilities for support of windstorm mitigation efforts. This modeling is occurring within the Federal sector, through FEMA's HAZUS–MH, and within the private sector, through efforts of various modeling companies that provide services to the insurance and reinsurance companies. A major focus of the modeling efforts in both the Federal and private sectors has been on predicting damage and losses for large portfolios of property and infrastructure. This helps emergency managers plan and organize response efforts, secure needed supplies and stage resources. It helps insurers in quantifying their risks to help them make better business decisions. The loss estimates produced by these catastrophe models are also used by insurers to help them set reserves, determine the need for reinsurance and provide input for setting appropriate premiums. Real time analyses also help insurers plan and stage their resources to facilitate rapid response through adjusting and settling claims in the days and weeks following a major windstorm disaster.

The laws of large numbers have made the applications listed above a somewhat easier task than the prediction of the performance of an individual structure and the associated benefits of a specific mitigation measure. Nevertheless, the modelers are tackling the individual property and mitigation issue and making progress in their predictive capabilities for these cases. Insurers are using the results of these models along with available post-storm evaluations to negotiate rates and incentives for mitigation measures in Florida policies.

In 2000, the Florida Windstorm Underwriting Association (now known as Citizens Property Insurance) increased their rates dramatically (200–300 percent) as they introduced a class plan whereby buildings insured through the wind pool could be inspected for wind resistant features and thereby qualify for mitigation related discounts. Under this plan, homes can qualify for up to a 70 percent discount if they contain all the mitigation features considered by the program. This case clearly shows the kind of dynamics at work in this process. As risks are better defined, more vulnerable properties receive less favorable treatment and less vulnerable properties receive more favorable treatment.

Insurance policies issued in Florida currently consider mitigation features as a factor in the rating of a home for insurance. With the implementation of the latest version of the Florida Building Code in 2002, all insurers in the state were required to recognize the hurricane resistive features of the codes in future rate filings in the state. The result is lower insurance premiums for homes that are built in accordance with this stronger new building code as compared to older more vulnerable homes. The wind resistive features that insurers are required to give credit for include: opening protection (storm shutters), roof to wall connections, roof deck connections and roof covering type.

In addition to Florida, the Texas Department of Insurance mandates insurance discounts for homeowners that have impact resistant roofing products installed on their homes in this hail prone state. In the Dallas, TX, area, consumers can see as much as a 25–30 percent decrease in their premiums for using these products on their roofs.

Note that because of the regulated nature of rates in nearly all states, this is a process that is negotiated between individual companies and the regulators.

It must be emphasized that insurance related incentives are only one of the ways to promote better construction and mitigation of existing buildings. In general, it is hard to motivate homeowners to spend thousands of dollars on upgrades or retrofits to save hundreds of dollars a year on insurance. Where I used to live in Clemson, South Carolina, a reduction of my entire insurance premium would not have been enough financial incentive for me to retrofit my house. When I re-roofed my house in Clemson, I did strengthen my roof, but I did it for reasons other than a cold fiscally based benefit-cost calculation.

To be effective, incentives need to go beyond those offered by or required of the insurance industry. Buildings that survive windstorms unscathed are a benefit to their communities. People can stay in their homes, businesses can remain open and people can continue to go about their lives with minimal disruption. These people are also likely to not be victims, and will not require any government assistance to recover from a disaster since their impact would be minimized.

Because of the far reaching effects of mitigation, IBHS believes that incentives for windstorm mitigation need to go beyond just insurance and include things like tax breaks, mortgage rate or fee incentives, and incentives from businesses within the community. We need to adequately recognize the role that wind resistant construction of homes and businesses play to keep the community alive and well throughout these events. If homes are destroyed, then workers will not be able to come to work and if businesses are destroyed, then workers will not have employment to go to. The interconnections run deep and it is critical that we address strengthening of all elements of the fabric of our communities. Fully one quarter of small businesses that close following a disaster do not reopen. Some communities such as Homestead, Florida, are just now recovering from Hurricane Andrew.

IBHS Works to Promote Windstorm Disaster Resistance

The majority of IBHS activities relating to windstorm impact reduction involve applying research and development that has been conducted by universities, Federal agencies and construction industry related trade associations. The goal of these activities is to understand, communicate and implement the latest knowledge on windstorm mitigation into the work of the organization. These activities include:

- Maintaining a series of consumer focused guides and brochures that relate to a wide range of natural disasters including windstorms.
- Maintaining a website with publicly available information on natural disaster mitigation, including windstorm damage mitigation.
- Developing two interactive web-based programs to help home and business owners develop customized pre-disaster mitigation plans and post-disaster recovery plans, as well as identify home structural improvements.
- Serve as a technical resource for our member insurance companies to help them better understand technical aspects of windstorm mitigation.
- Support the improvement of building codes with regard to natural disaster damage mitigation on behalf of our member insurance companies.
- Support the adoption of the latest model building codes at the state level and working to ensure that they are not weakened by local amendments.
- Participate in the development of the ASCE 7 wind provisions that are the basis for wind loads in the current model building codes.
- Establish statewide coalitions for natural hazard loss reduction that incorporates land use planning emphasis in mitigation activities among multiple state and local government agencies.

Over the past few years, IBHS has worked with a number of universities including Clemson University, the University of Florida, Florida International University, Texas Tech University, Louisiana State University, and Colorado State University to stay abreast of current research and information. Similarly, IBHS works with FEMA on flood and wind related retrofit issues as well as the Department of Energy through Oak Ridge National Labs as a part of the Roofing Industry Committee on Weather Issues (RICOWI). IBHS also has working relationships with several construction and testing related trade associations including APA, the Engineered Wood Association, the National Roofing Contractors Association, and Underwriters Laboratories.

IBHS is a strong and consistent advocate of the adoption and enforcement of national model building codes and standards. We work with our member companies, emergency managers, building officials, civic leaders and code officials to build coalitions that will endorse and support the adoption of statewide building codes. We understand the power and effectiveness of a strong well enforced building code to protect homes and businesses. We seek to establish incentives for states and communities to adopt the latest model building codes, without local amendments that would weaken the disaster mitigation measures. The Federal Government can help incentivize the statewide building code adoption process by increasing pre- and post-disaster mitigation funds for those states that do adopt up-to-date model building codes and promote adequate enforcement of these codes.

However, we also understand that the building code is the minimum capacity required (the poorest quality home you can legally build) and we are actively promoting code + construction through our Fortified . . . for safer living® new construction program. This program is small but growing. We recently entered into agreements for a development of 600 to 800 homes in the panhandle of Florida, and another development of approximately 60 homes in the Myrtle Beach, South Carolina area where every home will be a Fortified . . . for safer living® home. One of our member companies is planning to file a rate reduction for the Fortified homes in South Carolina.

During the 2004 hurricane season, IBHS provided technical support to Clemson University, the University of Florida and Florida International University in the deployment of instruments to measure wind speeds and wind pressures on houses. This data has provided much needed surface measurements of wind speeds in areas impacted by the storms. We have actively sought to bring this information and the wind field analyses of NOAA and HAZUS–MH related wind field modeling to the attention of the public so that they better understand the magnitude of the wind event they likely experienced. We continually encounter a public that is convinced that they experienced the peak wind of the storm at their business or home location, while data and modeling would suggest substantially lower winds. This understanding of the event is a critical factor that can help property owners make judicious decisions about future mitigation activities.

In the aftermath of the hurricanes of 2004, IBHS participated in FEMA Mitigation Assessment Teams and is helping to prepare reports on Hurricanes Charley and Ivan. IBHS also worked with the University of Florida on a Florida Department of Community Affairs (Florida DCA) funded project to conduct a stratified statistical sample based study of the relative performance of buildings built under the 2001 Florida Building Code versus ones built under the Standard Building Code between 1994 and the adoption of the 2001 Florida Building Code. IBHS is analyzing building permits for reconstruction in Charlotte County, Florida following Hurricane Charley to assess the relative performance and reconstruction costs of buildings built in different eras and to different standards. IBHS has also been awarded funding from the Florida DCA to develop a web-based interactive retrofit guide for homeowners. We are working with builders, state and national experts to develop that tool.

In addition to the applied research related activities above, IBHS does occasionally get involved in performing and funding of research. One such case involved IBHS providing match funding to Clemson University to conduct full scale, destructive testing of houses in Horry County, SC. This project involved testing actual homes before and after hurricane retrofits were applied to determine how much strength was being added to the structure using various retrofit techniques. The houses were made available because they were bought out by FEMA following flooding during Hurricane Floyd. Primary funding was provided by the South Carolina Department of Insurance. IBHS is currently funding research being conducted jointly with a Florida home builder to investigate ways to retrofit soffit materials that suffered widespread failures during the hurricanes of 2004.

IBHS also works with other partners from time to time to fund research studies that estimate the savings provided through the implementation of new and stronger building codes in coastal environments. Three such reports have been prepared over the past four years by Applied Research Associates in Raleigh, NC, for analysis of the impacts of new codes along the North Carolina, South Carolina and Texas coastlines. These reports point to the dramatic savings over time that can be achieved through the use of stronger building codes.

The results of this research are used to help validate and refine the mitigation messages that we use at IBHS. We understand how expensive it can be to properly retrofit an existing home, and seek to create a demand for disaster resistance in new construction that will exceed the desire for carpet and appliance upgrades.

