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WEATHERING THE STORM: THE NEED FOR A NATIONAL HURRICANE INITIATIVE

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

JULY 28, 2009

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

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CONTENTS

WITNESSES

APPENDIX

WEATHERING THE STORM: THE NEED FOR A NATIONAL HURRICANE INITIATIVE

TUESDAY, JULY 28, 2009

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10 a.m. in room SR–253, Russell Senate Office Building, Hon. Bill Nelson, presiding.

OPENING STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Senator NELSON. Good morning. Welcome to the Commerce Committee.

We are joined by a distinguished group of experts. The Assistant Administrator for Oceanic and Atmospheric Research, Dr. Richard Spinrad, leads the office at the National Oceanic and Atmospheric Administration. Dr. Spinrad is going to discuss NOAA's efforts to improve research for predicting, modeling, and forecasting hurricanes, the agency's work with coastal States to assess vulnerability to hurricanes, and their efforts to try to create something that we all desire, which is a disaster-resistant community.

Dr. Kelvin Droegemeier is the Associate Vice President for Research and Regents Professor of Meteorology at the University of Oklahoma. Dr. Droegemeier is testifying today on behalf of the National Science Board's Task Force on Hurricane Science and Engineering. He will discuss the task force findings in their report, "Hurricane Warning: The Critical Need for a National Hurricane Research Initiative." Dr. Gordon Wells, a Program Manager in the Center for Space Research at the University of Texas at Austin. Dr. Wells has worked on synthesizing satellite imagery, GPS signals, and the best hurricane and storm-surge models available to support coastal evacuation. His testimony will address the current state of science, the data needs of stakeholders, as well as future needs to improve research for predicting, modeling, and forecasting hurricanes.

Ms. Leslie Chapman-Henderson is the President and CEO of the Federal Alliance for Safe Homes, a national nonprofit dedicated to strengthening homes and safeguarding families from disaster. Her testimony will address how model building codes can improve the resiliency of structures and reduce the economic cost of post-storm recovery efforts. A lot of her experience comes from the after effects that Florida suffered after the mega-hurricane, Hurricane Andrew, in 1992.

Mr. Frank Nutter is the President of the Reinsurance Association of America. He currently serves on the board of the International Hurricane Research Center, the Council of American Meteorological Society, and the board of the University Center for Atmospheric Research. He will address the economic impacts of hurricane planning, damage, and recovery on vulnerable communities.

We thank you all. Dr. Droegemeier, I want to especially thank you. You left your vacation early to come back so you could testify today, so thank you very much.

I could say all of the obvious things about the destructive force of hurricanes. The fact is that we have this extraordinarily vulnerable coastline, and most of the population of America is along the coast. Certainly that's the case with regard to my State of Florida. We can see that this is an enormous cost, not only to insurance companies, to people, and to States, but also to the U.S. Government, and therefore, the people of this country.

It's also deadly; 2,000 deaths in the United States since 2003, and account for 66 percent of the insured losses due to natural hazards, hurricanes, and other tropical cyclones. You just think about it. It was the hurricane of 1928 that killed, drowned, 2,000 people in and around Lake Okeechobee. What a turning point in our history that was. We're experiencing a similar kind of thing with regard to the number of deaths since 2003.

Images like that, that's Hurricane Charley, a Category 3. It covered up virtually the entire State of Florida. Charlie, by the way, was the first of four hurricanes in 2004. Within a 6-weeks period, four hurricanes hit Florida. Hurricanes hit virtually every part of the State within that 6-weeks period. That's a typical kind of destruction. I'm going to insert the rest of my introductory comments.

[The prepared statement of Senator Nelson follows:]

PREPARED STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Hurricanes are amongst the most destructive natural phenomena on earth. With our expansive, vulnerable coastline, the United States experiences physical and economic damage, disruption of commerce and business, and loss of life as a result of hurricanes.

Hurricanes and other tropical cyclones have directly caused more than 2,000 deaths in the United States since 2003 and account for approximately 66 percent of insured losses due to natural hazards.

This image from Hurricane Ike in Galveston, and the images we watched with sadness on the news after hurricanes Andrew in Miami and Katrina in New Orleans, leave no doubt as to the destructive potential of hurricanes; a destructive potential that not only impacts all aspects of our built environment—our homes, businesses, and roadways, but also fragile coastal ecosystems that are already under considerable threat.

More hurricanes have ripped through my home state of Florida than any other state in the Nation. Forty percent of all land-falling hurricanes in the U.S. hit Florida. Of those storms, hurricanes Andrew, Wilma, Charley and Ivan together cost more than $100 billion.

While hurricanes tend to strike in the coastal regions along the Gulf of Mexico and Atlantic seaboard, many other areas of the country feel the impacts of hurricanes. As these storms move away from the coast and into the interior of the US, they carry tropical air with them, which has caused some damaging floods in areas such as the upper Ohio Valley, a region well removed from the initial coastal impacts. Further, hurricanes in the eastern Pacific send forth streams of moist air thousands of miles long up the northwest coast. When this warm air interacts with a passing extratropical storm the result can be flooding and landslides in Oregon and Washington State.

And there are farther reaching national effects. For instance, the disruption and damage done by Katrina to oil extraction and production facilities in the Gulf of Mexico and New Orleans resulted in an almost immediate spike in fuel prices, a 2–3 percent increase in the consumer price index, and a 10–15 percent increase in the transport consumer price index. Hurricane Katrina caused at least ten oil spills, dumping in total more than 7.4 million gallons into the Gulf Coast region's waterways. That's more than ⅔ the amount that spilled during America's worst oil disaster, the rupturing of the Exxon Valdez tanker off the Alaskan coast in 1989.

The American public is increasingly aware of the potential for high recovery costs and financing of natural disaster losses. The importance of prior preparation and insurance coverage for large catastrophic risks, including natural disasters such as hurricanes and earthquakes and efforts to promote a stable, affordable catastrophic insurance market cannot be understated. Insurance in affected regions has become either too expensive or simply unavailable to many customers. Many states like Florida have turned to state operated insurance and other vehicles to prepare for these large catastrophic risks.

Senator Martinez and I have introduced several bills this year because we want a pro-active approach to addressing these natural catastrophe concerns.

These bills include the Homeowners Defense Act, the Catastrophic Obligation Guarantee Act, the Commission on Catastrophic Disaster Risk and Insurance Act, the Policyholder Disaster Protection Act, the Catastrophe Savings Accounts Act of 2009, and the bill that we are here to discuss today—the National Hurricane Research Initiative Act of 2009.

The National Hurricane Research Initiative Act of 2009 will create a coordinated Federal hurricane research program focusing on high priority scientific, engineering, and socio-economic studies; and effectively applying the research results to improve forecasts and to mitigate the impacts of hurricanes on society. Investing in a national hurricane research initiative will help the Nation better prepare, respond to and recover from hurricanes. And, translating the research and developments into practice through adaptation and mitigation will repay the investment many times over.

I look forward to hearing from our distinguished witnesses on their observations and recommendations on this important national issue.

Senator NELSON. And I would call on Senator Vitter, our Ranking Member of our Subcommittee.

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

Senator VITTER. Thank you very much, Mr. Chairman.

I want to welcome and thank all of our witnesses. I'm very much looking forward to the testimony.

I'm here for a pretty obvious reason, too, just like you are, a natural interest in these phenomenons, representing Louisiana. Of course, the best-known example of a hurricane to hit Louisiana recently is Katrina, which caused enormous devastation, beginning with the death of over 1800 people. But, sort of like Florida, Louisiana has experienced multiple hurricanes in the last few years alone. Right after Katrina, we had Hurricane Rita, which was very, very serious, that particularly hit southwest Louisiana and southeast Texas, and then Hurricanes Gustav and Ike, since then.

I won't go through all the statistics, all the devastation, the death, and the dollar loss, but clearly, particularly in places like Louisiana and Florida, the Gulf Coast, but also our other coasts are vulnerable, as well. I think there is a clear need for advanced and increased research in many areas, areas like understanding and predicting: predicting hurricane intensification and size, and reducing the uncertainty associated with where and when hurricanes make landfall; understanding air-sea interactions; predicting storm surge, rainfall, and inland flooding; and improved observations.

Also, in the broad category of impacts, I think we need to understand even better the interaction of hurricanes with engineered structures, the economic and social impact of hurricanes, and mitigation measures, and the interaction of hurricanes with natural ecosystems.

The third big category is preparedness and response measures, and certainly we have a lot of additional work to do there: assessing and improving the resilience of the built environment, disaster response and recovery, and certainly I'm working very hard with many members regarding a much more streamlined bureaucracy at FEMA, human behavior and risk planning, and evacuation planning. Evacuation is absolutely critical, particularly to lessen and mitigate any impact on people and any possibility of human deaths.

So, I look forward to all of your testimony and look forward to continuing on the track of significant and aggressive research in all these areas, using our resources at NOAA and across the Federal Government.

Thank you, Mr. Chairman.

Senator NELSON. Senator Martinez, my colleague and my cosponsor——

STATEMENT OF MEL MARTINEZ,
U.S. SENATOR FROM FLORIDA

Senator MARTINEZ. Thank you, Mr. Chairman.

Senator NELSON.—share some comments.

Senator MARTINEZ. You weren't going to call me "Martin-ez," were you?

Senator NELSON. Excuse me?

Senator MARTINEZ. You almost called me "Martin-ez," I thought.

Senator NELSON. Oh, no, not at all.

Senator MARTINEZ. OK, good.

[Laughter.]

Senator NELSON. I mean, I know better; I'm from Florida.

Senator MARTINEZ. I could take that from someone else, but not from you. Thank you very much, sir.

[Laughter.]

Senator MARTINEZ. We are so pleased to have you here today, and so glad to have this hearing on something that is so, so important to the Gulf States, for sure, but, we think, really to the whole country.

During my time in the Senate, I've been very focused on this problem, and I've worked very closely with my dear friend and colleague, Senator Nelson, as well as others here in the Capitol, to try to look for ways that we could get more expertise, more research, get some of the very brightest and best in our science and government, academic institutions, and the private sector, to better understand hurricanes.

According to the National Science Board, from 2002 to 2007, hurricanes cost approximately $180 billion in losses, compared to $14 billion from earthquakes, yet there isn't a nationally targeted research initiative for hurricanes, like the National Earthquake Hazard Reduction Program. These deadly storms have killed over 2,000 people in the last 6 years, and with the majority of our Nation's population living near the coast, it is critical that we begin to have

more coordinated and targeted strategy for dealing with hurricanes.

There's no doubt in my mind that, in a State like Florida, this is very, very much connected to the future of our State as we look at the economic damage that can occur, but also the problem that we've had with insurance, which I know we'll be addressing today.

And I should also say that, as a neighbor to the Caribbean Basin and to Central America, that so much damage and devastation has occurred in that region in the last several years. And it does, seasonally, because it is an area that is prone to these kinds of events. And so, the kinds of research that we can do will not only be of great benefit to our country—we'll save, as we do more mitigation, billions of dollars in after-storm cost—but it will also be of some real help to our neighbors and countries who really have a lot less wherewithal to deal with these problems themselves.

So, thank you for being here. I look forward to your testimony.

Senator NELSON. Gracias, Senador Martin.

[Laughter.]

Senator MARTINEZ. All right, touché.

Senator NELSON. All right. Now, as we discussed, what we're going to do is, not read a bunch of boring statements. I want to have a conversation. I want to have a dialogue, and I want you to bring it out. What I'll do is ask a couple of questions. We're not going to have a time limit. Then I'm going to throw it to you, Senator Vitter, and then to you, Senator Martinez.

[The prepared statements of Dr. Droegemeier, Mr. Nutter, Dr. Spinrad, Dr. Wells, and Ms. Chapman-Henderson follow:]

PREPARED STATEMENT OF DR. KELVIN K. DROEGEMEIER, PROFESSOR OF METEOROLOGY, UNIVERSITY OF OKLAHOMA; MEMBER, NATIONAL SCIENCE BOARD; AND CO-CHAIRMAN, TASK FORCE ON HURRICANE SCIENCE AND ENGINEERING

I thank Chairman Rockefeller, Ranking Member Hutchison, and the other Members of the Committee for the opportunity to speak today. My name is Kelvin Droegemeier and I am Associate Vice President for Research, Regents' Professor of Meteorology, and Weathernews Chair at the University of Oklahoma. I also am a member of the National Science Board (Board) and am appearing before you today in my role as Co-Chair of the former Task Force on Hurricane Science and Engineering of the Board. The final report of this Task Force was released on January 12, 2007.

As you are aware, every year hurricanes pose a threat to life, property, and the very economic vitality of our Nation. We spend billions of dollars on rescue and recovery after hurricanes occur, and yet hurricane research is a modest, loosely coordinated enterprise. Although of high quality, this research is conducted within the boundaries of traditional disciplines—stovepipes like meteorology, hydrology, engineering, computer science and ecology—with insufficient integration. And the engagement of social, economic, behavioral sciences—which is foundational to actually turning physical science and engineering research into useful practice—is woefully inadequate. In short, the hurricane is perhaps one of the best examples of a problem—absolutely vital to society—which *must* be studied in a multi-disciplinary fashion if we hope to lessen our vulnerability.

In recent years, the National Science Foundation (NSF) has supported research dealing with the geophysical, social, and engineering aspects of hurricane processes and the resultant impacts on society and the environment. This research has included the study of the physical genesis and lifecycles of hurricanes, the development of new simulation and forecast models of hurricane processes, the effect of land-falling hurricanes on ecosystems and the natural environment, the impacts on social systems in hurricane impacted areas, the engineering and structural aspects of damage resistant practices in areas prone to hurricane exposure, and damage assessment of facilities and infrastructure in hurricane impacted areas.

Despite the excellent research funded by NSF, there are still many areas that need to be addressed. While advances have been made during the past decade in meteorological understanding and prediction, we still know relatively little about the most important aspects of hurricanes from an integrative perspective, including their internal dynamics and interactions with the larger-scale atmosphere and ocean; methods for quantifying and conveying uncertainty and mitigating hurricane impacts; associated short and long term consequences on the natural and built environment; and the manner in which society responds before, during and after landfall.

Additional research relevant to hurricane understanding, prediction, mitigation, consequences and societal responses is especially needed in the social, behavioral and economic sciences. Communities are often overwhelmed with sometimes conflicting information regarding risk planning and procedures for action. Additionally, effective training and outreach activities, involving policy and decisionmakers, are needed to ensure that research efforts are appropriately applied, thus meeting the societal demand for protection of life and property and responsible management of resources. Finally, the social impacts of human-induced changes to coastal and offshore vulnerability—ranging from land use development and practices that drastically modify the fate of precipitation runoff to social demographics of communities and their mobility—must be better understood and effectively incorporated into societal decisionmaking.

Specific areas of concern raised in the National Science Board's 2007 report, *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative*, include: (1) Impacts—including interaction of hurricanes with engineered structures, economic and social impacts of hurricanes and mitigation measures, and interactions of hurricanes with natural ecosystems; (2) Preparedness and Response Measures—that is, assessing and improving the reliance on the built environment, disaster response and recovery, human behavior and risk planning, and evacuation planning; and (3) Crosscutting Activities—such as computational capability, and training and education programs related to hurricane impacts. In that report we note, moreover, that many of the hurricane research efforts conducted to date are narrowly focused, with limited coordination across disciplines. This makes it difficult to engage the more challenging questions, the answers to which are not obtainable with short-duration studies. The bottom line is that many of the disciplines for which hurricanes are an important research challenge (*e.g.,* physical science, engineering, social science, behavioral science, and economics) do not regularly interact, resulting in a myopic view that limits the effectiveness of problem formulation and translation of research outcomes into operational practice. Efforts are needed to bridge communications across disciplinary boundaries through workshops and interdisciplinary research approaches.

The Board encourages interdisciplinary research and NSF is experienced at supporting research that crosses disciplinary boundaries. The Board's Hurricane Task Force found in our roundtable discussions with the science and engineering community that researchers from multiple disciplines are eager to work with one another. An example of this is that in FY 2008 NSF and the National Oceanic and Atmospheric Administration issued a joint announcement calling for proposals to advance fundamental understanding of the communication of hurricane outlooks, forecasts, watches, and warnings both to decisionmakers (*i.e.,* emergency managers, elected officials) and to the general public. NSF is also discussing with other agencies their interests and how coordination can be improved, taking into account the priorities related to hurricanes under development by the Disaster Reduction Subcommittee of the National Science and Technology Council's Committee on Environment and Natural Resources.

On behalf of the National Science Board and our Chairman, Dr. Steven Beering, I want to thank the Committee for the important work they do for U.S. scientific research, education, and training. We understand and appreciate that the Federal Government is undergoing significant budget pressures at this time, but the future strength of the Nation depends on the investments we make in science and technology today. We appreciate your attention to the recommendations of the Board concerning hurricane research and stand ready to assist in whatever ways might be most beneficial.