IBHS works with Federal, State and local governments a couple of different ways to support windstorm impact reduction. The first is through the distribution of our consumer related materials through state and local governments. Oftentimes, this is accomplished through providing materials to local grassroots style organizations to help get the work out locally. Two notable partners include South Carolina Sea Grant and North Carolina Sea Grant. The second way is participating in the building code adoption process on the state level. Over the past few years, IBHS has taken an active role in wind prone states including North Carolina, South Carolina, Texas, Florida, Louisiana and New York. Following the hurricanes of 2004, FEMA and member companies distributed large numbers of IBHS pamphlets that provided guidance on the claims process. Members indicated that information calls to their catastrophe call-in centers dropped after the guides were distributed.

Barriers to Adoption of Windstorm Resistance

The main obstacles to widespread implementation of windstorm mitigation techniques in new and existing structures relate directly to issues of complacency, education, research and cost. Throughout the country, homeowners are, in general, complacent about their exposure to extreme windstorms or believe that there is little that can be done to provide protection from the most intense storms where people frequently are killed or injured. People who live in central Florida have typically said that the real risk is in South Florida, or the Panhandle. Likewise, builders and legislators who live and work in the Florida Panhandle think that they are protected by a shelf of cooler water off their coast and that the real risk in the Keys or in the Carolinas. A major problem is that the typical return periods between major storms is such that people do not think it will happen to them.

Because of this low perception of threat from windstorms, consumers are less likely to spend the money required to make their homes more resistant to windstorms—especially when they can spend their money on upgrades they can enjoy everyday like granite counter tops and hardwood floors. The competition to spend extra money rarely ends with the mitigation winning out.

The lack of data and research on the benefits of mitigation and strong codes also poses a barrier to the implementation of mitigation measures. The data that insurers collect as a part of the claims process following a major wind event relates mainly to documenting the damage that the policyholder needs compensation for and making sure the insured is compensated according to the policy coverage in a timely manner. The role of the insurance adjuster in such a scenario is to document, estimate and pay or arrange for payment of covered expenses. Typically there are extreme time constraints placed on the adjustors and the companies they represent to review properties and act on claims in a short time frame. Given these responsibilities, it becomes too onerous (particularly in a catastrophe when large amounts of disaster victims need to begin their recovery) to expect that the adjuster would be able to determine and document the actual causes of loss and identify mitigation measures that could have prevented or reduced the damage. Because of this, insurance data alone provides little insight into the impact that wind mitigation can have on total losses.

In order to produce meaningful data to assess the effect of windstorm mitigation activities, several things need to be known. First, the actual wind speed that the building was exposed to needs to be known. Then, details as to what parts of the building failed due to excessive wind force need to be documented and most probable causes of initiation of failure need to be identified. By comparing the wind speed with a careful study of the failures, researchers can begin to make credible quantifications of the potential benefits of windstorm mitigation.

Unfortunately, many of the NOAA Automatic Surface Observing Systems (ASOS) lose power and stop recording or reporting wind speed data during severe wind storms. There is a clear national need to harden these systems and provide backup power so that NOAA and all those affected by these storms have better data on surface winds in various areas impacted by the storms. In the interim, to get better data on surface winds, IBHS works closely with hurricane researchers from a number of universities. As mentioned earlier, teams from Clemson University, the University of Florida, Texas Tech University and Florida International University have for several years now deployed mobile wind data acquisition towers in front of landfalling hurricanes to provide "ground truth" data on wind speeds so that these speeds can be correlated with building damage. Hurricane Isabel in 2003 was the first time that these mobile towers were equipped with cellular modems that allowed for uploading of wind speed data in real time to the Internet. This information was relayed to NOAA and provided them with real time ground truth data. These systems were active in all of the 2004 hurricanes. For 2005, NOAA is making access to the GOES satellite available for these instruments so that data can be reported in a more reliable manner and better integrated into NOAA's analyses.

Post storm analyses have also been alluded to earlier in this testimony. IBHS is working with builders, state building officials, building departments, university researchers, and property appraisers to accumulate data from a wide variety of sources and to seek insights into the merits of stronger building codes and mitigation efforts. This work is ongoing.

A number of barriers to building stronger and safer also relate to the adoption and enforcement of building codes and standards. First, a large number of local communities throughout the Nation have not adopted any building codes and standards for residential construction. Second, a large majority of local communities have not adopted the latest model building codes without any local amendments that weaken the model provisions. Third, while there is more widespread adoption of model building codes and standards for commercial properties, there are again many local jurisdictions where code adoption is non-existent or woefully out of date. Uniform and strong enforcement is another key issue, even in local communities that have adopted the latest standards. This lack of uniformity in the baseline for construction of homes and businesses means that the performance of buildings is less predictable and the levels of risk vary dramatically from jurisdiction to jurisdiction. We find that responsible builders have difficulties competing in areas where there are no building codes, which leads to building to the lowest denominator. Furthermore, we see national builders building differently in areas with identical design wind speeds, simply because the local code adopted in a particular area does not require the same level of construction as the national model code being enforced in the other area. All too often, the local building code is treated as the maximum rather than the minimum.

While issues of states' rights and local authority generally keep Federal agencies from trying to mandate building codes except for Federal buildings, there are opportunities for the Federal Government to initiate a number of incentives that would encourage states to adopt and enforce statewide building codes without local amendments that weaken the minimum requirements. FEMA could use the adoption and enforcement of statewide building codes as criteria for providing additional pre- and post-disaster mitigation funds to states. Federal mortgage agencies could provide lower interest rates or lower fees for mortgages on properties built to the latest building codes and standards.

Finally, many of the test and evaluation methods available for assessing the windstorm performance and durability of materials, components and systems fall short in reproducing the true nature of the loads and effects of severe windstorms and/or the effects of environmental factors on aging and associated degradation of windstorm resistance. Federal agencies can play an important role in funding research and developing facilities that will allow the more realistic simulation of windstorm loads and effects and in the development of tools and facilities for assessing the effects of aging. Some efforts along these lines have been supported through the Partnership for Advancing Technology in Housing (PATH) through research and grants initiated by the National Institute for Standards and Technology and the National Science Foundation. Much more work is needed. One IBHS member company recently donated $400,000 to Florida International University to create a new windstorm simulation facility capable of testing actual building components and systems in a realistic wind and wind-driven rain environment. IBHS staff are assisting with the development of this facility.

Benefit-Cost Analyses of Disaster Resistant Technologies

As indicated earlier in this testimony, IBHS with partners has funded several benefit-cost studies for specific building code adoption issues in Florida, North Carolina and Texas. These studies have clearly demonstrated the positive benefit-cost ratios of the particular provisions under consideration. We are aware of a study conducted by Texas A&M that evaluated the benefit-cost ratios for specific individual provisions, combinations of provisions and the entire code that related to the proposed adoption of a Texas Department of Insurance Wind Resistant Construction Code. The analysis showed that the benefit-cost ratios for various individual provisions varied significantly depending on home size and wind climate but that the benefit-cost ratios tended to increase and stabilize as the suite of provisions became more complete in addressing the most common sources of losses. For individual provisions, the benefit-cost ratios ranged from less than 1.0 to as high as 60 depending on the building size and windstorm intensity. For adoption of the entire code, the benefit-cost ratios were typically in the range of 4 to 7, meaning for every additional dollar spent on increased construction costs, losses were reduced by 4 to 7 dollars over the expected life of the property.

FEMA has funded an independent national benefit-cost study of its mitigation expenditures. This study was contracted to the Multi-hazard Mitigation Council (MMC) of the National Institute for Building Sciences (NIBS). The MMC hired the Applied Technology Council (ATC) to conduct the independent study and the ATC report is in the final review stages within the MMC. I represent IBHS on the MMC and have been involved in the review of the ATC report. While the report is still going through the final review stages and I cannot be precise in the numbers that will be finally reported, I can say that my assessment is that with one exception, the study is conservative in its assumptions and still shows a positive benefit-cost ratio for both the Nation as a whole and for the Federal Treasury. The one potentially non-conservative aspect is the assessment of the number of deaths avoided by tornado shelters constructed with partial funding from mitigation grants. However, even if the number of deaths avoided is reduced by an order of magnitude, the benefit-cost ratio for the wind related mitigation measures is still positive. With this reduction in deaths avoided, we expect that the conservative benefit-cost ratio for all the FEMA funded mitigation measures will be on the order of 3, both for the Nation as a whole and directly for the Federal Treasury.

The types of modeling tools needed to conduct benefit-cost studies in the area of windstorm mitigation have been improving in recent years. With the data that is being gleaned from the hurricanes of 2004, there should be significant new opportunities to calibrate and validate these models. The time is ripe for a major effort to conduct benefit-cost studies to assess the value of adopting and enforcing model building codes and standards, and for building to code + levels of protection from natural and man made hazards.

Summary

Windstorms and other natural disasters happen every year in the United States, and impact thousands of homeowners and businesses. Yet we do know how to build homes and commercial structures so that impacts from natural disasters are significantly reduced. Ongoing research teaches us more every year, and ongoing communication and education to the public has the potential to reduce losses every year. All of the stakeholders can contribute to the creation of a climate where hazard resistant construction is valued and demanded and where a myriad of incentives are offered that will encourage local communities and states to build hazard resistant communities that become known for their resiliency in the face of severe windstorms or other natural and manmade hazards.

There are clear opportunities for the Federal Government to support research and the removal of barriers to the development of hazard resistant construction. We believe that a good way would be to create incentives for states to adopt and enforce statewide model building codes and standards. NOAA and other agency support for wind field analyses that better communicate expected winds across regions impacted by severe windstorms will help with public communication of risks and experience. We are also interested in partnering with Federal agencies to conduct benefit-cost studies for building codes and natural hazard mitigation measures. Appropriation of new funds in FY06 and beyond to support the National Windstorm Hazard Reduction Program, that was authorized as part of the National Earthquake Hazard Reduction Program, will further the IBHS goal of making communities safer from coast to coast.

Senator DEMINT. Your credibility just went up a good bit when I found you'd been at Clemson.

[Laughter.]

Senator DEMINT. Mr. Ahlberg?

STATEMENT OF DOUG AHLBERG, DIRECTOR, LINCOLN–LANCASTER COUNTY EMERGENCY MANAGEMENT

Mr. AHLBERG. Thanks very much. First of all, it's an honor and a privilege to be invited to testify to you this afternoon. I am a Director of Emergency Management for Lincoln-Lancaster County in Nebraska. As you may or may not know, on the 22nd of May of last year, southern Lancaster County as well as five other counties in Southeastern Nebraska fell victim to a tornado that was on the ground for 54 miles. At its widest point it was two and a half miles wide, and on the Fujita Scale it had an F rating of four. Because of the forecasting and this information that was provided to us by the National Weather Service out at Valley, we lost one person, and had 37 injuries that basically did not require an overnight stay at the hospital, so we were extremely fortunate. Without those forecasts, I think that the numbers would have been considerably higher as a direct result of the storm.

Now, Lincoln and Lancaster and a county called Saline and Gage are the only three counties in the State of Nebraska that have been certified by the National Weather Service as being storm-ready. This is kind of an accreditation of our abilities to report and to provide for advanced warning in the approach of severe weather. Last spring, the National Weather Service initiated out of Valley a conference call system where if they are predicting severe weather for the Southeastern portion of the State of Nebraska, all emergency managers and local broadcasters are provided an opportunity to participate in that conference call.

Now, just a couple of weeks ago we had a conference call with the anticipation of severe weather, and that was during the NCAA baseball regional that was held in Lincoln, so it was with quite a bit of interest that I participated in that particular telephone call. We had well over 6,500 people that were in attendance at one ball field at that particular time. Ten minutes after the first pitch of the evening game, the National Weather Service put Lincoln and Lancaster County in a tornado warning. With the advanced information that we had we were able to have the necessary precautions in place to allow for the events that did follow after that announcement was made. But that brings me to one of the concerns that I have and the consideration I would like for NOAA to look at, and that is a warning was issued, we were begging and pleading with people to leave their seats to take shelter because of the warning that was issued, and the response that we got was, "Well, we've had five or six already, and nothing's occurred, so we'll just stay here in our seats and see what happens." I really would have liked to see, it isn't going to cost anybody a dime to look at a third tier of warnings to be established, especially when you talk about severe weather, it's kind of like your timer, it's green, yellow, red, it doesn't go from green to red, there's this little intermediate step that's in the middle, and that would allow people an opportunity to know that there is a tornado vortex that is present in Doppler radar, and to add significance to the word "warning," and that would be that a storm has been confirmed in one form or another. Right now, people listen to a warning and we issue five or six and nothing occurs, they really don't pay any attention to it. They should, and I think everybody knows that we should, but I think we have a tendency to become rather apathetic after awhile, especially when you're confronted with it almost on a daily basis during the months of April, May and June, especially in Nebraska.

Now, several years ago, and this is my second concern, the National Weather Service combined in the Lincoln and Omaha region, as far as providing weather service to a particular part of our state.

The National Weather Service out of Valley covers 30 counties in Nebraska and 9 in Western Iowa, that runs from the South Dakota/Nebraska border on the north, to the Kansas border on the south, and I think that oftentimes bigger is not better. As far as consolidation is concerned, the technological advances that you have seen over the past few years, the total number of improvements that you've seen in forecasting still relies on those forecasters that are sitting there making those predictions and providing us with those forecasts. Now, Lancaster County alone is 864 square miles, and we have a population of around 246,000. Omaha, the largest city in the State of Nebraska, is also included in the service area provided by Valley.

Now Lincoln and Lancaster County is 55 miles away from the National Weather Service radar site in Valley. Again, bigger isn't necessarily better, and I would hate to see additional forms of consolidation of the radar services, and what National Weather Radar Sites we presently have across the whole country.

Now, since September 11, 2001, Homeland Security has invested millions of dollars to deter terrorism, and for that, we in Nebraska are very thankful. However, does Mother Nature fit the definition of a terrorist? I think so, and I think that moneys can be wisely spend to improve NOAA's capabilities to provide for the safety of those folks that live in those coverage areas. Thank you.

[The prepared statement of Mr. Ahlberg follows:]

PREPARED STATEMENT OF DOUG AHLBERG, DIRECTOR, LINCOLN/LANCASTER COUNTY EMERGENCY MANAGEMENT

I have come here today to discuss two topics which are important to those of us who live in the Midwest and both topics are related to severe weather. The first topic I will discuss is our severe weather warning system and the second topic concerns our weather forecasters.

On May 22, 2004, southern Lancaster County, along with 5 other counties, fell victim to a tornado that was on the ground for 54 miles, had a damage path at its widest point of 2½ miles, and an F4 rating on the Fujita scale. One death was reported and a total of 37 injuries were reported as this storm decimated the Village of Hallam.

The National Weather Service in Valley, Nebraska, along with local broadcasters, provided the citizens of southern Lancaster County and surrounding counties with a minute by minute forecast of the tornado's path and projected future movements. Without these warnings, there is no doubt in my mind that the number of deaths and/or injuries would have been much greater.

Lancaster, Saline and Gage Counties were affected by this particular storm and are the only 3 counties in the State of Nebraska, on May 22, 2004, to have been certified by NOAA as "Storm Ready" counties. Since last spring the Weather Service in Valley has initiated a conference call program for all Emergency Managers and media representatives in their coverage area. The purpose of this conference call is to provide information about the possibility of severe weather on any given date. During a recent NCAA regional baseball tournament in Lincoln (where over 4500 people were seated), this advance information was extremely helpful in preparing for the possibility of tornadic activity in the area of Lincoln. Within 10 minutes of the first pitch of the evening game, Lincoln and Lancaster County were placed in a tornado "warning". Advance precautionary information provided to us allowed for a timely response to this "warning".

One suggestion I would like to make with regard to watches and warnings is to provide for three (3) phases of weather warnings rather than the two (2) which are currently being used. An example of a three-tiered system would be a tornado "watch", tornado "alert", and a tornado "warning". Currently, a "watch" and a "warning" are used. The addition of the "alert" would indicate a radar image of a tornado vortex signature. Then a tornado "warning" would be issued when a tornado is confirmed. This would be very similar to a signal light with the green, yellow and red. I feel that often when a "warning" is issued and nothing happens, the general public begins to question the validity of the "warning". Adding the additional "alert" advisory would allow for the seriousness of the "warning" to have significant impact.

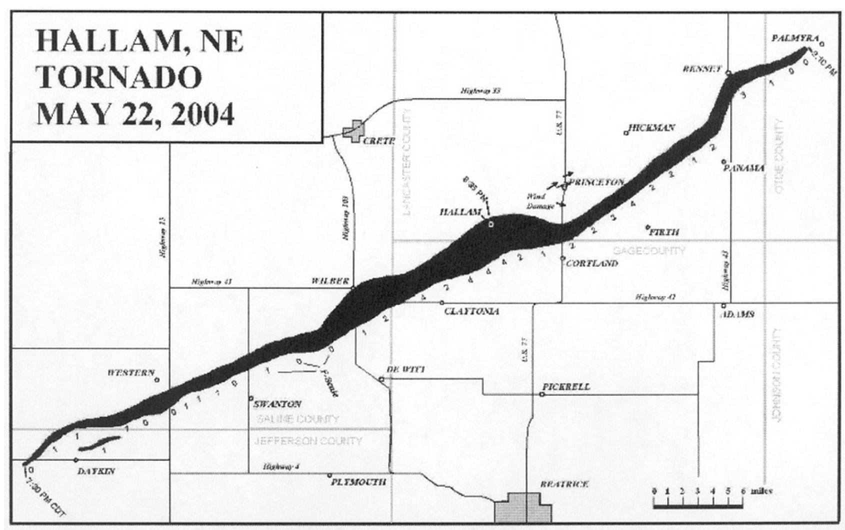
Several years ago Lincoln and Omaha's weather services were combined and placed in Valley, Nebraska. All Emergency Managers would like to have a weather service in their own backyard and we all understand that is not practical. However, the service area for each weather service site has been increased dramatically. The service area for the Valley Weather Service consists of 30 counties in eastern Nebraska and 8 counties in western Iowa. This service area extends from the Nebraska/South Dakota boundary on the north to the Nebraska/Kansas boundary on the south. With the consolidation of facilities and the increase of service area size, an additional burden has been placed on those forecasters tasked with warning over half of the State of Nebraska's total population.

Lancaster County alone consists of 864 square miles that had become extremely urbanized, with a large portion of the population moving into a rural-type setting. With a population of over 246,000, Lancaster County is over 55 miles from our weather service provider in Valley, Nebraska. Sometimes bigger is better, but not necessarily when dealing with public safety issues. Consolidation of facilities, when dealing with weather issues, is not the solution that provides the best service for those living in areas affected by severe weather.

Since September 11, 2001, Homeland Security has invested millions of dollars to prevent acts of terrorism. Does "Mother Nature" meet the definition of a terrorist? I think so.