PREPARED STATEMENT OF FRANKLIN W. NUTTER, PRESIDENT,
REINSURANCE ASSOCIATION OF AMERICA

My name is Frank Nutter and I am President of the Reinsurance Association of America (RAA). The RAA is a national trade association of property and casualty

reinsurers doing business in the U.S. Its membership is diverse, and includes reinsurance underwriters and intermediaries licensed in the U.S. and those that conduct business on a cross-border basis. It is a pleasure to appear before you today on "The Need for a National Hurricane Research Initiative." The RAA supports efforts to enhance the science of hurricanes. We also strongly endorse increased Federal funding for hurricane research and forecasting. These research initiatives are critical to efforts to minimize the economic and human loss associated with hurricanes. Today, my testimony will address the economic impacts of hurricane activity and the reinsurance perspective on managing risk by promoting the conservation of our natural resources and through risk mitigation efforts along our densely-populated coastlines.

I want to thank Senators Martinez and Nelson for their sponsorship of S. 1485, the National Hurricane Research Initiative Act of 2009, a bill that would enhance the country's hurricane research agenda in a manner that would strengthen our ability to protect citizens and property, and lessen the financial burden to society of the aftermath of the most intense storms. The bill's research priorities target key elements such as forecast model development and improved observations, both of which would contribute to better prediction of hurricane intensity and structure; storm surge and aftermath flooding; and the relationship between hurricanes, climate change, and ecosystems. But considering the enormous costs associated with major storms that I will discuss in my testimony, we would support a greater level of funding for the National Hurricane Initiative, such as that recommended in H.R. 327, which authorizes $150,000,000 to be appropriated for each of Fiscal Years 2009–2013.

U.S. Reinsurance Industry's Support for Hurricane Research

(Re)insurers have a keen interest in improved hurricane forecasting and risk management as a means to reduce economic loss. The insurance industry's financial health is inter-dependent with climate and weather. The risk of natural events drives the demand for property insurance coverage, yet if not properly managed, it can threaten the financial health of an insurer. An insurance company's financial viability rests on its ability to estimate the economic consequences of future events. Because of this, the insurance and reinsurance industries have long supported private and public sector research efforts to better understand the frequency, severity, financial impact and mitigation of natural catastrophes, particularly hurricanes. Of special note are Munich Re and Swiss Re, which have devoted significant resources to study hurricane activity and made the results of these studies publicly available as a means to enhance appropriate risk management strategies. In addition to the success of the Federal Alliance for Safe Homes (FLASH), represented in this hearing by Leslie Chapman-Henderson, two private insurance sector research initiatives are noteworthy. The Willis Research Network, which is funded by the Willis Group—an insurance and reinsurance intermediary—is the largest collaboration between academia and the reinsurance industry to further the understanding of natural hazards and translating that understanding into effective risk management tools. The Willis Research Network has supported open academic research posts at the National Center for Atmospheric Research, Princeton University, and the University of Colorado with particular emphasis on high resolution modeling and forecasting. The Willis Research Network has established a liaison group between academics in the United Kingdom and the United States and global insurers.

The Institute for Business & Home Safety (IBHS) is another example of private sector research focused on reducing the social and economic loss from natural disasters. Partnering with manufacturers, insurers, and research groups, the IBHS has long advocated for stricter building codes for residential and commercial construction—especially along our coastlines—as well as better land use planning and improved building design and materials as risk mitigation strategies. Just last week, the IBHS announced that construction will shortly begin on its multi-peril, applied property loss research center. The center's research will focus on catastrophe-related exposures, including the natural hazards of wind, fire, wind-driven water intrusion, earthquake and hail.

Ultimately, collaborative public and private sector research efforts such as these will assist public policymakers, public officials and private sector interests in better understanding the dynamics of hurricanes and appropriate mitigation and adaptation strategies.

The Economics of Hurricanes

A report by the Risk Management and Decision Processes Center of the Wharton School—"Managing Large-Scale Risk in a New Era of Catastrophes"—observes that two principal socio-economic factors directly influence economic losses due to a catastrophic event: the increasing degree of urbanization and value at risk. The U.S.

Census Bureau data bears this out: 35.7 million Americans live in coastal counties most threatened by hurricanes; essentially the coastal populations from North Carolina to Texas—approximately 12 percent of the U.S. population. As a result, from 1980 through 2005, 29 percent of the Nation's population lived in a county that experienced at least one hurricane. This combination of urbanization and increasing property values translates into increased concentration of exposure in areas at high risk for hurricanes and extreme storms. Gulf and Atlantic Coast insured property exposure totals $9 trillion. Of this insured coastal exposure, $2.4 trillion is in Florida; $2.4 trillion in New York; $900 billion in Texas; $775 billion in Massachusetts; $635 billion in New Jersey; $480 billion in Connecticut; and $224 billion in Louisiana.

Catastrophe modeling firm AIR Worldwide estimates that catastrophe losses will double every decade due to this growing residential and commercial density. Since the first $1 billion-plus hurricane insured loss in 1989 (Hurricane Hugo), Munich Re reports that economic losses (insured and uninsured) of greater than $1 billion have risen dramatically: $60 billion in 2004; $170 billion in 2005; $58 billion in 2008. This reflects a rise in the number of global meteorological (storm), hydrological (flood) and climatological events, while geophysical events (earthquakes and volcanic eruptions) have remained steady. Worldwide in 2008, there were nearly 700 such extreme atmospheric events; over 900 in both 2007 and 2006.

According to the Insurance Information Institute, the U.S. insurance industry has reported $170 billion of insured hurricane related losses since 1988. Although that number is significant, estimated losses (in 2009 dollars) for past hurricanes based on current exposures [1] are more notable:

	Today's Economic Loss	Today's Insured Loss
• 1900 Galveston, Texas	$94 billion	$33 billion
• 1926 Miami Hurricane	$180 billion	$80 billion
• 1938 Long Island, NY	$45 billion	$35 billion
• 1960 Hurricane Donna (FL–ME)	$44 billion	$26 billion
• 2005 Katrina, Gulf Coast	$91 billion	$41 billion

Natural Hazard Mitigation

In addition to appropriating increased funding for hurricane research and improved forecasting, Congress should help people living in hurricane-prone coastal areas take proactive mitigation and adaptation steps to protect their property, rather than encourage unwise development in these high-risk, environmentally-sensitive locales. The research arising from new Congressional funding will assist in the assessment of planning aimed at mitigation and adaptation.

The RAA has partnered with environmental groups in support of the following principles:

- *Build Smart*: Based on the continuing scientific assessment of the effects and consequences of a changing climate, property and infrastructure in coastal areas and other high-hazard areas should be built, replaced or repaired according to the most modern building standards and codes reflecting exposure to natural disasters and effective loss-reduction measures.
- *Encourage Safety*: Government incentives should promote risk-avoidance and proactive mitigation measures to protect the public from a broad range of natural disasters, including wind, flood, wildfires and earthquakes.
- *Use Nature:* To protect both the public and ecosystems that provide natural "buffers" to storms, renewed efforts should be made to preserve coastal areas consistent with effective state and Federal laws, using uniform, objective standards.
- *Insure Based on Risk*: Private and public property insurance programs should be established on the basis of risk exposure, including catastrophic risk.

Consistent with these principles, the RAA supports legislation to encourage homeowners, businesses and other property owners to reinforce their homes, buildings, and properties to mitigate damage from natural disasters. For instance, we support legislation introduced by House Committee on Homeland Security Chairman Bennie Thompson. The Property Mitigation Assistance Act of 2009 (H.R. 1239) would provide grants to states to set up loans to homeowners for mitigation; the Predisaster Hazard Mitigation Enhancement Act of 2009 (H.R. 3027) would provide mitigation grants to states to promote pre-disaster mitigation measures; and the Hazard Mitigation for All Act of 2009 (H.R. 3026) would fund mitigation efforts for publicly-assisted housing. Research has demonstrated that pre-disaster mitigation efforts are

[1] iCAT Damage Estimator

very effective in saving costs and even human lives. The National Institute of Building Sciences' Multihazard Mitigation Council estimated that FEMA grants made between 1993 and 2003 to mitigate the effects of natural disasters will save more than 220 lives and prevent almost 4,700 injuries over 50 years.

Additional Considerations

The RAA is also part of the Building Code Coalition whose goal is to enact legislation to amend the Stafford Act to enhance existing mitigation programs by encouraging states to adopt nationally-recognized model building codes for residential and commercial structures. With billions of dollars paid by the Federal Government and the private sector for disaster relief and rebuilding of communities, legislation that would enhance FEMA's ability to "prepare for, prevent, respond to and recover from disasters" is critically important.

We also support an increase in funding for FEMA's Pre-Disaster Mitigation (PDM) program. This program provides funds to states for community-based hazard mitigation activities identified in a State Mitigation Plan such as increasing building elevations, flood-proofing, improving the survivability of existing and new buildings, and relocating willing sellers from natural disaster prone areas. In 2007, the Congressional Budget Office found that projects funded through the Pre-Disaster Mitigation program between 2004 and June 2007 resulted in a reduction of future disaster spending of approximately three dollars for every dollar spent on these projects. We also believe that infrastructure projects funded through Federal appropriations consider, and incorporate measures to reduce, the risks of the potential impacts of natural disasters, such as windstorms and floods, particularly in light of the anticipated effects of global climate change.

Hazard mitigation programs are well-established as a cost-effective means to reduce the impact of natural disasters. In 2005, a Congressionally-mandated study by the Multihazard Mitigation Council (an advisory body of the National Institute of Building Sciences) concluded that cost-effective mitigation saves an average of four dollars for every dollar spent.

Land-use planning, largely the purview of local governments, is also key to reducing development in environmentally-sensitive, high-risk coastal areas. We support the Coastal Barrier Resources System which prevents structures proposed for construction in undeveloped, environmentally-pristine areas from purchasing Federal flood insurance. The Coastal Zone Management Act could provide a tool—essentially a climate adaptation tool—to ensure states are planning for the potential risks posed by the impacts of climate change. If blended with the State Hazard Mitigation Plans already required by the Stafford Act and approved by FEMA, the combination provides states with the planning tools they need to develop and implement a climate adaptation plan.

Climate Change

With 30 percent of the U.S. population living in coastal counties most exposed to hurricanes, extreme storms, and related storm surge, global climate change will increase U.S. citizens' exposure to property losses and potential loss of life, and disrupt and degrade ecosystems and natural features such as barrier islands, mangroves, and wetlands that act as natural buffers to wind and flooding. Enhanced funding for hurricane research will help us to better understand the relationship between hurricanes, climate change and ecosystems. Such research should require regional climate models operating at much higher resolution over climatic time scales than previously attempted. The development of regional climate models capable of resolving hurricanes and producing statistics on future climate will provide a database that can substantially extend and render more accurate risk assessment methods. As the Senate considers climate legislation, we encourage the adoption of appropriate provisions that require Federal and state governments to develop and implement adaptation programs that will enable us to better prepare for the impacts of climate change on our communities and natural environment. It is important that the activities and projects identified in these adaptation programs are implemented in a way that is consistent with Federal conservation and environmental law. This can be achieved through the use of vulnerability assessments, as well as through a variety of cost-effective programs and measures I mentioned earlier that would make our communities safer and our natural resources more resilient to the effects of climate change.

Conclusion

I commend the Committee for conducting this hearing to better understand the many effects hurricanes have of on our Nation's communities, and its support for increased Federal research on the science of hurricanes and hurricane forecasting. The RAA is committed to working with Congress for legislative measures to improve

mitigation, adaptation, and increase hurricane research funding. All legislative efforts should ensure environmentally-sound and fiscally responsible policy that will ultimately reduce the costs borne by Federal and state governments, insurers/reinsurers, and the American taxpayers, as well as save lives, protect habitats, and ensure our coastal areas thrive for future generations.

Thank you.

PREPARED STATEMENT OF DR. RICHARD W. SPINRAD, ASSISTANT ADMINISTRATOR, OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

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

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

Introduction

More than 50 percent of the U.S. population is living within 50 miles of the coast,[1] and roughly 180 million people visit the coast annually. The coastal population explosion over the last half-century translates to increased risks for these coastal communities. Annual U.S. hurricane losses average about $10 billion and a recent historical analysis of hurricane damages from 1900 to 2005 suggests that every 10 years economic losses sustained from land falling hurricanes doubles.[2] While NOAA has a very good record of forecasting and tracking hurricanes, because of the importance of these functions there is still a great need to improve. Advancement in these areas is a key priority for NOAA. Improvement in NOAA's ability to forecast hurricane track and intensity will support our partners in the emergency management communities at the national, regional and local levels, who depend on these forecasts to make decisions on how to secure their communities. Emergency managers need to know where a hurricane will make landfall and they need to know how strong the hurricane will be when it does make landfall, in order to make their determination on any necessary evacuation orders. Therefore, it is important our forecasts be as accurate as possible, to ensure evacuation orders are not issued unnecessarily, which is both costly and can undermine future evacuation efforts (if citizens do not trust in the forecast and do not evacuate). These forecasts, and the public's ability to rely upon them, are an essential factor in avoiding loss of life and injury and reduced property loss and economic disruption. Without accurate hurricane forecasts, it is difficult for emergency managers to take necessary decisive action to save lives and mitigate economic losses.

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

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

Need for Improved Hurricane Forecasts

Since 1990, hurricane forecast track accuracy has increased by about 50 percent through the use of enhanced observations, improved model guidance, and increased

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[1] *http://www.ofcm.noaa.gov/p36-isrtc/fcm-p36.htm; http://coastalmanagement.noaa.gov/partnership.html.*

[2] Pielke, R. A., Jr., J. Gratz, C. W. Landsea, D. Collins, M. Saunders, and R. Musulin, 2007: Normalized Hurricane Damages in the United States: 1900–2005. Accepted for publications in the *Bull. Amer. Met. Soc.*

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

The sense of urgency for improved hurricane forecasts is consistent with the overarching recommendations in three recent reports: the 2006 NOAA Science Advisory Board Hurricane Intensity Research Working Group report, the 2007 report of the National Science Foundation (NSF) National Science Board (NSB): *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative*, and the 2007 report issued by the Office of the Federal Coordinator of Meteorological Services (OFCM): *Interagency Strategic Research Plan for Tropical Cyclones—The Way Ahead*. All three reports recommend an increase in funding for hurricane and tropical cyclone research and development, and transition of research to operations. In addition, many studies and reports have shown that investments in forecasts and other warning information needed for community planners have a significant return for the nation, including the 2007 report issued by the National Hazards Review,[3] *Hurricane Forecasting: The State of the Art*, and a report from the Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences.[4]

Operational Needs

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

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

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

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

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

Federal Investments

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

- Easy access to current and planned observing systems;
- Increased high performance computing capacity and capability to allow for higher resolution models;

[3] Willoughby, H. *et al.*, "Hurricane Forecasting: The State of the Art", National Hazards Review © ASCE, August 2007, p.45–49.

[4] *http://www.nibs.org/MMC/MitigationSavingsReport/Part1_final.pdf.*

- Institutionalized and transition research to operations to ensure an efficient process to incorporate demonstrated research results in modeling and observing systems;
- A plan for sufficient operations and maintenance resources; and
- Enhanced interactions with the broader science and engineering community to provide increased understanding of hurricanes while using all available resources.

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

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

Building off the Nation's Interagency Strategic Research Plan

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

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

NOAA Strategy to Align with the Larger Community

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

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

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[5] Office of the Federal Coordinator for Meteorology (OFCM) P–36, 2007; *Interagency Strategic Research Plan for Tropical Cyclones—The Way Ahead*.

National Science Board, 2007; *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative*.

National Oceanic and Atmospheric Administration Science Advisory Board, Hurricane Intensity Research Working Group Majority Report.

Hurricane Forecast Improvement Project (HFIP)

NOAA established the Hurricane Forecast Improvement Project (HFIP) to develop a national, interagency 10-year plan to improve our one to 5 day tropical cyclone forecasts, with an emphasis on rapid intensity change. The goal of HFIP is to improve the accuracy and reliability of hurricane forecasts and warnings and to increase the confidence in those forecasts to enhance mitigation and preparedness decisions by emergency management officials at all levels of government and by individuals.

The scope of the HFIP plan encompasses research and development:

- To improve understanding, with emphasis on the phenomena related to predictability of rapid intensity[6] change;
- To improve observations and observational strategies for the hurricane and its environment;
- To uncover novel methods for data assimilation, to utilize the diverse range of existing and new observations;
- To advance high-resolution numerical prediction systems for hurricane forecast guidance; and
- To accelerate the transfer of research results into operational forecasting.

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

Below are four examples of our metrics:

1. Reduce average track error by 50 percent

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

2. Extend the lead time for hurricane forecasts out to 7 days

In 2003 the NHC extended the lead time of its forecasts from three to 5 days. However state and Federal emergency managers have expressed that 5 days is not enough time to prepare certain areas, due to population growth, infrastructure, resources, etc. Extending the forecast out to 7 days would help address their concern and need for longer lead times to ensure those impacted (the public, businesses, etc.) have sufficient time to prepare for, and evacuate from, an approaching hurricane.

3. Reduce average intensity error by 50 percent

In July 2006, the NOAA Science Advisory Board's Hurricane Intensity Research Working Group recommended the overarching goal for NOAA Research and Development activity should be to reduce the 48-hour hurricane intensity forecast error by 10 knots, or about one-half of a Saffir-Simpson Scale category. The current hurricane 48-hour official forecast intensity error is 15 knots or roughly the wind speed range for one category on the Saffir-Simpson Hurricane Scale. Due to the uncertainty in today's intensity (strength of storm) forecast, NHC suggests that emergency managers prepare for one category above the NHC official intensity forecast (*e.g.,* if NHC forecasts a Category 3 hurricane at landfall, emergency managers should prepare for a Category 4). A 50 percent reduction in intensity error will allow emergency managers to better focus their preparedness efforts. Reducing the uncertainty in the hurricane intensity forecasts will

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

also support evacuation decisions by identifying the coastal and inland areas of greatest concern for wind and associated storm surge.

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

4. Increase the forecast accuracy of rapid intensity change events

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

Key Successes of HFIP

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

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

NOAA's Role in Enhancing Community Resilience to the Impacts of Hurricanes

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

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

In the 2007 Ocean Research Priorities Plan and Implementation Strategy developed by the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology, research priorities to help increase community resilience to natural hazards were identified, including the need to "Apply understanding to develop multi-hazard risk assessments and support development of models, policies, and strategies for hazard mitigation. The H. John Heinz III Center for Science, Economics and the Environment and Ceres subsequently documented the impressive return on investment from storm mitigation and community prepared-

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

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

ness in their report, *Resilient Coasts: A Blueprint for Action*. The National Institute of Building Sciences showed that every dollar spent on mitigation saves about four dollars on recovery costs.[9] Still, efforts to increase community resilience to hazard impacts should not be confined to the built environment. Given the natural mitigation benefits, habitat protection and restoration are considered integral elements of hazard resilience. In fact, coastal wetlands in the United States are estimated to provide $23.2 billion worth of storm protection services each year.[1]

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

Some examples of current NOAA hazard mitigation work include:

Assessing Risks

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

Developing Plans

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

Implementing Strategies

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

Models and Observations

- NOAA is undertaking several activities to improve how storm surge forecasts and impacts information are developed and delivered. The NOAA Coastal Storms Program is working with the Northern Gulf Institute to convene a group of surge modelers and managers to develop a unified surge grid catalog for the Gulf. Such a tool will result in more accurate, faster, and cheaper surge analyses in the future.

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

Conclusion

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

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

PREPARED STATEMENT OF DR. GORDON L. WELLS, PROGRAM MANAGER, CENTER FOR SPACE RESEARCH, THE UNIVERSITY OF TEXAS AT AUSTIN

Thank you, Mr. Chairman, and Members of the Committee for the opportunity to talk with you today.

My name is Gordon Wells. I serve as Program Manager at the University of Texas at Austin's Center for Space Research. During major disasters, my team and I work in the State Operations Center of the Governor's Division of Emergency Management, where we use the results from a variety of forecast models to assist decision-makers, including the State's elected leadership, to make decisions in response to a crisis, such as the landfall of a hurricane.

The bill under consideration today to enact The National Hurricane Research Initiative receives my complete support and my request for your urgent consideration. In the 2 years since the National Science Board issued the report that serves as the intellectual foundation for Senate Bill 1485, Texas has experienced Hurricane Dolly, the second costliest hurricane to strike the U.S. coast in the month of July, and Hurricane Ike, which at $30 billion is the third all-time most damaging hurricane in U.S. history. By all available evidence, the problems to be addressed by the scientific enterprise enabled by Senate Bill 1485 are steadily escalating.

Improvements to forecast modeling and simulation covered by the bill are particularly important. Let me tell you why.

If Jack Colley, the Chief of the Texas Division of Emergency Management, were here today, he would emphasize that Texas mobilizes to respond to an emergency based upon threat and does not wait for a Presidential declaration or other assurances of Federal support before taking action. When a hurricane threatens the Texas Gulf Coast, thousands of local and state first responders perform tasks for which they have trained and exercised according to guidance issued by the Division of Emergency Management. The only way to prepare appropriate guidance to orchestrate such a widespread, multi-faceted effort is with reference to the results of model forecasts. For instance, in preparation for a hurricane, one of my first responsibilities in working with Chief Colley is to create the countdown clock for the contingency time line used by the state to synchronize response operations. For a Cape Verdes storm crossing the Atlantic, that clock is calculated by analyzing results from a series of long-range forecast models to estimate the timing that would potentially bring the storm to Texas. We might track a system for several days before triggering the 120-hour countdown for operations in response to a storm crossing the eastern Caribbean or entering the Gulf of Mexico.

If the storm does indeed intensify to become a tropical cyclone and follows a track toward the coast of Texas, forecast models are used to define the impact region that will likely be subjected to high winds, storm surge and inland flooding. Based on the projections, the state positions assets to meet the needs for evacuation, search-and-rescue and re-entry into the damaged area as well as the communications and logistical support necessary to maintain the continuity of local government.

Because storm surge is by far the most lethal danger accompanying a hurricane, the state places special emphasis on the results from hydrodynamic models, especially the Sea, Lake and Overland Surge from Hurricanes (SLOSH) model run by the National Hurricane Center and the Advanced Circulation (ADCIRC) model that we run on the NSF-funded Ranger supercomputer at the Texas Advanced Computing Center at the University of Texas. The ADCIRC model is the creation of a national team of modelers, including Rick Luettich of the University of North Carolina, Joannes Westerink of the University of Notre Dame, who originated the code for ADCIRC, Randall Kolar of the University of Oklahoma and Clint Dawson of the University of Texas at Austin, who has led the algorithm development for ADCIRC. While the National Hurricane Center's SLOSH model predicts the regional risk of

storm surge, the high spatial resolution and additional physical parameters computed by ADCIRC permit more specific forecasts to be made of the magnitude and extent of coastal inundation.

ADCIRC is run in three different modes. First, in forecast mode, it leverages the more than 60,000 processors available on the Ranger supercomputer to complete a high resolution run in just over an hour, allowing the impact forecast to be updated with each advisory issued by the National Hurricane Center. During Hurricane Ike, the ADCIRC model correctly predicted the magnitude of the storm surge that struck Galveston Island, the Bolivar Peninsula and inland areas of Chambers and Jefferson counties. With the forecasts made by ADCIRC and SLOSH, the state targeted search-and-clear operations in the predicted impact region. The teams led by Texas Task Force One rescued 634 individuals who could not self-evacuate before Hurricane Ike made landfall. Many would likely have died without the assistance of the U.S. Coast Guard, Texas Task Force One, Texas Military Forces and allied search-and-rescue teams.

ADCIRC is also run in forensic mode. Although it is difficult to find any positive outcome in the aftermath of a large hurricane, the evidence left behind by destructive storms can be used to calibrate and improve the performance of future models. Most of the high-resolution hindcasts of hurricanes Katrina, Rita and Ike have been produced using the ADCIRC model. Better physical descriptions of the hydrodynamic processes of large landfalling storms have resulted from these forensic investigations.

Finally, ADCIRC is run in a mode that facilitates the design and planning of future protective coastal infrastructure. In the wake of recent destructive hurricanes, both "soft" options, such as wetlands restoration and restrictions on land use practices, and "hard" options, such as the construction of seawalls and giant storm gates, have been proposed. One current idea is the Ike Dike conceived by William Merrill of Texas A&M University at Galveston. The Ike Dike would shield a sixty-mile section of the Upper Texas Gulf Coast, including Galveston Island, Galveston Bay and the Houston Ship Channel. To assess the concept, Clint Dawson and Jennifer Proft of the University of Texas at Austin have run ADCIRC simulations for Hurricane Ike with and without the proposed dike and for a "Mighty Ike" Category 4 version of the hurricane with and without the dike. These are the first of many computer simulations that can be used to test the effectiveness of different kinds of protective infrastructure. The results will allow the selection of the best combination of design elements capable of withstanding a multitude of different hurricane landfall scenarios.

In support of The National Hurricane Research Initiative, I would amplify two subjects that are contained in Senate Bill 1485 with additional emphasis based on my own experience.

First, the bill authorizes the development of a National Infrastructure Data base to characterize the physical, social and natural infrastructure of coastal regions. Although the language mentions social factors, their importance is not highlighted to the same extent as the physical factors. As a major hurricane approaches the coast, the "threat geography" is not defined solely in terms of the magnitude and distribution of the physical impact to the region, where high winds, storm surge and inland flooding will occur. Beyond the physical risks, it is equally important to know the character and geographic distribution of vulnerable populations in the impact area. The concentration of certain portions of the coastal population, including elderly, fixed-income residents living in older housing stock, individuals who are homebound with medical special needs, low-income, single-parent families and those who do not speak English as their primary language among many other social factors need fully documentation. The intersection of these societal vulnerabilities with the physical risks, where the geographic distributions of the physical and social components overlap, defines the threat geography of the disaster. First responders need to know more than simply where the worst physical impacts are predicted to occur. They need to know who will be affected and where they live.

Second, while the bill discusses many requirements to improve our scientific knowledge of hurricanes and our ability to model and forecast their dangers, it contains little specific language describing how that knowledge needs to be communicated to the public. The greatest problem facing our coastal population is the failure of individuals to understand their personal risk to a natural disaster. Victims of events are often heard to comment that indeed they knew that the hurricane was going to be bad, perhaps as bad as or worse than one they had lived through, but they did not believe that the storm would be so bad in their part of town, in their neighborhood or in their home. Greater emphasis must be placed on communicating the results of forecast modeling and simulation to the public in ways that enable the comprehension of personal risk. Advances in the visualization of model results,

particularly in the production of photorealistic, three-dimensional portrayals of inundation and wind damage at the neighborhood level, offer new techniques to inform the public. Studies should be conducted with a cross-section of coastal residents to determine what methods of communication are most effective in leading citizens to make accurate judgments of their level of personal risk and then take effective measures to ensure their own safety.

Having summarized these areas deserving additional emphasis, I close by reasserting my support for the measures contained in The National Hurricane Research Initiative and once again call for its urgent consideration and rapid approval by the Congress.

PREPARED STATEMENT OF LESLIE CHAPMAN-HENDERSON, PRESIDENT/CEO, FEDERAL ALLIANCE FOR SAFE HOMES, INC.—FLASH®

I. Introduction

Thank you Senator. Committee Members.

My name is Leslie Chapman-Henderson and I am here today representing the Federal Alliance for Safe Homes—FLASH®, Inc. We are a partnership of more than 100 public, private and nonprofit organizations and leaders who have dedicated the past eleven years to making America a more disaster-resistant nation. Our mission is to "strengthen homes and safeguard families" from disasters of all kinds, including earthquakes, floods, hail, hurricanes, lightning, tornadoes and wildfires.

Our *Legacy Partners* include FEMA, Home Depot, International Code Council, NOAA/National Weather Service, RenaissanceRe, State Farm, WeatherPredict Consulting Inc. and USAA.

The Federal Alliance for Safe Homes helps reduce impacts from catastrophic losses like windstorms by providing the public with accurate and timely information on how to make homes more disaster-resistant—either at the time of construction or with post-construction hardening or retrofitting techniques. We want consumers to understand that they can protect their property, and that "luck" is not their best tool when they confront natural disaster threats.

Our work is part of a movement to establish disaster safety as a public value in this country. We support a built environment strong enough to reasonably resist and survive natural disaster threats. We specifically focus on mitigation and the collective work undertaken beforehand to prevent or lessen impacts of hurricanes and other threats.

Our goal is to create widespread public demand for safer, better-built homes. We modeled this approach after the highway safety movement, which succeeded in creating American demand for safe, well-built vehicles with seat belts and air bags. Just as the highway safety movement has saved lives on our roads, the disaster safety movement can save lives and reduces losses from catastrophic events. We recognize the following elements as essential to the success of the disaster safety movement:

1. Model building codes that are enacted and enforced intact
   - Applied to new construction, rehabilitated construction and restored construction, especially following large scale catastrophes
2. Financial incentives
   - Including banking, insurance, real estate and tax
3. Mitigation public policy
   - Home inspection and matching grant programs for home "hardening" or retrofitting activities (combine disaster mitigation and weatherization retrofit activities addressing attics, walls, windows and doors to leverage economies of scale)
   - Federal mitigation funding levels linked to the quality of the locally adopted building codes
4. Public awareness
   - Create a public value and market demand for mitigation
5. Professional education
   - Architecture, construction, emergency management and engineering
6. Research and innovation
   - Continuously enhanced products and construction techniques

- Effective and ongoing knowledge and technology transfer to ensure end use
- Reliable system to support superior product testing and consumer protection

We convene stakeholders that serve in all of the above roles, and our primary activities include public policy forum events, public awareness campaigns featuring free consumer resource and referral services, integrated multi-media campaigns, accredited professional education programs, extensive public outreach and subject matter expertise as requested by policy leaders.

Below are some of our initiatives:

- *Blueprint for Safety*®—(*www.blueprintforsafety.org*) A national, award-winning curriculum for contractors, design professionals and home inspectors featuring training on disaster-resistant construction techniques. Blueprint recommendations are referenced as the basis for mitigation policies and programs enacted in many states and municipalities.
- *Mitigation Leadership Forums* (*www.mitigationleadership.com*)—The risk mitigation leadership forums bring together academics, scientists and public and private sector representatives to advance hurricane risk mitigation scientific efforts and public awareness.
- *The Tale of Two Houses—Wildfire*—A motivational video story of seven families impacted by the 2007 San Diego Witch Creek Fires. One home in the center of the cul-de-sac survived while six burned to the ground because one homeowner took affirmative, prescriptive steps to prevent wildfire losses while others did not. The compelling FLASH video story is the consumer outreach basis of the National Wildfire Education Initiative launched in 2007, and is the subject of an upcoming retrospective by a national news program.
- *The Tale of Two Houses—Wind*—A motivational video story of two neighboring families and homes affected by Hurricane Charley in 2004. The story highlights dramatically different building performance and outcomes based on the different building practices used. The Tale of Two Houses program inspired two seasons of nationally syndicated television shows and joint work with home improvement guru Bob Vila.
- *Turn Around—Don't Drown*—A jointly sponsored public awareness life safety campaign with the National Weather Service that helps raise awareness of the risks associated with walking or driving into moving water. The slogan is in widespread use by broadcast meteorologists, forecasters and others.
- *StormStruck: A Tale of Two Homes*® (*www.stormstruck.org*)—FLASH and three of its Legacy Partners (RenaissanceRe, Simpson Strong-Tie and State Farm) opened this 3 year, interactive "edu-tainment" experience in August of 2008 at Epcot at the Walt Disney World Resort in Florida. The 4–D, virtual storm experience combines fun and entertainment with game-based learning to provide more than four million annual guests to Epcot with motivation and information on how to protect their homes and families from severe weather of all kinds. After just 1 year, the StormStruck experience is so successful that FLASH is developing a parallel approach to earthquake "edu-tainment" at Disneyland in California.

II. Background—Windstorm Risk

We believe that the U.S. built environment is highly vulnerable to windstorm hazards, and the vulnerability is increasing. There are various ways to characterize the level and demonstrate the increase, including:

A. *Coastal Population Growth*. According to the U.S. Census Bureau, as of July 1, 2007, 35.3 million people lived in areas of the United States *most* threatened by hurricanes.[1] These areas are defined as the coastal portions of Texas through North Carolina and represent approximately 12 percent of the U.S. population (Coastal counties include those with at least 15 percent of their total land area within the Nation's coastal watershed.[2]). This figure represents an increase from the 1950 level of 10.2 million, which represented 7 percent of the U.S. population. Florida alone represents 6 percent of the current coastal population.

Three of the 20 most populous metropolitan areas from 2006 to 2007 were within Atlantic or Gulf coastal areas from North Carolina to Texas.[3] These areas are:

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[1] Source: Population Estimates *http://www.census.gov/popest/estimates.php.*
[2] Source: *http://www.census.gov/geo/landview/lv6help/coastal_cty.pdf.*
[3] Source: *http://www.census.gov/Press-release/www/releases/archives/population/011671.html.*

- Houston-Baytown-Sugar Land, Texas (sixth)
- Miami-Fort Lauderdale-Miami Beach, Fla. (seventh)
- Tampa-St. Petersburg-Clearwater, Fla. (19th)

B. *Historic Losses*[4] *(United States).* Disaster losses tell a compelling picture of our economic and societal vulnerability to windstorms. From 1987 to 2006 the inflation-adjusted, insured losses break down as follows:

- $297.3 billion—total disaster losses
- $137.7 billion, or 46.3 percent—tropical cyclone losses
- $77.3 billion, or 26 percent—tornado losses
- $19.1 billion, or 6.4 percent—earthquake losses

Seven of the 10 most expensive hurricanes in U.S. history occurred between August 2004 and October 2005.