In conclusion, I have come here today to ask that you consider two issues. The first one is that you consider adding a third tier to the warning system used for severe weather. The second issue is that you reconsider the size of the service areas that the National Weather Service forecasters have to work with. Our lives depend on the accuracy of the weather forecasts and our warning system.

Thank you.



Senator DEMINT. I think calling Mother Nature a terrorist will be right up there with some of the great comments in history, so thank you for making that in our Committee today.

I'm going to yield to our Ranking Member, Senator Nelson, to begin the questions.

Senator BEN NELSON. Well, thank you, Mr. Chairman, thank you for that privilege, and Mr. Ahlberg, it's great to have you here. I think one of the reasons you had trouble trying to get the people to leave the stadium is Nebraska was leading the Miami Hurricanes, they were a little bit worried about their luck changing if they left the field.

Maybe you could give us an idea of some of the things that you do to achieve that certification so that you can show how you deal with the communities in the Lincoln and Lancaster outreach in the communities that provided some benefit in this particularly devastating tornado.

Mr. AHLBERG. The National Weather Service, by certifying us, brings up a lot of protocols that we have to meet. My grandfather told me a long time ago, if it's fact, it's not brag. We are very fortunate in Lancaster County to have one of the premiere spotters networks anywhere in the country. As a matter of fact, 2 weeks ago, National Geographic sent a film crew to my emergency operation center to basically document how we function with that spotters network. That's only part of it. Our ability to get warnings out, whether it's through NOAA's weather radio, all hazard radios, whether it's through tone alert receivers, whether it's through our ability to interrupt cable vision, the use of the VAS systems, all of these things are part of the certifications to ensure that we're getting this information out. We have looked at alternatives of getting those particular warnings out, one of which is a reverse 911 callback system on the telephone, but that's something that's extremely expensive to accomplish. A lot of people have the feeling, we'll rely on outside warning devices, the outside warning sirens, that's all well and good if you have one in your backyard at two o'clock in the morning, but it's not going to wake you up, they are outside warning devices, and we have a large number of those in our county, we looked at this emergency callback system that would make 3,500 phone calls a minute, I think in the last gubernatorial race that we had in Nebraska, I was receiving some of those phone calls in the evening with a political message, but it is something that is relatively expensive, and when you get into the smaller populated states, the smaller populated counties, that is an additional cost that they cannot afford. This particular system, you can GIS it, you can GPS it, you can have it call back by prefix numbers, you can have it call back by zip codes—all of these things that will wake a person up when there's a life-threatening situation at two o'clock in the morning, I think should be looked at, and that's technology that we have available right now. The problem is, like everything, it costs dollars to pay for it.

Senator BEN NELSON. Having toured the Hallam, Nebraska site a day after the storm, seeing the devastation that was there, it's remarkable that anyone survived, and I remember visiting with a gentleman whose house was entirely gone, including the bathtub, and he survived by wrapping himself around the commode and held on and survived while everything else left him. The power and sometimes the suddenness of a tornado, even with a warning, does create a need for such devices as the reverse 911, and in your opinion, are you comfortable with any kind of reduction of funding for the National Weather Service?

Mr. AHLBERG. No.

Senator BEN NELSON. I appreciate that answer. As you think about it, are there other ways to supplement the work of the National Weather Service at the local level with what you do? Do you work back and forth and make their job more doable, certainly their ability to reach out, better?

Mr. AHLBERG. I don't know if I make it—sometimes I think I make it very uncomfortable for them with some of the requests that I make, as do most of the emergency managers around the country, it's a resource that I don't think we can do without, first of all. I don't think with the technology that we have, the ability to dovetail all of those technological advances with the National Weather Service, with commercially produced weather sentry systems through meteorologics, Accuweather, all of those things dovetailed together to give us the best possible solution, to provide adequate warning for severe weather, especially in the Midwest. Like you said, Senator, it's rather spontaneous, it develops rather quickly. No offense, but hurricanes basically take a long time to evolve and to have a landfall. For example the other night, Seward County, which is west of Lancaster County, was placed in a severe thunderstorm warning. That storm moved in and dissipated as it moved into Lancaster County. As it approached the middle portion of our county, it again increased in severity, and again, Lancaster County was placed in the severe thunderstorm warning, so these things developed rather quickly.

I'm not a meteorologist, I'm not a weather forecaster, but we rely quite heavily on their expertise, and those forecasters' information that they provide us, and that's why when you talk about consolidating facilities, you're still talking about the human element of looking at the radar and making that forecast, and you could have four or five in one particular geographic area, storms that develop that are taking up every waning minute of those forecasters to ensure that they have proper information provided to us as emergency managers and to the general public.

Senator BEN NELSON. Well, thank you very much for what you do and for being here today, and thank you, Mr. Chairman.

Senator DEMINT. Thank you, Senator, I've got pages worth of questions I wish I could ask all of you, but I've got to run to the next meeting. This has been so helpful to us, I assure all of your comments will be in the record, and we may be getting back to all of you on things that we're following up on. Mr. Walsh, it is good to hear that you have a good working relationship between the media and the Weather Service, just some good things to work with. We appreciate it, and you are dismissed.

[Whereupon, at 4:30 p.m., the Subcommittee adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JIM DEMINT TO MAX MAYFIELD

Question 1. You testified that intensity prediction is one of the greatest challenges facing hurricane prediction. Can you explain why intensity is not one of NOAA's GPRA metrics and whether you plan to include it in the future?

Answer. Given the large number and variety of basic science issues associated with intensity prediction, including questions concerning observation and modeling improvements required to improve hurricane intensity forecasts, it has been difficult to determine an appropriate goal under the Government Performance Results Act (GPRA). To formulate an appropriate GPRA measure, first, an internal NOAA National Weather Service intensity performance measure was created, which calls for a 30 percent reduction of the intensity error by 2015. Second, while we review and monitor the internal measure we must simultaneously begin to (1) address the many science issues and surrounding questions, and (2) make progress on the intensity issue through a multi-pronged approach involving: (a) improved observations; (b) improved models; and (c) an independent science review team focused on the hurricane intensity forecast issue. A GPRA appropriate measure will result from this process.

NOAA has already committed to improving intensity forecasts by:

- Developing the ability to collect high-resolution data and observations through NOAA's Gulfsteam-IV (G–IV) jet. The aircraft is being outfitted with Doppler tail radar to provide unprecedented precipitation and wind field data to aid our understanding of the circulation of a hurricane throughout the depth of the troposphere.
- Installing seven new marine buoys at high priority sites in the Caribbean and Atlantic Ocean. Forecasters require highly accurate real-time measurements of wave height, wind speeds, and surface pressures to run hurricane models and ground-truth satellite observations. These new buoys address gaps in the current marine buoy network, providing forecasters with an early warning system of marine observations in the open ocean.
- Developing the next generation hurricane model, the Hurricane Weather Research and Forecast model (HWRF). The HWRF is a high-resolution coupled air-sea-land prediction system that relies on advanced physics and will be operational by 2007. The HWRF will assimilate high-resolution G–IV data from the inner core of the hurricane with other operational buoy, aircraft and satellite observations surrounding the hurricane system. NOAA also has committed to increasing the computational speed required to run this improved model, and to make the results available to the forecasters in the Tropical Prediction Center/National Hurricane Center on a real-time basis.
- Accelerating enhancements to the Global Forecast System (GFS) and Geophysical Fluid Dynamics Laboratory (GFDL) model, which have shown promise in improving forecasts of intensity (strength), and structure (size) of hurricanes so far this season.
- Establishing a Hurricane Intensity Research Working Group (HIRWG) under the auspices of the NOAA Science Advisory Board to review current plans and make recommendations to accelerate improvements in intensity forecasts. The HIRWG can also assist NOAA in establishing credible goals, leading to meaningful GPRA goals, in intensity forecasts that can be addressed through improvements in science, observations, and modeling.

Question 2. Does the National Hurricane Center plan to link State Department of Transportation evacuation plans on its website?

Answer. The Tropical Prediction Center/National Hurricane Center provides links to emergency management Internet sites for all hurricane-vulnerable states. Some of these state websites include information on evacuation zone and route maps.

These are locally tailored products, which the public can use in their personal disaster planning. These maps incorporate the findings from the evacuation plans into a format that is more easily used by the public.

In addition, the NOAA Coastal Services Center is working with hurricane-vulnerable states to develop a single Internet site that enables citizens to locate and map hurricane evacuation zones. Mapping these zones helps citizens become more prepared to evacuate and avoid the potentially life-threatening affects of a hurricane. This work-in-progress can be visited at *http://www.csc.noaa.gov/hez*_tool/.

Question 3. NOAA's GPRA track error target for 2004 was 129-mile error, and your actual performance was 94-mile error. The 2003 actual track error was 107-mile and in 2002 it was 124-mile error. The Weather Service has been exceeding its 2004 target since 2002. Additionally, your FY 2010 target (124 miles) is the same as its 2002 actual performance. Do you continue to believe this target is still of value and if not will you be revising the metric? Are you considering longer time frame GPRA targets? Is the recent performance anomalous and do you expect performance to degrade?