C. Today's Insured Values (Sample: Florida).

- 4.5 million single family homes
- $1.8 trillion in residential property
- $1.0 trillion in commercial property

D. Coastal Construction (Sample: Galveston, Texas).[5]

- More than $2.3 billion in residential, commercial and public construction was under way in 2007
- More than 6,500 residential units under construction
- Mostly condos, including towers up to 27 stories high
- One Centex Homes development—2,300 condos and houses on 1,000 acres
- Galveston is the site of the deadliest natural disaster in U.S. history
- At least 8,000 people were killed in a 1900 hurricane
- 3,600 homes were destroyed

The seawall in Galveston is 15.6 ft. high; Katrina's storm surge was nearly 30 feet. Insured losses today from a repeat of the 1900 storm would exceed $21 billion, and it would become the 3rd most expensive hurricane in U.S. history (after Katrina and Andrew).

E. *Attributes of the Built Environment*. Vulnerability will continue to increase due to a variety of economic and other factors, including the aging of our built environment, the percentage of the built environment constructed without use of model building codes and the increased cost of new construction.

III. Commentary/Response to Committee Questions

Question 1.—How can model building codes improve the resiliency of structures?

A. Model, Engineering-Based Building Codes are the Key to Resiliency

The greatest challenge in implementing improvements to new or existing buildings is a continuous breakdown in communication and knowledge transfer between homeowners, homebuilders, policymakers, regulators and the marketplace. During years of post-storm interviews and damage investigations, we have met stakeholders who are frustrated to learn of opportunities lost. They are astonished to learn that an additional handful of nails may have made a difference in keeping a roof on during a hurricane. This is especially unfortunate since loss of roof covering and roof sheathing failure during windstorms is often how a total loss of structure and contents begins.

Model building codes improve the resiliency of structures by incorporating uniform, consistently applied and continuously updated construction practices that provide protection from windstorm damage. Some of the strongest, specific attributes for high wind and water-intrusion protection include:

- Roofs—Bracing gable ends
- Roof Decks—5/8″ Thickness, Plywood v. Oriented Strand Board

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[4] Insurance Information Institute—Presentation to the National Hurricane Conference—*http://server.iii.org/yy_obj_data/binary/784319_1_0/nhc2008.pdf.*

[5] Source: Insurance Information Institute from "A Texas-Sized Hunger for Gulf Coast Homes," *New York Times*, March 18, 2007 and *www.1900storm.com* and *www.twia.org* accessed July 9, 2007.

- Roof Coverings—High wind shingles or tiles with mechanical attachment like nails or screws
- Secondary Water Barrier-Applied under roof covering or in attic
- Roof-to-wall connections—Metal Connectors v. Nails
- Entry doors—Impact-resistant
- Garage doors—Impact-resistant
- Window Protection—Code-approved shutters, coverings or impact-resistant window systems

Use of model codes at the time of new construction is the best means of protecting consumers from economic losses and potential injuries or even death. This was demonstrated during the 2004–2005 hurricane seasons as homes constructed to modern, model building codes outperformed those built to older, less stringent standards.

A 2005 University of Florida/Institute for Business and Home Safety/FEMA post-storm engineering study documented decreased damage vulnerability for homes with opening protection like hurricane shutters or impact-resistant windows and doors. When looking at building components, the study found damage to post–1996 homes resulted in:

- 44 percent fewer total roof covering replacements
- 38 percent fewer claims for window glass and/or frame damage
- 32 percent fewer total garage door replacements

Instead, newer homes needed only partial roof covering replacement, window damage was primarily limited to screens, and garage door repairs were minor, such as track adjustments or dent repairs.

Despite the clear case for strong building codes to reduce damage, model codes are not always adopted and enforced intact. Local amendments are used to weaken the code quality or the code is not updated swiftly enough to meet the threat of future storms.

B. The Challenge of Adopting and Enforcing Intact Model Building Codes

Despite the deadly and costly lessons of recent windstorms, many hurricane-prone states have adopted model codes only on a partial basis or have failed to include adequate enforcement provisions. Surprisingly, some states and local governments still lack any type of model building code.

Further, model codes are often undermined, weakened or adversely amended upon adoption at the local level. Many coastal, windstorm-exposed communities adopt the model residential codes like the International Residential Code, but then insert provisions that remove requirements for protecting windows with code-approved shutters or other opening protection.

Florida's Building Code included an "exception" along these lines for its Panhandle region until 2007. Another example of this problem is a current effort underway by a local architects' association chapter that is working to weaken windborne debris/opening protection requirements in coastal Long Island. While Long Island may not have the hurricane frequency of Florida, we believe that the tax-payer impact and financial severity for a potential Long Island strike makes a clear case for windborne debris protection. Incorporating protective devices at the time of new construction is the most affordable way to provide life and property protection.

Expanded investment into engineering research could speed the process of enhancing building codes by providing a clearer case for swift adoption of the newer, model codes and continuous updating based on real time storm findings. The current system of engineering research is inadequately funded, inconsistently funded and poorly coordinated.

C. The Challenge of Keeping Pace

Model building codes impact approximately 2 percent of the built environment in any non-disaster year through new construction, however that percentage can increase dramatically in a post-storm rebuilding period. As such, it is essential to put policies into place to align post-storm relief and construction with implementation of enhanced, modern building codes. Failing to embrace and enforce model codes during post-storm recovery and rebuilding represents a lost opportunity to rebuild damaged communities in a stronger way.

The private and public academic, engineering, research and scientific communities provide ongoing information regarding enhanced construction techniques to reduce windstorm hazards. This information can be integrated into model building codes eventually. However, the pace is often too slow to help storm victims make use of post-catastrophe findings.

For example, widespread loss of roof covering and failed soffits caused water intrusion into thousands of homes during 2004–2005, yet post-storm rebuilding efforts failed to promptly include new, uniform roofing standards requiring enhanced nailing and installation of secondary water barriers or bracing of soffits.

And many of these same communities still lack requirements for stronger nailing patterns and installation of secondary water barriers.

This situation perpetuates the cycle of "build-destroy-rebuild" that our organization and partners are working to suspend.

Question 2.—How can model building codes and mitigation reduce economic impacts and post-storm recovery costs overall?

A. Studies Address Cost/Benefit Ratios on Mitigation and Building Codes

Conservatively derived measurements of the value of mitigation deliver a compelling case for mitigation. Consider these findings from an independent study by the National Institute of Building Sciences:[6]

Mitigation provided a return on investment of up to four-to-one. A 10-year snapshot of FEMA mitigation grants and projects found that mitigation:

- Reduced human losses (death, injuries and homelessness)
- Reduced direct property damage
- Reduced direct business interruption loss
- Reduced indirect business losses
- Reduced non-market damage
- Reduced cost of emergency response

The NIBS study was the first of its kind to establish reliable cost/benefit ratios for mitigation and building codes. Additional applied science, programmatic evaluation and behavioral studies are needed to further establish the case for widespread and consistent investment in building codes and mitigation.

B. Catastrophe Modeling Identifies Potential Economic Impact of Building Codes and Mitigation

Modeling the strength of existing building stock based on the historic building code practices and structural attributes provides a compelling case for implementing windstorm mitigation; however, additional data sets of residential construction attributes on a house by house basis would provide valuable insights and afford the opportunity to verify modeled projections.

The tables in Appendix A illustrate relevant examples of scenarios projected by comparing the current dollar value of annual, expected catastrophe losses on a state-by-state basis based on:

1. Current building codes in force
2. Lowering standards to pre–1974
3. Implementation of model codes caught up to 2008
4. Implementation of code-plus programs like the FLASH Blueprint for Safety disaster-resistant construction curriculum

It is important to note that "code-plus" does not always denote construction techniques that exceed required code minimums. Typically, code-plus refers to the emerging or future code requirements and/or practices that are not yet addressed by codes and are "silent" in the body of existing model codes.

This analysis is available for the following states in Appendix A:[7*]

- Alabama
- Connecticut
- Delaware
- District of Columbia
- Florida
- Georgia
- Louisiana
- Maine

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[6] Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities, National Institute of Building Sciences, December 2005, accessed at *http://www.nibs.org/MMC/mmcactiv5.html.*

[7] Source: Risk Management Solutions, Inc.

[*] Appendix A is retained in the Committee files.

- Maryland
- Massachusetts
- Mississippi
- New Hampshire
- New Jersey
- North Carolina
- Pennsylvania
- Rhode Island
- South Carolina
- Texas
- Vermont
- Virginia
- West Virginia

C. Post-storm Forensic Engineering Studies Validate Superior Building Practices

The previous-referenced University of Florida/FEMA/Institute for Business and Home Safety post-storm engineering study found that:

- Homes built before 1996 suffered an average loss of $24 per square foot or $48,000 for a 2,000-square foot home, according to claims filed after the hurricane. Insured homeowners paid approximately $2,600 on average through their hurricane deductible.
- The average size and severity of the loss dropped by 42 percent to $14 per square foot for homes built between 1996 and 2004 when modern engineering-based building codes were in place and builders and building officials were educated about the requirements.

Expanded, reliable funding for academic institutions to perform and share post-storm forensic engineering studies and to establish a consistent, systematic approach to data gathering and analysis is needed. Each storm's finding could be banked into a database for use and information sharing. This would provide an invaluable and reliable insight into building performance in windstorm events.

Question 3.—How can assistance programs focused on improving building integrity mitigate storm damage and reduce recovery costs?

Two states (Florida and South Carolina) have implemented landmark programs to address the challenge of hardening older or non-code homes to withstand hurricanes. Several more (Alabama, Louisiana, Mississippi and Texas) are either bringing similar programs online or examining the feasibility of doing so. These programs help residents who live in harms' way that do not enjoy the benefit of modern building codes or code-plus practices.

These programs provide the following:

- Consumer Education
- Home Inspections for Wind Mitigation Detailed Homeowner Reports
- Matching Grants for Retrofitting
- Hurricane Resistance Ratings (0–100) Professional Education and Training

A. Florida—My Safe Florida Home[8] *(www.mysafefloridahome.com)*

In 2006, state lawmakers took action and appropriated $250 million to create the Florida Comprehensive Hurricane Damage Mitigation Program, and directed the Florida Department of Financial Services (DFS) to implement and administer the program. Subsequently renamed the My Safe Florida Home (MSFH) program, it was created to help Floridians identify and make improvements to strengthen their homes against hurricanes through free hurricane mitigation inspections and grant funds. Florida Statutes direct the MSFH program to target its resources to homeowners living in single-family, site-built homes in Florida by providing up to 400,000 free hurricane mitigation inspections and at least 35,000 grants.

To maximize service delivery and leverage resources, the MSFH program delivers services through the Department of Financial Services, local governments and through partnerships with non-profit organizations like Volunteer Florida and local housing organizations.

The MSFH program uses a trained workforce of more than 1,200 hurricane mitigation inspectors to perform free inspections and more than 2,000 licensed contrac-

[8] 2009 My Safe Florida Home Annual Report.

tors to make specific improvements, including but not limited to protecting or replacing window and door openings, and strengthening roofs by bracing gable end walls. The program has developed new technology and undertaken public outreach efforts to further enhance service delivery. As of December 31, 2008:

- More than 88 percent of grant program participants were using grant monies to protect their home's openings—windows, doors and garage doors
- Ninety-nine percent of homeowners approved for a grant live in the wind-borne debris region
- Forty-four percent of homeowners approved for a grant are insured by the state-run Citizens Property Insurance Corporation
- Average home age is 25 years
- Average insured value is $272,315
- Average buying power is $7,000 (MSFH pays 1/2)
- Average savings reported by homeowners who retrofitted their home is $773
- Homes retrofitted moved an average increase of 18 points on the rating scale
- The program retrofitted an average of 258 homes per week during the past 2 years

Summary of My Safe Florida Home Program Outcomes

- $170 million has been set aside for grants. Of this amount, $108 million has already been paid out which has been used to buy hurricane materials (mainly opening protection) and for installation services. At an average sales tax rate of 6 percent, that's $6.5 million in sales tax revenue.
- 2,271 contractors signed up to participate in the My Safe Florida Home program. Many report that they would have gone bankrupt more than a year ago had it not been for the program.
- The MSFH inspection firms, at one point in time, employed a total of 900 inspectors to perform $58 million dollars worth of inspections. Many of these inspectors are contractors, insurance adjusters, engineers and building inspectors who experienced a slow down in their work sectors and needed the job opportunities through the MSFH program.
- Retrofitting 50 to 75 houses a week creates jobs for 160 Floridians. The My Safe Florida Home program retrofits nearly 300 homes a week, on average, so nearly 1,000 jobs are created in any given week.

According to an independent analysis of the program, the MSFH return on investment is $2.75 for each $1 spent.

B. South Carolina—South Carolina Safe Home (www.scsafehome.sc.gov)

This program, while smaller than Florida's program, is ongoing and provides a steady source of home hardening opportunities for low income residents of South Carolina while increasing market attractiveness to private insurance capital. These inspections are fee-based and retrofits include roof and window replacements, roof to wall tie-downs, gable-end bracing and storm shutters. As of June, 2009:

- *761* grants totaling approximately $4 million awarded
- Workforce includes:
  - —119 SC Safe Home Certified Wind Inspectors
  - —57 SC Safe Home Certified Contractors
  - —3 SC Safe Home Staff Members
- Approximately *65 percent* of the applicants qualify as low-income
- Average age of home retrofitted is *27 years*
- Average value of home retrofitted is *$91,786*
- Approximately *76 percent* of the grantees elected to retrofit their roof
- New windows and/or hurricane shutter systems for more than *150* homes
- New hurricane rated building code compliant roofing systems for more than *500* homes [9]
- Homeowners report insurance savings up to *23 percent*

[9] The majority of homes receiving new roofing systems are replacing roofing systems installed following Hurricane Hugo in 1989. These older roof systems were constructed prior to the adoption of the statewide building code in 1998.

- Homeowners report an average *29 percent* savings in their energy costs after replacement windows are installed

Both of these programs lack necessary resources and funding despite the fact that they widely acclaimed and considered successful. These state program models should be examined and considered as a framework for national best practices or model policy programs for all hurricane-prone states. Research could facilitate this evaluation and ensure that the final program fits into existing FEMA, HUD and DOE program guidelines.

IV. The Case for Integration: Strong Building Codes and Mitigation are Green and Energy Efficient

Consider the environmental value following catastrophic windstorms of building structures sturdy enough to survive instead of becoming storm debris that clog landfills. Hurricane Katrina destroyed homes, buildings, forests, and green spaces and left behind 118 million cubic yards of debris, more than enough to fill the Louisiana Superdome 22 times over at a cost of $4 billion. One year earlier in 2004, workers removed more than forty million cubic yards of debris from Florida counties that would have filled 75 college football stadiums from top to bottom. The storms dumped debris on the streets, highways, curbsides and private yards and included fallen trees, limbs and trash from damaged buildings on private and public property.

According to local residents on Galveston Island, each high tide immediately following Hurricane Ike in 2008 seemed to dump a load of debris on the beaches. One four-mile stretch produced enough debris to fill 3,000 industrial-size trash bags just 2 week after the storm.

Eliminating roof shingles and tiles, framing, decking, siding, windows, and personal property from the debris field would reduce the post-storm relief costs, accelerate recovery and provide beneficial environment protection.

Weatherization and Mitigation Activities Can and Should Be Combined

Mitigation inspections complement energy audits as it is financially cost-effective and practical to inspect housing components such as the roof, attic, windows and doors for both energy and wind mitigation during one inspection. Further, existing products in the marketplace meet the requirements of both energy and mitigation.

Product examples include windows that deliver debris impact-resistance as well as energy efficiency; closed cell spray foam insulation for attics that save energy and provide a secondary water barrier for wind-driven rain; and spray foam and comparable insulation products that provide additional wind uplift resistance by helping strengthen joints between roof decking and framing members.

Research to identify and refine synergies between disaster mitigation and energy efficiency products and techniques would be invaluable. Further, protecting taxpayers' dollars invested in weatherization of homes in hurricane-prone regions by mitigating those same homes for wind and flood damage is sound. If we do not, weatherized homes destroyed in the next hurricane or flood could represent a waste of taxpayer dollars.

V. Conclusion

Immediately enhancing our Nation's building practices with better adoption and enforcement of model building codes for new construction and mitigation programs to retrofit existing structures will reduce impacts from windstorm damage to families and communities. Specific strategies should:

- Provide increased funding for scientific research, innovation, behavioral research and public awareness programs regarding building structure performance
- Accelerate adoption of new construction technology findings into model building codes
- Establish an integrated, standardized approach to conducting and sharing post-storm forensic research findings to support a better understanding and acceptance of the value of adoption of strong building codes for windstorm
- Enhance and accelerate the knowledge transfer of all research findings to ensure that communities benefit from findings and codes are updated on a timely basis
- Enhance Federal disaster mitigation and relief funding for communities that enact intact, model building codes and resist efforts to weaken codes upon adoption at the local level

It is our belief that this country needs to embrace a high-quality system of research-informed, engineering-based building codes and mitigation programs to en-

sure optimal construction practices and windstorm damage prevention that benefit all citizens. Research can improve and sustain model building codes and mitigation programs in a manner that enhances our built and natural environment. When that happens, we will prevent deaths, reduce injuries and avoid needless economic ruin for families and communities from disasters of all kinds.

Senator NELSON. Dr. Droegemeier, tell me, from 1987 to 2006, hurricanes caused $137 billion in insured losses, whereas earthquakes caused 19 billion in losses. Yet, hurricanes receive substantially less money in research funding than earthquakes. Can you share with us why this might be?

STATEMENT OF DR. KELVIN K. DROEGEMEIER, PROFESSOR OF METEOROLOGY, UNIVERSITY OF OKLAHOMA; MEMBER, NATIONAL SCIENCE BOARD; AND CO-CHAIRMAN, TASK FORCE ON HURRICANE SCIENCE AND ENGINEERING

Dr. DROEGEMEIER. Well, in fact, Senator—let me thank you and your colleagues for holding this hearing, for your tremendous support of—and recognizing the importance of hurricanes to our society. You've nicely laid out some of the challenges we face, the economic and societal impacts, the tremendous loss of life that occurs, so I really thank you for that.

To your question, Senator, that was, in fact, one of the things that motivated the National Science Board to begin looking at the notion of why, in fact, we don't have a concerted, focused effort on hurricanes. Not in the sense that we were competing with the earthquake community, but we really look to them as a role model, to some extent. They've done a great job of mobilizing the necessary assets, the intellectual capital, the talent, and have really attacked the problem in a credible way.

And so, we said hurricanes, as you mentioned, are very devastating, huge losses, so why do we not have that? So, the Board really set upon a course to actually address that question by putting together what we think is a thoughtful plan, a really focused plan, a very balanced approach for addressing the hurricane problem, not just as a weather problem, which, in fact, has been the case for a long time, and appropriately so, but if you look at the hurricane, the hurricane is really a weather-driven social-science, infrastructure, economic, policy problem, in its many dimensions, all the way from installing sensors in the field to collect data, like they do for earthquakes; taking those data, putting them into predictive models; predicting where and when hurricanes are going to form, the intensity, the track; and providing uncertainty estimates to those types of quantities; looking at evacuating, mobilizing people for predisaster preparation; the actual landfall, the post-response recovery and rebuilding. So, it's a problem that is really unique. And it's actually different than an earthquake problem because of its totality, the totality of what it encompasses, from sensors in the field to prediction, to human response, behavior, recovery, and that sort of thing.

And so, what the National Science Board did in recognizing that fact, was to put together this plan for a national initiative that really would look to the earthquake community as a good example, a role model, yet taking it in the context of hurricanes and asking, What research do we need? Who needs to be involved? What are

the key challenges? And especially, what are the priorities? What needs to come first?

And one of the things that I think, as lawmakers, you might be interested in knowing—and this has some similarity to earthquakes—how predictable are hurricanes? Fundamentally, how predictable are these things? And the reason that is important to you is, if we're 90 percent of the way to predicting hurricanes, which I don't think we are, and that last 10 percent is going to be an enormous cost, then it might not be the best way to invest. But, if we know that we're quite a distance and we have a lot of room to go and progress to be made, then, in fact, we ought to be investing. And I think it is very clear that we are not near the limit of predictability of hurricanes. But, that's an important question that vexes the earthquake community, as it does the atmospheric science community.

So, Senator, it's a very important question, and we thoroughly address that in our report, to look at putting on track a very sustained, focused effort on hurricanes. Not just as a weather problem, though, but bringing in the social behavioral sciences, the economic sciences, engineering, wind engineering, ecological sciences, in a completely integrated way, where all these folks talk to one another, they interact, their models communicate with one another. And we're looking at, then, predicting a hurricane as a complete, total problem for society, not just as a weather problem.

Senator NELSON. All of your written statements will be entered into the record, so that we have that basis of information.

Mr. Nutter?

STATEMENT OF FRANKLIN W. NUTTER, PRESIDENT, REINSURANCE ASSOCIATION OF AMERICA

Mr. NUTTER. Senator Nelson, I wanted to add to what Dr. Droegemeier said. Munich Reinsurance studies hazard events worldwide, and if—I could provide to the Committee, for the record, their charts showing exactly what has been mentioned here, and that is a relatively steady number of geophysical events—earthquakes, that nature—and a pretty dramatic rise, which I realize you can't see from that distance, in the number of climatological events.

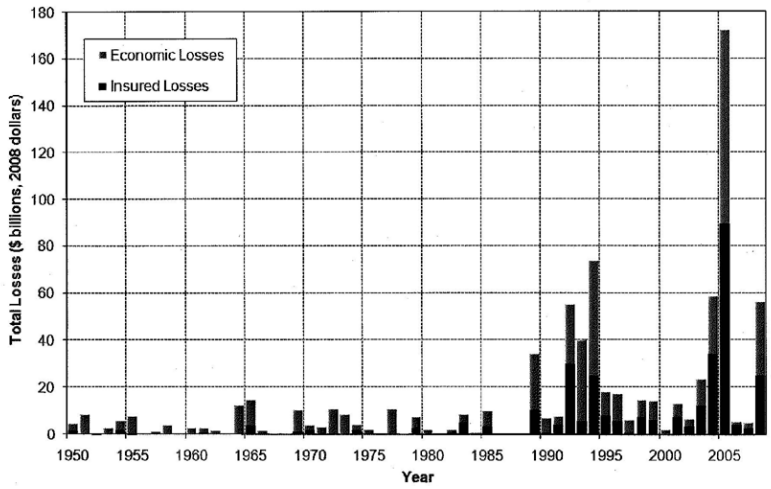
It seems to me that what should be driving this agenda is that our population, and the values at risk, have increased an extraordinary amount in hurricane-prone areas, and that if we were not, in the past, providing enough research money to support hurricane research, we have every reason to do so now, as our population has shifted into areas at greater and greater risk. And in my prepared statement there's data to support what the insured values have risen to be, and the number of people. It's a pretty dramatic rise.

Senator NELSON. And your chart will be entered into the record.

[The information referred to follows:]

Losses from U.S. Significant Natural Catastrophes
1950 - 2008
$1 billion economic loss and/or 50 fatalities

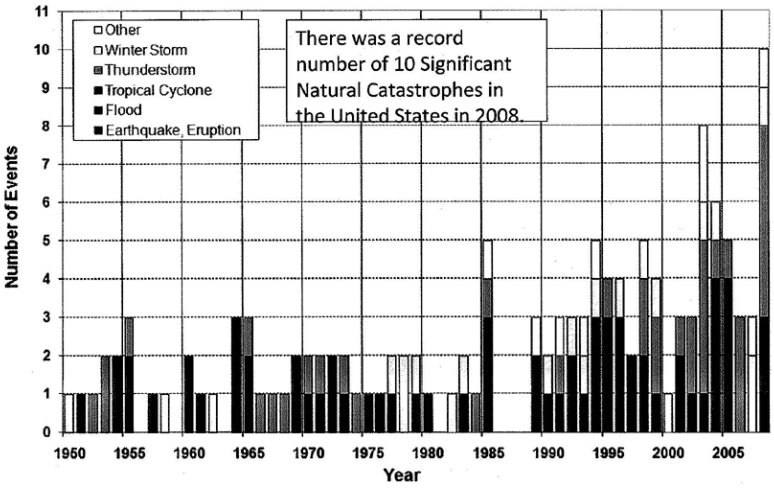
Munich Re America
Munich Re Group



Sources: MR NatCatSERVICE.

Number of U.S. Significant Natural Catastrophes
1950 - 2008
$1 billion economic loss and/or 50 fatalities

Munich Re America
Munich Re Group



Sources: MR NatCatSERVICE.

Senator NELSON. Senator Vitter?

Senator VITTER. I'm going to pass for now, Mr. Chairman.

Senator NELSON. All right.

Senator Martinez?

Senator MARTINEZ. Well, I wanted to, maybe what I should do is give each of you who have not spoken at this point to just maybe

give us a quick opening, and then I'll follow up with some questions. I want to make sure all of you get a chance to get in some of your thoughts and ideas on what we're discussing today. And then let me come back to you with questions.

Senator NELSON. And you might discuss whether or not you think we're making progress on reducing hurricane impacts.

Dr. Spinrad?

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

Dr. SPINRAD. Thank you, Mr. Chairman.

Actually, I'd like to follow up on a particular aspect of what Dr. Droegemeier alluded to, in that the hurricane forecast and prediction capability is a comprehensive set of solutions.

Within NOAA, which of course includes our National Weather Service, we have responsibility for developing improved capability on the front end, especially on the prediction and forecast, and providing warnings and information that emergency managers, local managers, can use.

Now, we do that through a rather extraordinary combination of capabilities, and I found it fascinating—the image that you showed, sir, of Hurricane Charley, represents the culmination of capabilities, in terms of satellite support, in terms of enhanced models and observations, in terms of our ability to work with coastal managers through the National Ocean Service, and, of course, on the very front end, the research that goes into that capability to provide an improved forecast. We've made dramatic improvements, over the last several decades, in the track forecast: Where will that hurricane make landfall? Not as dramatic in the intensity forecasts. And the consequence of this is that emergency managers will, through a precautionary approach, take the forecast, with respect to intensity, and make assumptions about increased intensity, because all too often, as well, many of these hurricanes rapidly intensify as they make landfall.

I had the personal experience of flying through Hurricane Ike last year as it passed from Cuba to the shore and intensified, over a very short period of time, to a Category–2 hurricane. Why does it do that? How does it do that? When does it do that?

We have recognized that, in order to do our part in the comprehensive forecast-and-response capabilities that Dr. Droegemeier alluded to, we need to enhance our investments, our research investments, specifically to improve the intensity forecasts, and, most notably, for those rapidly intensifying storms.

As a result, with an emergency appropriation—supplemental appropriation last year, we were able to dramatically increase the investment on the research and predictive capabilities. This year, in our FY–10 budget, in fact, we have increased our request so that we can develop high-resolution models, work with our partners—which is a fundamental aspect of the research initiative that you have put forward, so we work closely with the National Science Foundation, we work closely with the U.S. Navy, we work closely with NASA, we work closely with the Minerals Management Serv-

ice, and with the Department of Homeland Security, to develop new techniques to enhance that forecast.

For example, this year, in about a month, we will deploy high-altitude balloons—lots of them—in the spawning area for hurricanes, to see if that information that we get before the hurricanes develop—even as they are simply tropical depressions—Can that help us to provide improved forecasts, especially for the intensity forecast?

That, coupled with increased investments, especially in association with the National Science Foundation, on some of the social sciences—How does one interpret the forecast? We may have the best forecast ever. And, in fact, I would use Hurricane Katrina as an excellent example. It was one of the best forecasts that's been provided. But, we all know the devastation. Why is it that people respond the way they do? How can we help people manage in uncertainty, and improve our products and services?

So, it's both the physical sciences of improving the forecasts, or improved observations and models, and the social scientists—sciences associated with interpretation, that is the NOAA responsibility embedded within that comprehensive enterprise that Dr. Droegemeier alluded to.

Senator MARTINEZ. But, one thing I would say in that regard is that it seems like, when the forecast gets enhanced, because of the lack of predictability of intensity, you then end up with a forecast that doesn't meet the expectations of the population. So, we were ready for a big storm, and there was a big nothing. We get another warning, it was a big storm, and it was a big nothing.

Well, then, as the old story about the third one that comes along, you don't get prepared for, because we always ride them out. We're always finding, it was going to be a 4, and it turned out to be a 2, or whatever. I think people develop a sense of, particularly in places like Florida, where we get them so often, of, "Oh, well, this is no big deal."

With the enhancement part, I also remember flying with Senator Nelson, I think it was Wilma, over Naples, and the damage was surprisingly mild. As we came across the Everglades and on into Fort Lauderdale, the damage there was horrendous. That storm intensified after it made landfall, while it went over the Everglades. I think it was Wilma that did that, which is remarkable.

Dr. SPINRAD. If I may?

Senator NELSON. Wilma actually hit an unurbanized part of the State. The counterclockwise winds hit the coast actually down there in the Ten Thousand Islands.

Senator MARTINEZ. Right.

Senator NELSON.There is no civilization there, except mangroves. But, that's right, across that moist Everglades, it kept up its speed, and by the time it got to Miami and Fort Lauderdale, it did some real damage.

Dr. SPINRAD. But, one of the thing—Wilma was a record-setter in the meteorological community with respect to that intensification, which is exactly why we have emphasized trying to focus on the rapidly intensifying storms.

The other point that I'd make is, we need to work hard to make sure the public understands, for example, that our 2- and 3-day

forecasts are now as good as the 1-day forecast was, say, a decade ago. And, for the most part, what we have seen is that people have enhanced confidence in that 24-hour forecast. But, the other issue, of course, is, How does one interpret the uncertainty associated with that forecast? And as I think all of the members of the Committee understand, when we put the forecast out, we include a cone of uncertainty. What does that mean? It's not good enough for us simply to put that out. We need to develop the tools so people understand how to interpret that.

Senator NELSON. Dr. Wells?

STATEMENT OF DR. GORDON L. WELLS, PROGRAM MANAGER, CENTER FOR SPACE RESEARCH, THE UNIVERSITY OF TEXAS AT AUSTIN

Dr. WELLS. I want to agree that it's very important to study the intensification and the problems that we've had with that. I would like to say that, in the Texas experience in the last several years, we've dealt with two hurricanes, both Rita and more recently with Ike, in which the track was not very well forecast until the last 24 to 36 hours before landfall.

Now, let me give you a concrete example of the impact that that has. We can all agree that it's necessary to evacuate nursing homes, assisted living centers, citizens that are homebound, that have physical or sensory disabilities, that live in the areas that would be affected by storm surge and high wind. Well, we can do this in a couple of different scenarios. We can wait until the last 24 to 36 hours before tropical-storm-force winds reach the coast, in which, at that time, we have a reasonably good track prediction. However, if we do that, we're likely—if we have an over-evacuation, as we had during Hurricane Rita, we could have them trapped in traffic; we could even—with feeder bands coming inland, we could have flooding, which could also cause them to be trapped; or they would have a very long and tiring evacuation for this fragile community.

Or, we can do as we do in Texas now. We can take that period between 72 and 48 hours before landfall and attempt to evacuate that community at that stage. Now, when we do that, in the cases of these storms with poor track predictions, we over-evacuate, and we place in jeopardy these very fragile citizens that, if we had as good a forecast as we now have, 24 hours out—if we had that at 48 to 72 hours out, we would have a solution to this dilemma. Right now, there is no good solution.

Senator NELSON. It's amazing how the tracking has progressed and how much better it is. Dr. Spinard, interestingly, you use the example of Charley. I flew, not into Charley, but above Charley, in your NOAA G4 when it was still south of Cuba in the Caribbean. By the time it got to the peninsula of Florida, it was headed straight for Tampa Bay. All of a sudden, despite all of our predictions it suddenly came in with a left hook. It turned sharply to the right, and it went right across Charlotte Harbor, hitting Punta Gorda straight on. People had evacuated from Tampa Bay to the Holiday Inn at Punta Gorda, and they were at ground zero. Then, it kept right up the spine of the State, right up the Peace River, through Polk County, Orlando, and came out somewhere just north

of the Kennedy Space Center. I think, because of your G4, you figure that you've got a 15-percent better accuracy. Is that correct?

Dr. SPINRAD. The accuracy over that last decade is, I believe, even higher than 15 percent; attributable, in part, to the G4, but, I would also say, largely attributable to other observational techniques, and probably mostly because of the improvements in the models.

Senator NELSON. What are you going to do if the G4 is down for maintenance or because of an accident?

Dr. SPINRAD. We have several contingencies. First and foremost, we're relying on our strong and codified relationship with the Air Force. They have agreed to provide the C–130 gap-filler capability from Keesler——

Senator NELSON. Well, it can't get as high——

Dr. SPINRAD. It can't get as high.

Senator NELSON.—as the G4.

Dr. SPINRAD. Part of this, though, alludes to the work that we've done with the Department of Homeland Security, using the high-altitude balloons. The experiment we're doing this year, in fact, would suggest that we can get similar kinds of observations from those arrays of balloons. Also, we can increase the dropsonde observations—and I believe you saw that activity from the G4—we can increase the dropsonde density with the aircraft, C–130s, and with our P–3 Hurricane Hunters.

So, we have a series of steps that we can accommodate. And I would point out, the additional observational capability that we are testing this year, I'm convinced, will provide some of those enhanced observations.