Answer. Since 1995, we have seen a marked increase in the number of hurricanes in the deep tropics. These systems typically take long, primarily straight tracks through an uncomplicated environment and, as a result, are associated with relatively low track forecast errors. For seasons in which much of the hurricane activity occurs at higher latitudes (such as in El Niño years), the Tropical Prediction Center/National Hurricane Center usually registers higher average forecast errors. GPRA targets are developed based on analysis of long term performance thereby taking into account this year-to-year natural variability. Therefore, it would be premature to extrapolate the recent downward trend in forecast errors to derive a new GPRA target. Overall, however, we would expect forecast errors to decrease as we continue to make improvements to our observing systems and forecast models, and we continue to review and analyze past performance to determine when downward revision of the GPRA goal may be appropriate.

Question 4. Please detail, with cost estimates, what tools, both computational and observational, are necessary to increase the effectiveness of hurricane intensity predictions.

Answer. The computational tools and observational platforms necessary to increase our effectiveness of hurricane intensity forecasting are included in current efforts (FY 2005) and planned for FY 2006. Again, these efforts are consistent with our three-pronged approach to address the hurricane intensity forecast issue, by addressing:

Observations:

- Hurricane Buoys.
  —The procurement and deployment of hurricane buoys provides forecasters highly accurate real-time measurements and fills data gaps in the current marine buoy network. The Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005 (Pub.L. 108-324) provided $1.8M for the purchase and deployment of 7 Hurricane Data Buoys for the South Atlantic and Caribbean.
- Satellite observations.
  —Significant efforts are ongoing in applying the latest technology to future remote-sensing instrumentation.
- Reconnaissance and Surveillance Aircraft.
  —Aircraft upgrades, including G–IV Doppler radar, are underway that will provide new data sources for assimilation into future hurricane models. The Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005 (Pub.L. 108-324) provided $3.5M for G–IV Doppler radar.

Modeling:

- Enhancements to the Global Forecast System (GFS) including data assimilation activities that effectively use satellite and high resolution ground-based radar data.
- Implementation of the Hurricane Weather and Research Forecasting (HWRF) system is scheduled for 2006 with full implementation expected in 2007. The Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005 (Pub.L. 108-324) provided $1.0M to accelerate HWRF.

Research:

- The Joint Hurricane Testbed currently has 12 projects active, focused on the mission to rapidly and smoothly transfer new technology, research results, and observational advances of the United States Weather Research Program into operational forecast products. The Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005 (Pub.L. 108-324) provided $0.7M to improve Hurricane Intensity Model development.

Short-term intensity forecasts can be improved indirectly through model guidance provided to forecasters and directly through improving the surface observing network available to the forecasters. Proposed additional buoys and improvements to dropsondes will contribute to such advances. Those platforms, however, provide limited spatial and temporal resolution, e.g., relatively isolated point observations in the case of buoys. A longer-term solution to specify at high resolution the surface wind field over the areas covered by hurricanes requires additional advances in satellite technology. At present, such systems as Quikscat and SSM/I do not provide accurate surface wind information in areas of precipitation. These precipitation areas are of great importance in hurricanes.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TED STEVENS TO DENNIS MCCARTHY

Question 1. Dr. Syun Akasofu, the Director of the International Arctic Research Center of the University of Alaska has provided my office with satellite photographs of a typhoon type storm in the Bering Sea close to Barrow. Additionally, in October 2004 Alaska's West Coast (Nome) experienced a "Coastal Storm" (the equivalent in millibars Low Pressure) to a Category 4 Hurricane. What are the National Hurricane Center and the National Weather Service working on to broaden "warning" and "watch" notifications and to increase their ability for all parts of the country and specifically Alaska?

Answer. The October 2004 coastal storm proved to be one of the strongest storms on record for the western Arctic coast of Alaska. While loss of property was unavoidable in this instance, lives and personal property were protected through nearly unprecedented lead time, education, outreach, mitigation and preparedness activities provided by NOAA's National Weather Service (NWS), working closely with Alaska's Department of Homeland Security and Emergency Management. NOAA's numerical weather prediction and ocean wave models performed unusually well, especially given that this storm had its origins as an ex-typhoon originating in the western Pacific (where lives were lost in Japan).

NWS forecasters provided 3 days of lead time to emergency managers and the public, allowing physical mitigations to be erected and evacuations to take place well in advance of the initial winds. The NWS, working with emergency managers, has for several years used a special "Hurricane-Force Wind Warning" for use in these circumstances, to draw attention to non-tropical hurricane-force winds.

Forecasters and managers do plan for such cases using guidance provided by models and forecasters at the NWS National Centers for Environmental Prediction (NCEP), as well as guidance developed by the NWS Meteorological Development Laboratory on storm surge in Alaska. These guidance sources need improvements, especially over the North Pacific, where upstream weather observation data (over Asia and the Pacific Ocean) is particularly sparse. NOAA's efforts to deploy an Integrated Ocean Observing System (IOOS), as part of the Global Earth Observing System of Systems (GEOSS), will help fill the data void.

Question 2. The National Weather Service in Alaska has limited ability to predict severe weather and storms. The lower 48 contiguous states have overlapping weather radar, Alaska on the other hand has 7 radar sites, and only about a sixth of the state has weather radar coverage. Alaska does have satellite coverage but satellites don't show storm severity. For example, there is no radar coverage over Yakutat, so Cape Fair-Weather, when there is heavy traffic of commercial vessels, is literally without storm severity forecasts. What is and could be done to improve weather prediction coverage in Alaska?

Answer. The NWS has an effective weather warning program in Alaska. The NWS modernization resulted in significant improvements and advances in weather technology and in forecast and warning services. Radar siting throughout the United States was carefully considered. Nearly ⅓ of Alaska by area, and nearly ⅔ by population, is covered by NWS Doppler radar technology below 10,000 feet. Given the terrain and climate, it is cost prohibitive to establish full radar coverage via deployment of additional NEXRAD radars. We are exploring the use of other radars, owned by other government agencies and private industry, to supplement the existing radar coverage.

Significant improvements to Alaska's weather prediction capabilities, and extension of lead times for gale and storm conditions for commercial vessels, will come mainly from improved modeling. When data is effectively assimilated, increases in satellite and in-situ observations will have the greatest direct impact to model performance. The National Polar Orbiting Environmental Satellite System (NPOESS) will greatly enhance our observational capabilities in this data sparse region, and significant improvements in modeling and forecasts are expected to result from NPOESS deployment.

Question 3. Alaska is not part of the National Lightning Detection System, which is provided year round to the lower 48 states by the National Weather Service. The Bureau of Land Management (BLM) provides lightning information for Alaska—but only from April thru October (fire season) of each year, but it does not report data to the National Weather Service East of Longitude 140 West (Yakutat). My staff has been briefed that the data exists, but not supplied because it also shows data belonging to Canada. This communications breakdown leaves citizens in cities like Juneau (the State Capital of Alaska) with no advanced storm warning. What is the Department of Commerce doing to obtain an international agreement with Canada to allow lightning detection reporting in South East Alaska? Additionally, why isn't Alaska part of the National Weather Service's National Lightning Detection System?

Answer. The Department of the Interior's Bureau of Land Management has a contract with a private vendor to supply lightning data. There is only one vendor and consequently only one National Lightning Detection System at this time. The NWS uses the BLM contract to obtain data. As of now, there are no sensors in Alaska. Expansion of the National Lightning Detection System into Alaska is under consideration as part of the National contract. At the same time, the NWS is developing an agreement to acquire Environment Canada's Canadian Lightning Data (CLD). This will provide data East of Longitude 140 West. As a demonstration, the NWS Alaska Region accessed the CLD data during the current 2005 fire weather season. In addition, the NWS is also in the process of negotiating with the Department of the Interior's Bureau of Land Management (BLM) on expanding their sensor network. This negotiation could potentially lead to the BLM acquiring two additional sensors within the next two years. These efforts will strengthen the CLD and the BLM Alaska lightning detection network. The NWS and the Meteorological Services of Canada have been strong partners for many decades.

Question 4. Nine of the twelve remote weather facilities in Alaska are old and in poor repair. What is NOAA doing to upgrade these facilities?

Answer. NOAA's National Weather Service has an Alaska Region facilities upgrade program to address safety and building code violations. The program successfully acquired new housing at our facilities in Kotzebue and Annette in 2005. In addition, the Saint Paul office is currently under renovation and a contract for new housing has been awarded. Housing at Cold Bay has also been renovated as well as the office in Kodiak. Additionally, the Weather Service Office in Annette is in the design phase, which includes plans for construction under the U.S. Green Building Council's Leadership in Energy and Environment guidelines. Future plans will consider office projects in Nome and Barrow and housing projects in McGrath, Barrow, Nome, Valdez, and Yakutat. However, these are major long-term projects that require significant planning.

Question 5. Climate impacts such as coastal erosion, melting glaciers, drought and flooding are all occurrences happening in Alaska. In discussions on Climate Change, scientists have been calling Alaska the "Canary in the Coal Mine" implying it is the Climate Change warning area for the rest of the world. We have data scarcity on Global Climate change partially because current technology and equipment are not being placed in Alaska. What is NOAA doing to correct this oversight?

Answer. NOAA is supporting enhancement of the International Arctic Buoy Program to provide ice thickness measurements in the Arctic Ocean north of Alaska to track the changes in thickness of multi-year ice and to learn how changes in the atmosphere and the ocean are affecting the ice. An ice profiling sonar system is located in the Chukchi Sea north of Alaska to determine changes in the seasonal ice zone that affects the Alaska northern coast.

The expansion of the Climate Reference Network (CRN) is progressing in Alaska, with two CRN sites installed in 2002 and three sites in 2005. These sites will provide a reliable record of climate variability and change in this climate sensitive environment. NOAA is aggressively partnering with other State, Federal, and non-governmental agencies (such as the Alaska Ocean Observing System) to develop requirements, plans, funding mechanisms, and priorities for installation of new climate observing (and modeling) capabilities in Alaska.