Senator NELSON. So, you're not worried about the column of air from the max altitude of the C–130 and the P–3, which is somewhere in the range of 30 to 33,000 feet? You would miss that column of air at the top of the hurricane, which is from 45,000 down to that 33,000.

Dr. SPINRAD. That's why we're trying techniques using the balloons. That's why some of our modeling capabilities should allow us to do some extrapolation from the top of the profile of the P–3 and C–130 flight profiles, as well. But, I cannot tell you what the consequences of not having that full set of observations will be, absent the observations we get from the balloons.

Senator NELSON. Senator Martinez, please continue.

Senator MARTINEZ. Well, I'm very interested in the issue of mitigation. We've had a bill. I wonder, Ms. Chapman-Henderson, if that's not part of something that you might be able to share some information on with us?

STATEMENT OF LESLIE CHAPMAN-HENDERSON, PRESIDENT/ CEO, FEDERAL ALLIANCE FOR SAFE HOMES, INC.—FLASH®

Ms. CHAPMAN-HENDERSON. Certainly. I think—and the science here would cross the range, and "integration" is the key word here. The notion of having a system where we connect the dots between social, behavioral, forecasting, engineering, and all these different sciences, to get a system in place where we would protect the communities, is really music to our ears.

Building codes help us on new construction—new homes, those homes we rebuilt after Katrina, after Charley. Mitigation, or retrofitting, we look at as more of something to help with the unfortunate problem that we've constructed most of our homes without the benefit of the modern building codes. So, we have to have both.

The problem is, we don't. We have pockets of success with building codes in places like Florida, although I would point out that even Florida had a very big loophole in the Panhandle until 2007. We have pockets of success with mitigation programs. Again, Florida, South Carolina—soon Mississippi—have put programs in place to harden existing precode on older homes. Their activities are things like enhancing roof attachment, better high-wind shingles, protecting windows, doors, and garages.

Again, unfortunately, just as we've got these new, emerging programs, they're desperate for funding. Having to make their case very hard, now they find them selves again, unfortunately, competing with things like weatherization.

So, as an organization in a 100-partner-strong movement of people who are looking at how to get that end result, stronger homes into communities, so—we need the forecasting, we need the tracking—but, in the end, maybe, if we could get to the point where the structures are sound, damage is minimized. Because we can safely shelter in place. Families outside the flood zones can do what people do in places like Bermuda: they can batten down the hatches, and they can stay put, and safely so. They don't have to evacuate, they don't have to go to shelters and be fed and cared for.

So, when we look at things like the new mitigation programs and the hardening, we applaud that. We'd love to see a national model, because those programs work. The Florida return on investment has been calculated, 3-to-1. South Carolina has reported homes that are in the program are getting 23 percent, on average, savings on insurance, 29 percent, on average, savings on energy, because—if they do the windows. But, with the focus on weatherization, what we've got to stop doing is simply looking at one piece. We can't pit green building against energy-resistant construction against disaster; we need to be holistic.

For example, with weatherization, you're talking about things and activities that look at attics, windows, doors, walls. Well, those are the very same things you look at for wind resistance. So, if we're going to inspect homes in coastal-vulnerable communities, and weatherize them, we're replacing the windows, let's also put in an impact-resistant window, so that the dollars spent for weatherization are not wasted when those homes which remain vulnerable are swept away.

The building code system that we have is excellent in terms of creating model codes, but it's not fast enough. Applied science and research-informed building codes could help resolve some of the debates that occur unnecessarily. Simple things, like taking additional nails and putting them into a roof decking, often mean the difference between a home that is completely destroyed and one that is not. But so often that isn't done, and roofs are destroyed, and communities are destroyed, as a result.

So, that is our focus. And it's incredibly encouraging to hear that you're putting forth a program that would integrate across all this.

Because the key is information sharing. Our engineers across the academic community, in the States that typically get hit, like Texas and Florida and South Carolina, are doing phenomenal work. They are discovering things, like a simple handful of nails, other affordable ways to strengthen homes. But we've got to get these practices into a system so that it's always done.

With research behind that information—and I think that's where earthquake research has succeeded, really, by comparison. When you talk about the investment in earthquake research, it's almost made a lot of the debate about the specific building practices moot, because people know, "This is what we have to do." So, ditto on wind. If we can get past the debate over whether or not things work, because we've put adequate resources behind the findings, then the building codes will deliver that protection to the homeowners each and every time. The breakdown between the developer, the code adopter, you know, the trained building official, down to the citizen who doesn't even know to ask, is extraordinary, and I think that's why we lose communities.

Senator NELSON. I'll never forget, in the aftermath of Hurricane Andrew, in 1992, in which all of the Habitat for Humanity homes survived, when so many of those other subdivisions were just blown away. People would come up to the head of Habitat, because he had a Habitat sticker on his briefcase, and say, "Oh, thank you, thank you." And the press would come up and ask him, "Well, why did the Habitat homes survive?" And his answer was, "Inexperience." They would say, "Inexperience? What do you mean?" He would say, "Well, we do it with volunteers, and instead of driving two nails they would drive ten nails."

[Laughter.]

Senator NELSON. And a home survives.

Senator MARTINEZ. Absolutely. It makes sense.

I was going to ask you about another type of housing, which many Floridians rely on, which is mobile homes, manufactured homes. And I know that, while I was at HUD, we did some work in trying to improve the national code for the construction of prefabricated homes. And I think they've had very, very good results with them, but we still inevitably, there was a tornado in central Florida last week, and a number of homes were lost, and inevitably they're all mobile homes. Obviously, the older ones are not very survivable. But, I think we've made some progress. I wonder if you can comment on that.

Ms. CHAPMAN-HENDERSON. Certainly.

Senator MARTINEZ. Because this is a very, at a time when affordability is a big deal, this is a very affordable way for people to house.

Ms. CHAPMAN-HENDERSON. Well, and this is another place where research can help us solve our problems. I think the traditional old—what we call the pre-HUD homes, before the regulations were enhanced, are—you absolutely have to evacuate from those homes. The structure itself of the new manufactured home is so much better, but we would still ask those folks to evacuate, because they can't resolve the attachment issue.

Senator MARTINEZ. Right.

Ms. CHAPMAN-HENDERSON. Traditionally, we've always held out the manufactured or mobile home as the affordable option. There are other options, to mobile homes, and there are modular and other types of things that can be done that—we can overcome the problem of attaching that home to its foundation. Attachment is essential, and that's where we get into trouble in wind.

This is another place that's rife with confusion. And the lack of information about what works and what doesn't—when it comes down to it, as a family we need to be confident that wherever we dwell is safe to stay. And our rule of thumb is, if—you know, if you don't know which building code or which regulation you're manufactured to, in that case, or the site-built home is built to, how can you possibly make a decision, that could be life or death, on behalf of your family?

With respect to the manufactured housing, I think, again, we're very decentralized, so we don't have good information. And until we resolve attaching those homes to the foundation, one good windstorm—and it doesn't really even have to be a tornado—brings—consistently brings death and injury, and that's unacceptable.

Senator MARTINEZ. And, really, property loss, too—huge amounts of property loss, because typically they're just blown up. Even if people evacuate. So the mitigation part, you know, not only is about life and limb, but it's also about property.

Ms. CHAPMAN-HENDERSON. That's right. And in my longer version of the commentary in the record, I have a 22-State analysis on the economic impacts of building codes and mitigation. It's clear—for example, I think I've pulled Texas out, but I have all of the 22 hurricane-prone States. In Texas, the average annual insured losses that are expected are around a billion dollars. And if you simply put in modern building codes, if you could magically do so, you reduce that by 40 percent. If you put in Code Plus, which is just some of the things that are absent from the code today, you could reduce that down to $200 million per year. So, taking the average annual expected insured losses from a billion to 200 million, mitigates insurance costs—and it becomes very clear that you can, you know, reduce them over time. I think that analysis is very compelling and, I think, has gone a long way toward helping us get some traction around this discussion. I'd like to think so.

Senator NELSON. Senator Vitter?

Senator VITTER. Thank you, Mr. Chairman.

I'd like to ask Dr. Spinrad, specifically, what research-gathering tools and programs would you put at the absolute top of the list, in helping NOAA achieve the goals laid out in the Hurricane Forecast Improvement Project? I know they're all worthwhile and helpful, but what tools and programs would you put at the top of the list, in terms of having positive impact?

Dr. SPINRAD. Senator, I'd start to answer your question by saying, we think about the categories of research investment that will contribute to improved forecast. And in a very coarse definition, those would be observations and modeling, and what we call "data assimilation," getting the observations into the models.

So, for example, on the observational side, one of the things that we feel is very important is characterizing the nature of the heat content in the ocean as the storms are coming across the ocean. So,

improving our ways of finding the total heat content, how much heat is in the full ocean, is one observational technique we need to improve.

Also, low-level winds. We've got high-level winds, upper-level winds, right around the storm, but for years we've not been able to make observations of those lowest-level winds, and there are indications that those may be particularly influential in how the hurricane is structured.

So, what we've started doing in that regard is launching unmanned aircraft—small, unmanned aircraft in areas where we would not want to put P–3s and C–130s and G4s. And we've had some success in those observations.

On the modeling side, I think, if you talk to most of the modelers, they would tell you our real challenge is increasing the resolution, bringing the size of the model grid down to 5 kilometers, maybe even 1 kilometer. And, as you might imagine, that demands much, much more computational horsepower. So, we've spent a lot of our resources of late investing in high-performance computing.

And on the data-assimilation side, this is really where we work very closely with our academic researchers, who have improved the capability to absorb these observations, including radar observations, from the P–3 aircraft, in real time, into the models, so that with a lag of less than an hour or two, we can have the observations going through a supercomputer, such as the one we use in Texas, into the National Hurricane Center to improve what we call the "forecast guidance," the model output that the forecaster, the critical human in the loop, can then take to develop that forecast.

So, it's—models, observations, and data assimilation are the critical components in the research investment.

Senator VITTER. OK. And let me ask you, on the other end of the process, in terms of the end result, the goals laid out in the HFIP for improvement, what do you see as being the most imminently achievable: reducing tracking error, extending forecast lead time, or increasing forecast accuracy? What area do you expect to see the most improvement, and the soonest?

Dr. SPINRAD. We've already seen dramatic improvement in continuing to improve the forecast on the track accuracy. Just last year, by using the supercomputer in Texas, we were able to bring the track down, on one or two storms that we were studying, significantly.

I would say that extending the forecast, of and by itself, is directly doable right now. The real parenthetical aspect of that is extending the forecast with some accuracy. So, we will make immediate improvements on track, we already saw that last year. We have started to make improvements on intensity. We have put the goal, in the Hurricane Forecast Improvement Project, rather high. It is a high bar to reach, to improve the track and intensity forecast by 50 percent over the 10-year period of what we call HFIP, the Hurricane Forecast Improvement Project. But, I'm convinced we'll reach all of those goals within that 10-year period. Probably, on the track we'll reach it sooner.

Senator VITTER. OK.

And then, for Dr. Wells, the simulations you've run, what do they suggest about the relative effectiveness, in terms of protective

coastal infrastructure of softer options like wetlands restoration, versus harder options like structures, and how those interact and build on each other?

Dr. WELLS. Well, we happen to be using the same supercomputer that NOAA is using for its experimental forecast in the hurricane model. We're using it in a hydrodynamic model called the advanced circulation model, ADCIRC. And that allows us to increase the model spatial resolution of the grid down to anywhere from 50 to 20 meters, if necessary, so that you can represent the built infrastructure on the surface.

What we have done recently—the team that's led by professor Clint Dawson and his assistant, Jennifer Proft, at the University of Texas—they've taken Hurricane Ike, all the observational data from that, especially from the wind fields, and they have run simulations of the landfall as the storm occurred, historically. And they have taken a concept called the Ike Dike, which is Dr. Bill Merrill's concept, at Texas A&M Galveston, which is a sea barrier that would be built along about a 60-mile segment of the Texas coastline, all of Galveston Island, all the way over to High Island and the Bolivar Peninsula, and they've run both of the simulations with and without the dike.

They've also taken Ike and created a Mighty Ike, a Category–4 Ike, and run the same simulation, so that you can see, on the hard-option side, of using things like dikes and storm gates, what the consequences might be.

There are also the soft options, wetlands restoration and some restrictions on potential land use and development on the coastline.

These are usually seen as, sort of, categorically the opposite; you have to pick one or the other. But, what we can do with the supercomputer modeling is see what best combination would work for different areas of the coastline. There may be combinations that would work for one particular landfall scenario that would fail or create potentially even greater problems for another landfall scenario.

The wonderful thing about the supercomputer modeling is that we can simulate hundreds of storms—use historical storms, use storms that are just purely our design—and we can test these different protective measures that could be taken, both built infrastructure as well as natural restoration processes, see which works best.

Senator VITTER. OK. And also for Dr. Wells, you mentioned, in terms of forecasting storm surge to help with rescue operations, that, in addition to natural geographic data, a full database should contain what you term "social geographic data" to help with that, in particular. From your experiences with Ike, in particular, give us some examples of that. What would be particularly useful, how it would be useful on the social-geographic data side?

Dr. WELLS. Yes, Senator. I should first say that I and my team work in the State Operations Center. We work with State elected leadership: with the Governor, with the chief of emergency management of the State, Jack Colley. We're constantly interpreting the model forecast, and we're taking runs from the supercomputer at the Texas Advanced Computer Center, and looking at the impact geography.

Now, what we see in the physical side, those high-magnitude impacts are not necessarily the areas where you want the first responders to go. I'll take—I'll give you a concrete example. If we had ground zero being in East Beach, Galveston Island, we have an area there that is developed with half-million-dollar beach houses, which are second homes; very high-rent condominiums; areas that are not primary dwellings; areas where, certainly, the residents would have a means to self-evacuate. That might well be the area that you would anticipate to have the highest-magnitude impact.

Six miles away, in the interior of the City of Galveston, you have a number of social factors. You have elderly, in neighborhoods, who are living in older housing stock. You have single-parent, low-income wage-earners who may not be able to leave the island because of their job requirements. You have people that are—again, they have a medical special need. You have a number of factors that are social factors. And you need to be able to overlay the impact from—the physical impact, that particular geography, with the distribution of these populations within the community that have special risks.

We need to be able to evaluate and compile that as a distribution of the population, because where those two overlap, the social and the physical risk, that's the threat geography, that's where we need to be able to do search-and-clear operations before impact, and it's where you want to be able to get into, at the very earliest moment, when you can safely reenter the region with your first responders, to check those neighborhoods, to see that those people are safe.

Senator VITTER. OK. That's all I have right now, Mr. Chairman.

Senator NELSON. Mr. Nutter, we haven't forgotten you. I want you to comment on how better construction methods and the stronger building codes, that Ms. Chapman-Henderson mentioned, can save lives and property, and reduce economic losses. Since you're in the reinsurance business, if you could address improved forecasting and modeling also helps bring down the economic loss?

Mr. NUTTER. I think the—there's no question, as has been mentioned by several people, that improved forecasting, where people can be out of harm's way, is going to save lives. That will not necessarily save property damage, unless we do something to mitigate these properties.

Let me cite a statistic. Losses from Hurricane Andrew in 1992, as you mentioned, caused about $20 billion, in today's dollars, of insured losses. That would have been reduced by 50 percent for residential property, and 40 percent for commercial property, if the destroyed and damaged structures had been built in compliance with Florida's 2004 building code—to Ms. Chapman-Henderson's point, that we know how to do this, there are ways to do this, and it has real value to it.

We cite, in other statistics, that homes built to the modern Florida building code experienced a 60-percent reduction in the frequency—actual losses—of property losses, and a 42-percent reduction in loss severity, meaning dollar amount of insurance claims, during Hurricane Charley in 2004.

So, I don't think there's any question that improved research is important, but improved research needs to be tied with the societal impacts of hurricanes; not just the physical characteristics of the

hurricanes, but that interaction, both with the built environment, as we're saying, but also the natural environment and buffers.

Dr. Wells' point about the ability to evaluate natural habitat as buffers, as well as built buffers, is an interesting way to look at this, and research focused on that would be of immense value to the people who live in these high-risk areas.

Senator NELSON. I recall a huge part of economic loss that we've gotten better at preventing is by having FEMA ready so that it can get plastics in there so people can cover up holes in their roofs. After the hurricane has come through and people have holes in their roofs. You can save an enormous amount of economic damage, because if there's a hole in your roof, the rains come after the hurricane that causes all the insurance loss inside the home.

You want to comment about that, Mr. Nutter? And then I want Ms. Chapman-Henderson to.

Mr. NUTTER. Well, just that that's a clear value to immediate response, and preparation for that immediate response. The government has not always been fairly prepared, or maybe even fairly criticized, for its response; but the reality is that those who might come in to help mitigate those damages need access to those areas, which include debris removal and communications capability. So, anything that would focus on first responders, or to prioritize first-responding areas, would be of great value in reducing these insured losses.

Senator NELSON. All right. Dr. Spinrad, I'm going to test your forecasting ability, here.

[Laughter.]

Senator NELSON. We've had La Niña, the cold Pacific waters. Your bulletin, dated just a week or so ago, says, that El Niño is arriving. El Niño is the warming of the Pacific waters, which tends to lessen the activity in the Atlantic hurricane. Now, thus far, we haven't had any activity in the Atlantic on hurricanes. So, tell us what's going to happen in the Atlantic.

[Laughter.]

Dr. SPINRAD. The—first, I would point out that my meteorologist friends, who are in the Weather Service, are fond of pointing out, they're in charge of marketing, not production.

[Laughter.]

Dr. SPINRAD. With that in mind, I'll also add, I'm an oceanographer. That's my qualifying statement.

[Laughter.]

Dr. SPINRAD. The outlook that we provide every year at the start of hurricane season, from which the information that you've got comes, this year did take into account what we thought was the emergence of an El Niño. And, of course, that was developed several months ago. Now we have better information about the emergence of El Niño. So, the first point is that that outlook did include that.

The second is that our mid-season outlook will come out on August 6, which will presumably take into account the enhanced observations and more accurate characterization of El Niño.

You are absolutely right that the statistical indications from El Niño are that it, in fact, actually increases the upper-level winds and, as a result, if you will, knocks off—shears off—the developing

storms, and therefore diminishes number and intensity of them. So, based on that physics, one would assume you would see a reduced probability. As you know, this year's outlook effectively said, "a 50-percent probability of 9 to 14 named storms." On August 6, we will identify how that has changed.

I would simply point out that the paucity of named storms this year does not, of and by itself, give any indication of what the season will look like. I remind you, of course, Hurricane Andrew—"A," therefore the first named storm—occurred in late August. The latest "A" named storm—that is to say first hurricane—occurred in—on August 30. That was Hurricane Arlene. And historically, especially in Florida, you will see that August and September are the most intense months for hurricanes.

So, I think we can't simply say that, since we have seen an emerging stronger El Niño this year, we therefore can conclude that we are safe. And I'd also point out that obviously, from our standpoint, one severe storm is catastrophic, and we are more concerned with nailing the forecast with respect to those individual storms than what the statistical average outlook might be.

But, I think, in sum, since you have tested my forecast capability, we will see, on August 6th, an outlook that accommodates the consequences of what is now clearly an El Niño signal.

Senator NELSON. All right. That being the case, would it be reasonable to expect that the late hurricane season, of which you pointed out Andrew was in late August, that, because of El Niño appearing, that it lessens the likelihood of ferocious storms in the Atlantic, since it shears off the top of them.

Dr. SPINRAD. Statistically, yes, sir.

Senator NELSON. OK.

Dr. SPINRAD. Statistically. But, as I point out—and, in fact, I would have to look back at the record—there have been a number of very strong storms during El Niño years, as well.

Senator NELSON. Was El Niño present in any of those years that you mentioned? For Andrew or Arlene? It was.

Dr. SPINRAD. I believe there was a weak El Niño in 1992, during the Andrew——

Senator NELSON. I see.

Dr. SPINRAD.—evolution. Yes.

Senator NELSON. So, that just disproves the whole theory.

Dr. SPINRAD. Well——

[Laughter.]

Dr. SPINRAD.—to the extent that statistics are disprovable, yes, that's true.

Senator NELSON. OK.

[Laughter.]

Dr. SPINRAD. But, statistically, of course, it still holds.

Senator NELSON. In other words, we take no comfort in the fact that El Niño is there.

Dr. SPINRAD. That's right. For the climatologists, there may be some comfort in fitting curves, in the future; but, clearly, I would not want to go to the citizens of Florida, Louisiana, Texas, and say, "Since it's an El Niño year, the statistics are such that you might have a slightly reduced probability of severe storms." That's not consolation, in my opinion.

Senator NELSON. Is NOAA working with HUD and other agencies to tie the science and the coastal management and the community preparations together?

Dr. SPINRAD. NOAA is working with a variety of different agencies. I would also point out, of course, since we are in the Department of Commerce, we work closely with the National Institute of Standards——

Senator NELSON. Hey, Senator Martinez? Before you left, and I really appreciate you being here.

Senator MARTINEZ. I've got to——

Senator NELSON. I know you do since you and I introduced this package of bills.

Do you all generally support this six-pack that we've put together?

Senator MARTINEZ. Let me put on my glasses.

[Laughter.]

Senator NELSON. Basically, the legislation is a lot about what we've been talking about here.

Is there anybody that doesn't?

Mr. NUTTER. Senators, as you know, the reinsurance sector has always had an ongoing dialogue with you, and Senator Martinez, in the State of Florida, about the value of the private sector's role in financing catastrophe risk, and the role that government can or should play with it. With that caveat, we are strongly supportive of the bill that you and Senator Martinez have introduced about increased funding for research. In fact, we think the funding is more modest than it should be. It should be increased.

Senator NELSON. So, it's fair to say that the reinsurance industry would not support the bills that we've introduced with regard to the Federal Government giving a loan guarantee to the States for their hurricane catastrophe funds.

Mr. NUTTER. Senator, the loan guarantees, without some conditions with regard to the underlying insurance markets, for example, insurance being risk-based, would be important conditions. To make certain that the insurance markets are responsibly being priced, and that people are paying based upon the risk that they have.

Senator NELSON. You know, what I don't understand is, when the big one hits, the big one is a Category 4 or 5 hitting a dense part of the urbanized coastline, there's going to be more business than you can shake a stick at, and you're going to have to have the States strengthened in their reinsurance funds, their catastrophe funds, in order to accommodate that kind of economic loss. Rather than your industry looking at that as competition from the Federal Government, it seems that we ought to be able to marry up the two, going in the same direction.

Mr. NUTTER. Well, Senator——

Senator NELSON. Any comment?

Mr. NUTTER. Well, yes, I'd be happy to comment. The private reinsurance sector, which is all I would speak for, not the insurance sector, wants to write catastrophe risk in Florida and other States. It's a business that, in fact, is driven by the demand by insurance companies for reinsurance, and we want to provide that market.

To the extent that the State of Florida has a catastrophe fund that precludes or preempts companies from buying private reinsurance, it's an unfair advantage, we would say, for the government programs to do that. So, we would love to find a compromise that works, but I would say that the private sector cannot easily compete with the public sector in providing reinsurance, as it's being done in the State of Florida.

Senator NELSON. Thank you, Senator Martinez, for being here. I'd just say that, interestingly, the insurance industry is split on this issue, on what we're talking about here. The reinsurance industry doesn't support the Federal guarantees for a State catastrophe fund, whereas generally the insurance companies do. I just wanted the record to show that.

Thank you.

All right, Senator Vitter, may I continue on with regard to once we know that a storm is going to hit a lot of you have talked about the preparations that people need to make to move to safety. Dr. Wells, for example, you all had such a horrendous tie-up on your interstate in trying to evacuate. That's happened in Florida, as well. And then everybody gets smart and figures out a way, with the Highway Patrol, to make the interstate one way, so people can get out. What's your experience with other States doing what Texas and Florida have done?

Dr. WELLS. I'll risk arguing with you just a little bit, here. I'm—my background is in hydrodynamics, and I can say that, for Hurricane Rita—you only have so much roadbed available on which to put vehicles. If you have an over-evacuation that occurred, as did occur during Hurricane Rita, where you have—2.7 million people, over a very short time span, decide that they're going to get on the roads out of Houston, there's basically no solution to that. You can start with 20 lanes of traffic heading outbound, and 20 miles down the road, there'll be 6 lanes. Where do you want to choke flow? Do you want to choke flow back toward the city, where you have some resources to take care of people in that situation, or do you just let them go out into the countryside and sit out there for several hours? Again, without the built infrastructure to take care of that, in terms of transportation—contraflow, I don't think, really gets you out of those particular instances.

What you need, of course, is a phased evacuation, where the people in the greatest jeopardy have the opportunity to get out first, where Galveston County, and Galveston Island, have that opportunity to get ahead of the traffic stream. And then, you do not want to evacuate certain areas of Harris County, which are more than 50 miles from the ocean, and which are not going to be subjected to devastating high winds or flooding of the kind that would put life in jeopardy.

Senator NELSON. Ms. Chapman-Henderson, do you want to add to that?

Ms. CHAPMAN-HENDERSON. I do. And first, going back to your question from before, I am only familiar with the building-code mitigation and research aspects to the legislation, so I can heartily endorse those aspects. And our partnership of more than 100 is probably evenly divided on other insurance issues, as well.

With respect to evacuation, I think the way we like to look at it is in a—in an ideal sense. Differentiating between those that reside in a flood zone, or not, is step one. We always urge citizens and—you know, throughout—I think that it's uniform that if you live in a flood zone, you have to leave, because there are too many variables, and the threat of life safety being a reality there.

But, beyond that, the homeowner or the business owner or anyone who's seeking to take shelter from a storm that's coming, if they have knowledge of what their house can do, a performance forecast, for example, then they can confidently make decisions about evacuation and take themselves out of the over-evacuation problems of a Floyd. In Florida, during Floyd people on the east coast of Florida ended up heading west and causing all types of problems. People spent the night in parking lots, and were more vulnerable, because we really don't know, ultimately, exactly where the storm will make landfall.

So, when we work with consumers, which is our primary interaction, and we have, I think, as you know, an experience right now, down at Epcot, at Disney World, where we bring guests through. More than a half million, at this point, have come through and experienced a virtual storm, and engaged in game-playing to do decisionmaking around—good decisions for structures, and different aspects of this whole question of hurricane safety. And when we do that, what we find is, people do not know. They don't know that there are differences in building codes with respect to how things are built. Their expectation is that it would be built properly in the first place.

A very common question we receive is, "You mean there are different roof shapes?" Hip being more aerodynamic, gable end not as much, but they can be braced—people come to us every day and say, "What—why do we build a house that isn't aerodynamic shaped on the roof, if we're in the wind zone? Why would we do that in the first place?" So, I think the public's expectation is that we would do it right. But, they don't understand that the building code, in its best form, is designed to be a minimum legal standard. They don't know that there are different historical strengths to codes, and that the modern codes are better. So, they don't really possess the information to make sound evacuation decisions, and, as a result, they just leave.

And, I think, if we could get to a place where people understand what they have and what it can do, how they can be safe, then they can stay put, shelter in place, stay off the roads, and leave them available to the responders and the others that need to be there and need to be mobile, post-storm, they can remove themselves from the definition of "catastrophe." And we receive thousands of calls when, almost, it's really too late. People call—I remember, during Isabel, people from Maryland calling us and saying, "Am I in the flood zone?"

So, we have a great amount of work to do with respect to bridging those information gaps and equipping people with information about, first and foremost, "Am I in or out of the flood zone?" and, second of all, "Is this house going to survive?" And I think that is a very strong link to evacuation and how we could improve performance in evacuation.

Senator NELSON. With the amount that they're having to pay for homeowners insurance now if you're in a coastal area, you would think that people would be asking about those things when they buy a house.

Ms. CHAPMAN-HENDERSON. Absolutely, Senator. One of the things that is very promising that's being done, as I mentioned before, in Florida and South Carolina, and soon Mississippi, is programs to harden the homes. And there is a very definite link between the hardening or retrofitting activities that address the strength of roofs, windows, and doors, and insurance incentives and discounts.

For those areas, like southeastern Florida, that have the highest insurance rates, although they do compete with Texas for high homeowners rates—they are looking, often, at up to 50-percent insurance discount or credit on the insurance or wind—the wind portion of the insurance premium. So, there are those that report—the average savings in Florida from the hardening program is $773 per year, but in southeast Florida, it's closer to $2,000 per year. And that is a tremendous incentive, as you can imagine, for people who have older homes, to purchase shutters that are tested and approved, and to invest in high-wind shingles and impact-resistant garage doors. And I think that's why that program has been successful, because of the financial incentive, the safety value, and the information that people can shelter in place.

There are letters from people who reside in Miami. One, in particular, came from the program, an elderly citizen, who described her experience of being psychologically traumatized for all of hurricane season each and every year, following Andrew, but because she was able to receive a matching grant from the program, she could rest easy, this season, because she'd taken all the steps necessary to harden her home.

Senator NELSON. Senator Hutchison?

STATEMENT OF HON. KAY BAILEY HUTCHISON, U.S. SENATOR FROM TEXAS

Senator HUTCHISON. Well, thank you, Mr. Chairman.

I'm very pleased to be here, because I think what you and Senator Martinez are doing is very important for States like yours and States like mine that are hurricane-prone.

I also have, maybe, a more far-reaching and not yet proven suggestion in a bill that came out of the Commerce Committee, a month or so ago, to look at, not only to find ways that we are able to better predict the impact and the course of the hurricanes, which you all are doing, but also ways we might consider, through research, mitigating the effects of those hurricanes with some kind of intervention.

So, I hope that my bill passes. I hope that your bill passes. And I want to put my statement in the record.

Senator NELSON. Without objection.

[The prepared statement of Senator Hutchison follows:]

PREPARED STATEMENT OF HON. KAY BAILEY HUTCHINSON,
U.S. SENATOR FROM TEXAS

Thank you, Mr. Chairman, for holding this hearing on the need for a National Hurricane Research Initiative. As the United States—and especially Texas and other southeastern states—brace for the potential fury of the current 2009 hurricane season, this subject is both timely and relevant for Committee consideration.

Hurricanes account for billions of dollars of economic loss—an average of more than $35 billion annually in the last 5 years alone, reflecting the enormous economic tolls of individual storms like Hurricanes Katrina, Ike, Wilma, Charley, and Rita. Hurricane Ike alone caused $24 billion in damage and resulted in the loss of 112 lives. There are many portions of my home state of Texas that are still recovering from this devastating storm.

Storms like Ike and Katrina exposed how vulnerable the U.S. remains to natural disasters. As our coastal populations and urban centers continue to grow, our Nation must find new and improved ways to minimize hurricane damage and fortify our prediction and response capabilities.

Therefore, in December 2005, the National Science Board convened a task force to examine the state of hurricane science and research in the U.S. Not surprisingly, it found that our Nation must do more to improve forecasting, model intensity and impacts, enhance protection of the manmade environment, and refine response and evacuation strategies. Achieving these goals will require additional investment in advanced super-computing capabilities.

The Committee is fortunate to have Dr. Kelvin K. Droegemeier [DRO-ga-meier] testifying on behalf of the Task Force on Hurricane Science and Engineering, which produced the 2007 report recommending the formation of a National Hurricane Research Initiative. This initiative comes with a price tag of $313 million, and it will be critical for the Committee to understand all aspects of such an approach as we consider legislation for authorizing this Initiative.

Of course, I must also note the critical testimony we will hear from Dr. Gordon Wells of the Center for Space Research at the University of Texas. Dr. Wells will testify about his experience using the "Ranger"—the most powerful computer in the National Science Foundation's network of academic high performance computers—to synthesize satellite imagery, GPS tracking signals, and hurricane and storm surge models to orchestrate evacuations during Hurricane Ike. Dr. Wells' use of "Ranger" helped saved thousands of lives and we need to ensure that our scientists and emergency planners and responders have the best tools possible to help protect both life and property.

I look forward to hearing from these witnesses as well as Dr. Spinrad from NOAA, Ms. Chapman-Henderson of the Federal Alliance for Safe Homes, and Mr. Nutter from the Reinsurance Association of America. This expert panel will allow us to examine both the need for a new hurricane research initiative as well as the economic and other benefits to our Nation from such an undertaking.

Thank you again, Mr. Chairman, for holding this important hearing.

Senator HUTCHISON. I've tried to ask my staff, here, what has already been covered, so I'm going to try not to duplicate but, I do want to ask Dr. Wells, because I had the personal information, while we were all just watching Ike by the minute; I was amazed at the accuracy of where it would hit, when it would hit, and its projected intensity, that your Ranger computer was able to model, and share with all of the Federal agencies, the Weather Service, the local and State emergency services. It was the best I have ever seen. I want to ask you, What did you learn from what you were able to get? Is there something more that can be done that we should explore? Or is there something new that you think should be added for this year's hurricane season? Because the ability to track the way you did, and what was amazing is to look at it, after the fact, that everything you predicted was exactly where and when you had predicted it would happen.

So now, my question is, we're going into hurricane season, what more should we be doing, what can we be doing, and what is this

new Ranger capability going to do for the rest of our States that are so vulnerable?

Dr. WELLS. Well, I think—and Dr. Spinrad has also talked about their success at NOAA in running a forecast model on Ranger. We were running the hydrodynamic storm surge forecast, they were running the actual track-and-intensity forecast with a different model. We were sharing the computing resources there. There are 60,000 processors to share.

The *New York Times* had a nice graphic that showed Ranger in relationship to all the other supercomputers, a couple of months ago, and it was the 6th largest. And all of the other supercomputers shown in the graphic were at national laboratories or are similar Federal large facilities.