In 2007, we will celebrate International Polar Year. NOAA supports the concept of an International Polar Year. The International Polar Year is an ideal opportunity to advance observations of the polar region. NOAA uses polar observations in support each of its four strategic goals, and has responsibility for archiving and long-term stewardship of the data, and its application to societal needs.

The question suggests that drought is occurring in Alaska. Drought is not currently a problem in Alaska. Visit *http://www.drought.unl.edu/dm/monitor.html* to view an up to date U.S. drought monitor map.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DANIEL K. INOUYE TO DENNIS MCCARTHY

Question 1. Does the National Weather Service (NWS) plan to include three-dimensional ceilometry, a technology developed with NWS funds, into the Automated Surface Observation System (ASOS) upgrade plan?

Answer. The three-dimensional ceilometry technology has been explored under the Small Business Innovation Research (SBIR) program. While the technology shows some promise, its development is not yet at a stage where we have been able to incorporate it into the Automated Surface Observation System (ASOS) upgrade plan. The Automated Surface Observing System Product Improvement (ASOS PI) Program is currently replacing the existing ceilometers, because (1) they are not logistically supportable beyond 2007; (2) the height range is to be increased from 12,000 feet to 25,000 feet [at most sites], and (3) the height range is to be increased to 40,000 feet [at ~240 sites] if it is achievable and affordable.

Three-dimensional ceilometry could become part of the program in the future. We estimate providing the three-dimensional, as compared to the one-dimensional technologies now used, would raise the cost of the ASOS PI effort by 50 percent to 60 percent, and would extend the schedule beyond the limits of our ability to provide logistical support to the current network. The current ASOS processing capability also imposes limits on sensors within its suite. The schedule extension is based upon the need to revise, test, and implement a new algorithm to report three-dimensional cloud reports, and examine the feasibility of incorporating into the current ASOS configuration.

Question 2. Does the NWS find utility in the Small Business Innovation Research program?

Answer. Yes. The NWS has found utility in the Small Business Innovation Research program. This program has provided the opportunity for the NWS to perform research and development on technologies, observing systems and sensors, and computational advancements that will contribute to the NWS mission of providing the Nation's weather, water and climate forecasts and warnings.

The NWS presently has a Phase 1 program for a "Self Cleaning Temperature and Conductivity Sensor." The NWS also has an ongoing Phase 2 program for a "Prototype Computer Grid Software Product for NOAA." This year, the NWS is expected to have up to five Phase 1 contract awards for innovative research in the following topic areas:

1) NOAA Weather Radio (NWR) Broadcast Simulation
2) Measurement of Sea Surface Salinity
3) New Data Telemetry Protocols For Automated Flood Warning System
4) Predictive Modeling For Solar Insolation
5) Space Weather Data

The development of these topics and technology areas has the potential for providing future benefits and improvements to the NWS in meeting its important mission.

Question 3. The Small Business Innovation Research Policy Directive RIN 3245–AE72 for Phase 3 transition of NWS funded technology development states that Phase 3 projects are not required to be recompeted prior to the awarding of a contract. Does the NWS still intend to abide by this directive? How many Phase 3's have you funded? How many of these contracts were subject to further rounds of competition beyond that associated with Phase 1 and 2?

Answer. The NWS will abide by this Small Business Innovation Research (SBIR) Policy Directive where it is applicable and appropriate under law. The funding and execution of a Phase 3 program would be most likely applicable under the existence of the following conditions: (1) the Phase 3 program provides the best value to the government and fulfills the best interest of the government/agency in meeting its requirements and goals; (2) funding is available and appropriated (Phase 3 is not funded from SBIR funds); (3) the technology that was developed from the Phase 1 and 2 programs meets the stated agency program or procurement requirements. If these conditions exist and are applicable under law, the NWS would appropriately abide by this SBIR policy directive.

No Phase 3 programs have been funded by the NWS.

Under the above stated conditions no NWS Phase 1 or Phase 2 programs would have been or have been subject to further competition.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. E. BENJAMIN NELSON TO DENNIS MCCARTHY

Question 1. If the President's FY 2006 budget for the National Weather Service (NWS) is enacted as it was submitted to Congress, will it sustain NWS operations at last year's level? How much of a shortfall will there be? Is $40 million a good rough estimate?

Answer. Yes, if the President's FY 2006 budget for the NWS is enacted as submitted it will sustain NWS core operations at FY 2005 levels while providing targeted improvements. However, the President's Budget assumes a 2.3 percent pay raise. If the enacted pay raise differs from this assumption NWS will have to identify measures to absorb the additional costs to maintain core operations in FY 2006. NWS is particularly vulnerable to the cumulative effect of pay increases above budgeted amounts with approximately 67 percent of the NWS operational budget dedicated to labor costs associated with its nationwide 24/7 weather forecast and warning mission.

Question 2. What National Weather Service programs and services, including maintenance and hiring decisions, would have to be reduced, deferred, or eliminated under the President's budget?

Answer. As stated above, the FY 2006 President's Budget will sustain current operations at the FY 2005 level. As with FY 2005, our FY 2006 strategy will continue to prioritize continuity of service operations. If NWS labor cost reductions are considered, NWS will, to the maximum extent possible, limit these labor cost reductions to avoid degradation of current services.

Question 3. Would the National Weather Service be able to keep all of its current positions filled under the President's budget?

Answer. The President's Request incorporates a "labor lapse" rate assumption, which accounts for normal turnover and employee time to recruit and fill vacancies as they occur. In addition, in order to mitigate unfunded FY 2005 requirements, the NWS increased its labor lapse rates for its Headquarters components (+3.4 percent) and for its field components (+0.4 percent). The NWS plans to continue the increased FY 2005 lapse rates into FY 2006 and, depending on the viability of other options, may increase them. NWS is focused on ensuring that critical forecast and warning vacancies are filled.

Question 4. You testified that there are several upgrades in the NWS radar system planned for the next few years. Would the timeline for these upgrades be affected by the President's budget?

Answer. The President's FY 2006 Budget Request does not impact the timeline. Major upgrades to the radar system are funded through NEXRAD Product Improvement (NPI), administered by NWS but funded by: the National Weather Service (Department of Commerce), the U.S. Air Force (Department of Defense), and the Federal Aviation Administration (Department of Transportation).

Question 5. The Committee has been informed that training programs at the National Weather Service Training Center (NWSTC) in Kansas City were seriously curtailed this year due to budgetary shortfalls. How much money is needed to restore the training program to its prior status? Is the training program likely to be further curtailed under the President's budget for FY 2006?

Answer. In FY 2005 the NWS National Training budget for the NWSTC was reduced by $1.5M. At this time no additional FY 2006 reductions are anticipated for the NWSTC. As with the FY 2005 reductions, NWSTC training priorities will continue to focus on maintaining core operational training (meteorological, hydrological and technical/electronic training requirements). Also, as with our FY 2005 NWSTC curriculum and to offset the $1.5M reduction, we are increasingly focused on the use of remote/distance training, which is more economical and can reach more of our workforce than traditional in-residence training.

Question 6. How much of an increase in the FY 2006 budget would the National Weather Service need in order to make up for shortfalls incurred in FY 2005?

Answer. As stated earlier, the FY 2006 President's Budget will sustain operations consistent with FY 2005 levels.

Question 7. The Committee has been informed that the National Weather Service is considering plans to further consolidate its Forecast Offices into a dozen or so larger offices with greater areas of responsibility. Is this true?

Answer. There are no plans to consolidate forecast offices. As technology continues to evolve and science advances, we are exploring ways to take advantage of new science and technology to make the best use of our workforce and to provide a higher level of service. All options we are exploring are based on the existing complement of 122 weather forecast offices (WFOs), each maintaining responsibility and accountability for their existing areas. The only consolidation being considered is some routine production, which will allow forecasters in all WFOs to work in an event-driven mode to focus on significant impacts and provide more direct decision assistance to partner agencies (i.e., the emergency management community).

Note: Although there are no plans to consolidate any of the 122 WFOs, there are three smaller weather service offices, which were originally scheduled for closure as part of the NWS Modernization and Restructuring effort of the 1990s. These three weather service offices (Williston, ND; Erie, PA; and Evansville, IN) each have mitigation efforts underway to improve radar coverage, and may be proposed for closure depending on the results of these efforts.

Question 8. What process will be used to decide which offices are eliminated or consolidated?

Answer. There are currently no plans for office elimination or consolidation. Should future plans call for consideration of office elimination or consolidation, NOAA will keep Congress informed of these plans.

Question 9. How would such consolidation affect weather coverage and forecasts in Nebraska?

Answer. There are no plans for office elimination or consolidation. We expect to be able to continue improving services from our existing 122 weather forecast offices in the coming years, including Nebraska.

Question 10. Will the agency be able to certify that there will be no degradation of service to the public?

Answer. Any upgrades to our forecast and warning service will be coordinated closely with public officials. We monitor our forecast and warning performance metrics very closely, even posting them for display in our forecast offices. The "non degradation of service" standard was adopted to direct the NWS Modernization and Restructuring effort of the 1990s. As we look at upgrades to our services, we are certainly committed to meet the "non degradation of service" standard, but our focus is on improving services, not merely maintaining them.

Question 11. How many National Weather Service buoys experienced failed or faulty sensors during FY 2005? How many buoys failed completely?

Answer. The National Weather Service maintains 101 buoys. As of August 1, 2005, 33 of these buoys failed meaning that data was not being transmitted. Of the 33 buoys, 15 of the failures were caused by severe weather, 7 by a collision and/or tampering, and the remaining 11 failures were caused by communications or power failures.

Status of buoys: 28 of the 33 have been repaired. Of the remaining five, four are expected to be back in service by the end of September (pending availability of a U.S. Coast Guard vessel for deployment), and two will be repaired in FY 2006.

Question 12. Has the repair of these buoys been delayed as a result of insufficient funding?

Answer. In order to best manage our funding, we sought to reduce costs by allowing tolerable delays in servicing some buoys. Instead of paying the cost of renting a ship to perform a repair, we waited for opportunities to group multiple repairs into a single voyage, preferably using a ship for which we did not have to pay rent, such as a U.S. Coast Guard ship.

The most common cause of delay in repair of the buoys is the time of year and scheduling of vessels to complete the repair. Buoys located in the northern Pacific Ocean are difficult to service in the winter months, causing delays until conditions are safe for a vessel to service the buoy.

Question 13. Has the National Weather Service had to defer the acquisition of spare NOAA weather radio transmitters due to budgetary constraints? Has this had an impact on weather radio coverage?

Answer. In FY 2005 NOAA deferred the purchase of spares for NOAA Weather Radio (NWR) transmitters. These spares would have served as on-site spares, thus allowing a technician to repair a transmitter within a shorter time frame and without the expense of making separate trips to diagnose and then repair failures. These on-site spares are redundant and without them the NWR stations remained in operation via the backup transmitter until the primary transmitter was repaired.

With the funding requested in FY 2006 to complete and sustain NWR, NOAA's National Weather Service will begin replacement of the 1970's era transmitters, many of which are not redundant. By replacing old transmitters with modern, redundant, solid-state transmitters, overall reliability and availability of the NWR network will increase.

Question 14. What technology or analytical approach currently holds the most immediate promise for reducing the number of false tornado warnings?

Answer. In the short-term (a few years), NOAA NWS is planning evolutionary changes and upgrades to the existing Doppler radar network that are expected to reduce tornado false alarm rates (in approximate chronological order):

1) NOAA will access data from the Federal Aviation Administration Terminal Doppler Weather Radar (TDWR), as these radars are better able to discern storm winds than NEXRAD (under certain conditions at the same range). The combination of NEXRAD and TDWR data across the United States will result in finer sampling of winds and weather and will improve overall coverage.

2) New radar software (i.e. Open Radar Data Acquisition) will allow measuring the distribution of winds in small chunks of atmosphere (i.e., resolution volumes). Particular wind signatures that can be detected by radars with improved resolution can discern tornadoes; this data can reduce tornado false alarm rates.

3) Dual polarization radar and improved spectral analysis promise improved detection of tornadoes indirectly by identifying debris, key storm structures (e.g., mesocyclones, precipitation types known to affect tornado formation), and tornadic wind signatures. Recent research indicates there may be predictive value in knowing whether rain or hail is falling near the region of storm rotation at low levels, and dual polarized radar provides this information.

A longer-term approach to reduce tornado false alarm rates is the use of high-resolution numerical weather models capable of assimilating radar and surface weather data to generate detailed near-real time information on storm development and evolution. Forecasters will be better able to estimate storm tornado potential and reduce false alarms with supplemental information about the inside of the storm. These models are undergoing research and development.

The ideal way to reduce tornadic false alarm rates is to have high-resolution real-time measurements of winds within the storm cloud, as this affords the best chance of directly detecting actual tornadic conditions. These measurements could be achieved by systems such as networks of phased array radars at extremely high frequency combined with high-density surface observational networks. These technologies are currently being investigated.

From the perspective of our partners in the emergency management community, tornado false alarm rates are not considered a critical metric, as compared to improved detection and longer warning lead times. The feedback from emergency managers is that the cost of tornado false alarm rates is rather low in terms of warning communities whereas the cost of missing tornadoes is much higher and remains their key concern. In general, the decreased rate of false alarms is a consequence of improved detection and not a primary goal, as the technologies that improve tornado detection generally reduce false alarm rates as well (e.g., NEXRAD), as long as appropriate training is provided.

We are testing a new approach toward increasing the precision of our severe thunderstorm/tornado watches and warnings by redefining the areal extent they cover. This approach is called the "polygon warning" concept. This approach reduces the geographic area defined in most warnings (allowing us to warn for areas smaller than a full county), thereby reducing false alarms in terms of area and population warned. Preliminary results are quite promising.

We will begin another upgrade on the WSR-88D (NEXRAD) radar network late this summer: the Open Radar Data Acquisition unit. In addition to improving maintainability of the network, this technology will pave the way for future improvements in radar operations that will improve detection and warning.

We conduct annual training for all of our forecasters who issue warnings to make sure they are aware of the latest advances in the science of severe storm forecasting to provide the most accurate tornado warnings.

Question 15. What are the barriers to implementing this approach?

Answer. There are no real technical barriers to improving and implementing the evolutionary changes and upgrades to the existing weather radar network to achieve the short-term reductions in tornado false alarms.

Continued support for the "NEXRAD Product Improvement" program, along with substantial investment in research and development, will be required to improve the radar data processing/analysis and storm-scale model development.

Studies of the economic value of tornado false alarm rates and probabilities of detection should continue. Unless there is a major improvement in technology and science, a change in the false alarm rates will be accompanied by a similarly signed change in the Probability Of Detection. There is insufficient scientific knowledge available to assess the relative value of a high false alarm rate versus a low probability of detection.

Regarding reducing tornado false alarms in the long-term, developing and deploying networks of phased array radars across the United States, along with boundary-layer radars, are promising technologies. NOAA has a research effort underway to assess the long-term use of phased array radar.

Question 16. Are there gaps that the Committee should consider addressing? What are they?

Answer. We appreciate the Committee's willingness to work closely with NOAA on future gaps that impact NOAA's operations and research activities. As technology and other advances move forward in the fields of weather, climate, and environmental research, we will advise and look forward to working with the Committee on our efforts to engage the stakeholders, organizations and individuals impacted by NOAA's mission.

Question 17. I understand that the U.S. Weather Research Program was intended to facilitate the transition of new forecasting technologies and techniques from research to operations. What is the status of the USWRP today?

Answer. Yes, the U.S. Weather Research Program (USWRP) is focused on facilitating and accelerating the transition of new forecasting science and technology from research to operations. The Interagency Working Group (IWG), which is the decision-making body for the USWRP, is currently reviewing the program including its overall strategy and priorities. Although the program's focus and resource allocations may change as a result of the IWG's review, it is highly likely that the USWRP will continue to focus on coordinating weather research and on transitioning research to operations.

Specifically, the USWRP has prioritized research and development aimed at improving hurricane prediction, precipitation prediction, atmospheric observation strategies, and socio-economic impacts. The USWRP-supported Joint Hurricane Testbed (JHT) enables the transfer and operational implementation of new hurricane prediction techniques and technologies from the research community to NOAA's Tropical Prediction Center/National Hurricane Center. The USWRP also sponsors the Developmental Test Center (DTC) in Boulder, CO, which enables the transfer of new numerical modeling science to operations.

Question 18. Is the Hazardous Weather Testbed in Norman, OK the NWS's only such center? This type of facility seems to hold promise for moving new technologies from research to application. Are there plans for establishing more such centers?

Answer. No, the Hazardous Weather Testbed is not the only center of this type. Other test beds include the Joint Hurricane Testbed, the Developmental Testbed Center, the Hydrometeorological Testbed, and the Climate Testbed. All of these testbeds, including the Hazardous Weather Testbed, are designed to accelerate the transition of new science and techniques from research to operations.

The Hazardous Weather Testbed accelerates improved techniques for forecasting the initiation of severe thunderstorms and early detection of tornados into operational implementation. The Joint Hurricane Testbed at NOAA's Tropical Prediction Center/National Hurricane Center in Miami, FL, has been operating for five years and is accelerating research results into hurricane forecast guidance products, including hurricane model improvements. The Developmental Test Center (DTC) in Boulder, CO, focuses on improvements to regional weather modeling using the Weather Research and Forecasting (WRF) community model. The Hydrometeorological Testbed (HMT) is being established to accelerate improvements in heavy precipitation and flood forecasts.

The NOAA entities in Norman, OK, have an illustrious history of cooperation and collaboration in the exploration of new science and technology. The most outstanding example is the evolution, application, and deployment of Doppler weather radar. The Hazardous Weather Testbed is the latest iteration of this ongoing collaborative process, which we hope to emulate in other parts of the country where these kinds of partnerships and opportunities exist.

In addition to supporting the establishment of testbed facilities, NOAA has also established a research to operations policy and a committee to monitor, oversee, and improve the transition from research to operations, not only for weather and water, but also for climate, oceans and ecosystems.

Question 19. How should NOAA partner with academia and industry to improve its forecasts of severe storms and their impacts?

Answer. NOAA collaborates with academia, industry, and other governmental partners to develop goals, roles, and plans for improving severe storm forecasts and warnings. The newly formed American Meteorological Society's Weather and Climate Enterprise Commission, the NOAA Science Advisory Board, and the U.S. Weather Research Program are examples of venues that help facilitate this interaction. We also work with individual researchers and professors to bring state-of-the-art training to our forecasters through tele-training, workshops, and seminars.

NOAA will enhance its collaborative peer-reviewed research activities with academia and enhance data dissemination and warnings through the private sector in coordination with other Federal agencies with similar requirements. Any funded peer-reviewed projects should include those proposed by both the academic and the private sectors.

Question 20. I understand that Phased Array Radar systems have great potential for increasing the accuracy of tornado forecasting but I also know that they carry a big price tag. How exactly would a new PAR system improve the ability to predict tornados in Nebraska?

Answer. Changes in environmental conditions leading to tornado formation and continuing through a tornado's evolution occur on very small time scales. The new Phased Array Radar (PAR) system is capable of providing rapid updates on changing environmental conditions, five to six times faster then our current operational radars. Further, the phased array allows adaptive pointing of the antenna beam in directions where a tornado might be spawning, and allows in depth examination of such "hot" spots. The increase in resolution (number of data samples per time increment) is required to properly initialize high-resolution storm scale models. This is a developing area of research, but we feel there is a potential to blend real time observations with very short term forecasts (from minutes to tens of minutes), leading to the idea of "warning on forecast" rather than our current mode of "warning on observation." Warnings based on forecasts could increase the lead time of tornado warnings out to 25–30 minutes.

Question 21. What is the relative cost of a PAR system as compared to the current NEXRAD system?

Answer. The National Severe Storms Laboratory (NSSL) in Norman, OK, has been working closely with government, university and private sector partners to answer this question. According to the latest information from industry, by 2012 the cost of the phased array radar modules that make up the antenna array (the most expensive part of the radar; each antennae face has over 4,300 modules) is predicted to be reduced by a factor of 50. This means that the modules currently in use today at NSSL, which each cost $2,000 when they were produced in the late 1970s will cost $40 per module in 2012. This will reduce the cost of a four-faced antenna PAR system down to approximately $10–$15 Million per radar.

It is inappropriate to compare the two systems, especially since NEXRAD radars are no longer in production. Commercially developed Doppler radars are available, but come with many challenges to integrate the data into the NEXRAD network. The hardware for a commercial radar costs approximately $4M.

Question 22. Is there a difference in the total area each system can cover?

Answer. No.

Question 23. Is there a difference in the manpower required for each system?

Answer. At this time, it is not likely there will be any difference in manpower requirements between the two systems. More information on manpower requirements will become available as the phased array radar design progresses.

Question 24. What is the current status of the PAR system testing in Norman, Oklahoma?

Answer. The PAR system testing in Norman is on schedule. The system has been modified from a missile detection and tracking system used by the U.S. Navy to a system capable of collecting weather data. In the last 15 months, a limited amount of weather data on tornadic storms has been collected. Data quality appears quite good and compares well to the NWS WSR-88D. We are currently awaiting more weather events and are actively improving the radar features to speed up the data acquisition. At the same time, our partners at the Federal Aviation Administration (FAA) have developed an aircraft tracking processor as part of the plan to make the PAR a multi-function system. The FAA software will be tested on the PAR in late August.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JIM DEMINT TO TIMOTHY A. REINHOLDT

Question 1. In your testimony you discuss how risk modeling coupled with variable insurance pricing is helping to encourage homeowners to build storm resistant buildings. Do you know if this practice is widespread outside of the Southeast?

Answer. The practice is not even widespread in the Southeast, much less in the rest of the country. The two broad-based programs are in Florida and Texas where discounts have been mandated as part of a move towards more stringent codes and standards. Having said that, what is widespread is the use of basic catastrophe modeling to assess loss exposure and establish reserves and reinsurance needs. The move towards using these models to assess the value of mitigation measures is still somewhat in its infancy and has been driven largely by FEMA sponsored research and the need to establish some sort of a basis for the mandated discounts in Florida and Texas. While it is being used in these instances out of necessity, there are typically wide ranges in the overall loss estimates and even greater variability in the estimated benefits of particular mitigation measures.

Question 2. How successful has this approach been in Florida in terms of getting people covered by insurance? Has it made insurers more willing to stay in the market?

Answer. I can't comment on the influence of mitigation activities on availability or cost of insurance. However, where we are beginning to see movement in getting people to take protective measures has been when the amount of money on the table becomes large enough to make a difference in the return on investment. That has been particularly evident for properties in the Florida Wind Pool (Citizens) where large increases in premiums coupled with larger percentage reductions in premiums for mitigated properties have generated savings that can run into thousands of dollars.

Question 3. Ultimately, what do you think needs to be done to have more standardized building codes?

Answer. I do not believe that we are likely to see a federalization of building codes and standards. However, we have seen a merger of the National Model Building Codes (Standard Building Code, Uniform Building Code and Building Officials and Code Administrators Code) into a single International Code Council set of codes. These codes and standards are debated and developed in a consensus process at the national level and provide for local variations in hazards and risk. Unfortunately, in most states, the adoption is left to individual jurisdictions (counties, parishes, municipalities and cities) and these frequently change the model code provisions to suit the desires of local special interest groups. We believe that the states need to move towards statewide adoption of the model codes without local amendments that would weaken the provisions. We think that the Federal Government can help with this process by helping to create incentives for the states to adopt the model codes and ensure that they are well administered and enforced.

Question 4. What needs to be done or can be done to make older buildings safer?

Answer. Without a doubt, it is more effective and less costly to build well the first time than to come back and apply remedial measures after the fact. Having said that, I would offer the following suggestions for reducing the vulnerability of homes to windstorm or hurricane related damage. The first list is one that is best suited for construction of new homes. Following that, I have prepared a shortened list of the most practical items for retrofit.

The Key Structural Features for Hurricane Resistance of Homes Include:

- Enough elevation to avoid storm surge or flooding.
- If you are in a storm surge area, the pile foundation must be deep enough to prevent damage or failure from scouring of the beach.
- The home needs to be well built with all parts tied together with appropriately sized metal connectors and structural sheathing (plywood or oriented strand board) for wood frame construction or reinforcing if it is masonry construction.
- The roof structure needs to be well anchored to the walls using hurricane straps and the roof sheathing needs to be fastened to the roof structure using the latest code requirements for nails or preferably attached with ring-shank nails.
- If the home has one or more gable ends with a gable that is more than about 3-feet tall, the gable should be braced to keep it and the wall below from blowing in or being sucked out.
- Porches and carports should be well anchored to their foundations and support structure and pool enclosures should have hefty anchors at the end columns and

substantial diagonal bracing (cables or metal tubes running along diagonals) to keep them from blowing over.

- If the home is located in an area where the building code specifies gust design wind speeds of 120 mph or higher or if the home is within 1-mile of the coast and the design wind speed is greater than 110 mph, it should be outfitted with a code approved protection for windows and doors and a wind pressure and debris impact rated garage door.
- Purchasers of newer homes should be aware that some codes have allowed homebuilders to choose to strengthen the structure and connections as an alternative to providing window and door protection. If that is the case, you may well have a stronger house structure but you may have wind and water blowing through your house, ruining the contents and interior, if you get hit by a strong storm.

For Older Homes:

The structural wish list for older homes is similar to the one listed above for newer homes. However, if there are no hurricane straps or the house is not particularly well tied together, it can be very costly to fix the structural connections. If this is the case, then the priority for installing window and door protection and ensuring that the garage door is wind and impact rated or protected goes way up. Keeping wind out of the home by protecting the openings can give the home a fighting chance when a hurricane strikes, even if the structural connections are not what we would want in a home built today. If your home is not well connected, make your preparations early and evacuate to a better built refuge.

The easiest thing to add that will have an impact on protecting the structure is protection for windows and doors. If the house has a shingle roof, when the house is re-roofed, the home owner can also have the roof sheathing re-nailed and a self adhesive flashing tape installed over the joints between the roof sheathing for a relatively nominal cost. A high-wind rated roof covering should be selected and installed according to the manufacturer's recommendations for high wind areas. Anchorage of porches, carports and pool cages can be improved at a reasonable cost. Gable end bracing can also be installed to reduce the chances that the gable ends will give way. Most of these things can be added later, but when someone is financing the home, they may want to see if they can add some of these retrofits into the purchase price or loan.

Take a good look at the area surrounding the home. If there are significant sources of wind borne debris like flat roofs with gravel or tile roofs, then protection of glass becomes even more important. Evaluate trees in the area surrounding the home. Trees can be helpful in reducing wind loads on the house up to the point where they blow over onto the home. Tall pine trees are a particular concern because they can crash through the roof and walls like a guillotine. Pruning of trees to reduce their sail area can be an important mitigation measure if there are lots of trees near the house.

There are real limits to what can be done for tile roofs short of removing them and re-installing tile with mechanical or adhesive products or a combination of the two. Tile roofs do seem to have a higher failure wind speed threshold than older shingle roofs, but the repair costs are much higher when they do fail. For shingle roofs, homeowners can adhere the tabs to the shingles below using an asphalt roofing cement as a stop-gap measure until the house is re-roofed. Start with shingles around the edges of the roof and work towards the interior if the shingle tabs are not well sealed.

There is at least one bracing system for garage doors that has Florida Building Code approval. In other cases, garage doors are either being shuttered or replaced with a wind pressure and debris impact rated product. The effective bracing of existing garage doors requires structural braces that keep the door from bowing and buckling as well as bracing of or replacing the tracks that support the rollers.

A lot of soffits were blown out during the Florida hurricanes last year and water got into the attics and walls. Vinyl and aluminum soffit material that is not attached to a backup wood structure should be strengthened. Sealing around windows and openings in walls can also help keep water from getting into the walls of the home.

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