This is a university resource that's shareable, through the NSF, with many other investigators researching a very wide variety of problems. It's a highly adaptive computing resource that we can use for our hydraulic and hydrodynamic models, as well as the hurricane forecasters can use.

Senator HUTCHISON. And I know you were sharing with NOAA. Is there anything more that would be able to, between NOAA and the technology that you have, that would get any better or more helpful information to the people on the ground who are trying to prepare?

Dr. WELLS. Exactly. I was about to say, probably the area that we haven't explored to the degree that we need to are some of the ways that we can visualize the information from the models, the outcome of the model, and put it into a context where individuals—where the public—can really assess their personal risk. I think there are lots of model outputs that we see. There are maps, there are various other ways of displaying these results, but they just don't always capture the imagination of the public, in general. And they cannot see themselves, in their homes, as being vulnerable to this particular event that we're attempting to give them the model results.

We understand that, and we can actually place first responders in the field, and I can provide information to Mayor Thomas in Galveston, saying, "Here's what your community is going to look like tomorrow." But, I'm afraid that we are not doing as effective a job of changing the attitudes and the personal comprehension of risk that citizens have.

And I think that modeling visualization—and this can be cinematic, three-dimensional, really dramatic ways of presenting that kind of information, both on storm surge and wind damage, and inland flooding, where people see their neighborhoods, and even their residences, as affected by the event. That's the future of this. We can get to that level of demonstrating what the impact is going to be.

You always hear these people, after the event, saying, "Oh, I knew that this was going to be a very bad hurricane. It's going to be as bad as Camille or as bad as Carla, and I lived through that, and I realized—but I just didn't think that, in my part of town, or in my neighborhood or at my house, it was going to be as bad as it was."

Senator HUTCHISON. Well, one of the things about Hurricane Ike was the flooding, not just heavy flooding, it's not a tsunami, but it is that forceful flooding. I flew over the area on the other side of Galveston, to Bolivar Peninsula, not "Island," but Bolivar Peninsula. I've been there many times. I was flying over it and I was thinking, "Gosh, this must be a new construction area, because there's nothing here."

Dr. WELLS. Yes.

Senator HUTCHISON. It wasn't a new construction area.

Dr. WELLS. But, material was 10 miles away, in Chambers County.

Senator HUTCHISON. It was. And that's why all you saw were sticks in the ground. There were no turned-over refrigerators, there was no debris, there was nothing. So, I thought, "Well, it's new construction." And I realized, "No, I'm in the heart of Bolivar Peninsula, where all the houses are." Yet there was no debris. It had gone 10 miles up. And that's what people aren't prepared for.

I grew up in Galveston County. I lived through Hurricanes Carla and Camille. I've never seen anything like it in my life. That's what you're talking about. People can't visualize that they're going to come back and see sticks in the ground, and not a broken air conditioner, not a broken sink, not a thing.

Dr. WELLS. Right.

Senator HUTCHISON. It was unbelievable.

So, is that what you mean when you're saying people aren't prepared for what is actually going to happen in their immediate neighborhoods?

Dr. WELLS. They just have the general concept that this is going to be a bad event, but they cannot personalize it and see it in terms of their own geography, where they live. And I think that we have, now, and we certainly will have better in the future, a means of doing the modeling that predicts that impact, and the means of delivering that information more effectively.

We probably need to study how people respond to different kinds of information that's given to them. I don't think that there is enough research to show how people conceptualize their personal risk in this kind of event. It's probably the same for earthquakes and other natural disasters. I think we really need to take a careful look at that, because we could have the greatest science, and have the best knowledge of the physical dimensions of the impending event, but if we can't communicate it, it's not going to make a difference.

Senator HUTCHISON. Let me just ask one other line of questioning, to anyone who would wish to respond.

The bill that I'm putting forward, would study the present and the past weather modification activities to see if there is any future in weather modification. In other words, just as an example, I don't know if this is possible, but I think we ought to be looking into when you see a certain type of hurricane, 100 miles out in the Atlantic, whether there is something that could be done there that wouldn't stop it, but might make it less powerful when it comes into Florida or into Mississippi or Louisiana or Texas or Alabama. Is there something that we haven't looked at from the past that would give us an indication of, maybe, a mitigation of the impact?

Because the damages are so much higher now than they have ever been, because of the intensity. So, my question is to anyone.

Yes?

Dr. DROEGEMEIER. Senator Hutchison, it's a very important question you ask, and one that, as your bill states, got a lot of attention in the 1970s, but there was then a drought, so to speak——

Senator HUTCHISON. Right.

Dr. DROEGEMEIER.—of weather mitigation activities.

I would like to make four points with regard to modification. I think number one is, you really need good numerical forecast models to do weather modification, especially of hurricanes, because you need to know that the modification you're going to try to impute to the hurricane will have the intended effect. And so, that's a challenge, in and of itself, and it really requires the best research and the best forecast technology possible.

And we have run simulations of tornadic thunderstorms, of hurricanes, and we know, through our simulations anyway, that in fact there's no question you can change the course of a hurricane, you can kill it off, you can kill off a thunderstorm before it produces a tornado.

But, that brings me to the second point, which is, How do you actually, then, implement that change? And that's really an engineering problem. There have been some far-ranging, you might say, approaches proposed, all the way from launching ballistic missiles into thunderstorms, to doing all kinds of things in space, for hurricanes. The real challenge is, How do you actually deliver the disruptive influence that will change the course? We know, in our simulation models; we don't say how we're doing it, we just cool the ocean surface temperature, and sure enough, the hurricane dies. But then the question is, How do you actually do that?

So, the first point is, you have to have good forecast models to know that the change you're trying to achieve, is, in fact, the one that's going to occur, you're going to get what you ask for. The second thing is really the issue of, How do you deliver the influence?

The third one is an interesting one, and that is the unintended consequence. For example, hurricanes, although they are destructive, they have some very positive aspects as well, such as bringing fresh water inland. There is a lot of flooding, but they are an important source of water recharge in the hydrology system.

Another thing about hurricanes that's very interesting, we don't know why they exist. We know why weather occurs; it's the atmosphere's way of trying to reduce imbalances of temperature between the cold poles and the warm equator, and it never is successful at doing that, because the sun keeps shining all the time.

Hurricanes, we don't know why they're there. We don't know what purpose they play. And so, that has interesting implications in the climate system. If you got rid of all hurricanes, for example, what impacts might that have on the climate? This is where numerical models come into play. And when we actually are able to resolve hurricanes with climate models, which we can do now, we can run 100-year climate simulations; and when a hurricane starts to form, we can kill it off and then compare that simulation with the case where the hurricane is actually allowed to continue. So, the third point is really one of unintended consequences.

The fourth point relates to ethics and legal issues. I know you run into this in Texas; we do, in Oklahoma and Kansas—where you're doing rainfall enhancement studies, or hail suppression, and you're spending a lot of money actually doing that, you know, in the private sector, and somebody in Texas says, "Well, you've bled all the water out of my clouds in the Oklahoma Panhandle," and the farmers in southwest Kansas get very upset. So, it brings in a lot of interesting legal challenges as you cross State lines and geopolitical barriers and things like that.

But, I do think—and I read your bill, and I think it really is time for the Nation to get serious again about weather modification. And as your bill pointed out, and as the National Research Council study showed, there really is no compelling evidence that this works. But, we have much more powerful observing systems now, which we need—mobile radars, ground-based radars, things like that, aircraft, and especially numerical models. So, I think the scientific community is really well poised to address the important challenge you bring across in your bill. So, I applaud you for introducing it. There are some interesting nonscientific, ethical, and legal issues, as well, but——

The other point I would make, just in closing, here, is that, in fact when you study modification of the weather, the kinds of questions you ask have great relevance to some of the other issues that we deal with, in terms of predictability of the atmosphere, in general, and how you do data simulation, as Dr. Spinrad mentioned. So, we might think of it as modifying hurricanes or doing advertent weather modification, but there's a lot we can learn scientifically in other areas of—and challenges in weather forecasting, when we're studying weather modification.

So, it has a double-barreled positive effect, I would say, on the—studying the issue of weather modification, but all the other things that it relates to. We can get a great benefit, as well, from that.

Senator HUTCHISON. And I wanted to go to Dr. Spinrad, but that is the purpose of the bill. It's not only to see what might have an effect, but what are the unintended consequences. And I think, even today, when you have cloud seeding in one area, we need to know if it affects weather in another area adversely. I think that's something that, because we did take a pass on getting data, really, many years ago, we really need to know, now, more where to go and what the consequences are.

Dr. Spinrad?

Dr. SPINRAD. Thank you, Senator. I'd just like to add two points of emphasis to Dr. Droegemeier's comments.

And the first is, before we modify any system, we really have to know what the system is comprised of. And if we look, for example, to hurricanes, it's only in the last several years that we have begun to understand the role of phenomena such as El Niño/La Niña on hurricane development.

And something that's emerging right now is, we're discovering that dry air masses coming off the Sahara have a very strong influence on whether hurricanes will form or not. Five years ago we had no idea of that. And so, I'd say the research that goes into understanding the system and the development of any weather phe-

nomena would have to be addressed, whether it's to improve the forecast or to engage in any kind of modification.

My second point is an emphasis on the unintended consequences, and I'd hope we would include in that some understanding of the consequences to the ecosystem itself. There are some indications, for example, that because hurricanes have a major stirring effect, they reintroduce nutrients into the environment in the Gulf, for example. There are potentially beneficial consequences of hurricanes to the productivity of that environment.

So it's the physical consequences, it's the societal consequences, but it's also the ecosystem consequences, as well.

Thank you.

Senator HUTCHISON. I think all those points are absolutely well taken, and would be part of any kind of study. Basically, what I want to do is start getting the data, and then, from that, know if we do modify or don't modify, that's when you start getting into the consequences. But, it just seems like not knowing is not very enlightened. So, hopefully, we can do something about it.

Thank you, Mr. Chairman.

Senator NELSON. Thank you——

Senator HUTCHISON. I appreciate the opportunity.

Senator NELSON.—Senator Hutchison.

Earlier, Dr. Spinrad, you were talking about the importance of measuring the winds at the surface of the ocean as a means of trying to predict the direction and intensity of hurricanes. We used to have a satellite that measured that, but that satellite is beyond its designed life and either on the blink or it's about to go out.

There was an attempt to get another one in there called a scatterometer. The short name was QuikSCAT. Since we don't have that capability, how do you fill the gap, and what are NOAA's plans for the next generation of a QuikSCAT?

Dr. SPINRAD. Surface winds are important. I think there has been some debate as to the full value of those data, in terms of improvement of the forecast; but, nevertheless, I think most of our scientists and forecasters would say, having those surface winds is of value.

QuikSCAT, in fact, is viable, and is fueled to run through 2011, if all things go well. We are in discussion with NASA about development of next-generation ocean surface vector wind sensor, which would fulfill the same data requirements as QuikSCAT does. We also have ongoing discussions for data availability from a scatterometer being developed by the European meteorological satellite system, and that would be called ASCAT.

Finally, I would add that, as I mentioned earlier, there are some additional approaches that we are testing, one of which is the use of unmanned aerial systems, which we can actually fly into the hurricane and directly acquire the surface winds—near surface winds. And then the other is a new piece of equipment that we have installed on our aircraft and the Air Force aircraft, and that's called a step frequency microwave radiometer, which allows us to view the ocean's surface and extrapolate from that what the winds are.

So, there are a variety of different approaches that are at hand. We believe, with the viability of QuikSCAT currently, we have time

to develop the solutions so that we can, in fact, get those surface winds.

Senator NELSON. Earlier, you all testified about these computer models and the supercomputer with regard to intensity and direction. What about the hurricane models that model what is going to be the economic loss for the insurance industry?

Ms. Chapman-Henderson, do you think that, since the insurance companies have their own hurricane computer models, that we ought to have a public-domain computer model?

Ms. CHAPMAN-HENDERSON. I think it's fair to say that—when it comes to the models, that more is probably better. And having private-sector models, and having that information and findings from those models available, is essential.

As far as having a public model, I think it's like any model; as long as the data and the assumptions and everything that go into the models are accurate and correct, then you're going to get a good product from them.

One of the things I've heard—and I am not a modeler, but what I have heard in the work that we do is that it is important for us to not over-rely on models. They are predictors, like anything else, of economic loss. I think what's very instructive—and I think Mr. Nutter can probably add a lot of value to this conversation, as well—is that, when we look at the model's performance after a storm, there are some excellent track records, in terms of, you know, this was anticipated—this amount of economic impact was forecast, and that is indeed what occurred. Often, models are more conservative than what actually happens, because of the duration after the impacts of the storms, and the costs that aren't anticipated.

Ironically, it seems like we come away—and I think this is true on the weather side, the engineering side, and the economic side—that we learn things after a storm, and we develop a set of beliefs. For example in Hurricane Andrew, we learned that hip-shaped roofs performed better than gables; gables collapse, and we were going to do it better. What happens is, we labor under all those beliefs—and that's good—but, we learn something new each time.

With respect to—you talked earlier about Hurricane Wilma—you know, the rule of thumb—"As a storm makes landfall, you can expect to lose a category of strength—It comes in as a 4, it's going to go down to a 3—and down to a 2." But, take Wilma—after all those years of telling homeowners or, citizens, "OK, it's coming in as a 4. By the time it gets to you it'll be a 3"—and we like these kind of pat beliefs, because they give us comfort, *but* they're not always true. You know, Wilma came in as a weak 1 or 2, but then it increased and came out on the east side, and caused more damage on the east side than the west.

So, I guess the way I look at models is, as long as the information that goes in is excellent, that we can be guided by them. And I think, certainly on economic impacts, that's been proven. But, we have to keep an open mind, because every major catastrophe—and I've been in and around them for 25 years—we learn something altogether different about what the outcomes are going to be.

So, I don't know if Mr. Nutter wanted——

Senator NELSON. Mr. Nutter?

Ms. CHAPMAN-HENDERSON.—to add to that or not.

Mr. NUTTER. Senator Nelson, I've been proud to serve on the advisory board for the International Hurricane Research Center, which is affiliated with Florida International University, now, for some years, and that's where the public model in Florida was developed.

Florida also has an interesting approach to evaluating these models, in having a commission that's, I think, chaired by—or staffed by academics from the community. It's a responsible approach to try and understand the dynamics of these models.

It seems to me that one of the—one of the real values of the public model, where emphasis really ought to be placed is on what the public values are, here. So, by that I mean, what mitigation might benefit from an analysis using the public model—what evacuation systems, hardening systems—those kinds of things, a public model has not focused on as much as it could and should, and would be very valuable in doing so.

So, there is great utility in a public model that would really look at the kinds of impacts that these storms have, and help everyone understand what those impacts may be, but, more importantly, what you could do to minimize those impacts.

Senator NELSON. Does Florida have a public model today?

Mr. NUTTER. Florida does have a public model. It was developed at Florida International University, and funded by the State of Florida through the insurance department.

Senator NELSON. To what degree do the insurance companies and reinsurance companies use the public model to determine loss and therefore to determine what the premiums are?

Mr. NUTTER. I don't think the public model is used by the insurance or reinsurance companies. There are private models that are used. And those models all have to go through an accreditation process that's a commission in the State of Florida. So, to the extent that they are private and they have proprietary information in them, they are still subjected to a review, under the jurisdiction of the State of Florida, to see what the—the assumptions that are made in those models.

I think that the public model is used primarily by the insurance department as a guideline, if you will, a guidepost, in looking at what the insurance companies file, and what reliance they place on the public models—on the private models.

Senator NELSON. Do either you or Ms. Chapman-Henderson recall what year the public model was developed by Florida International University?

Mr. NUTTER. The Florida Hurricane public model was released in 2006.

Senator NELSON. OK.

Dr. Droegemeier, what is the relationship, if any, between climate change and hurricanes?

Dr. DROEGEMEIER. That's a very, very good question, Senator. And, in fact, we tend, a lot of times, to think about climate changing the nature of hurricanes; for example, the intensity and the frequency and so on. But, it's really a two-way street. In fact, hurricanes themselves can impact climate. So, we have to remember, first and foremost, that it's a two-way street.

Recent studies have suggested that, with the climate changing as we believe it is, as the records actually indicate, that we're seeing a shift, not in the total number of storms, but—keeping the number of storms constant, but more—a larger number of more intense hurricanes, and a smaller number of less intense hurricanes. So, we see that shift in the Atlantic, based on historical records of a few decades. There's also some sense of the hurricane—the power of the hurricane being greater in the last several decades than it had been prior to that.

So, those are some evidences that we're seeing. But it's a real challenge to draw definitive conclusions, so the work really needs to be ongoing.

Flipping the coin around, now, looking at the impacts of hurricanes on the climate system, we're seeing some things, in the last few years especially, that really, as Dr. Spinrad mentioned, some of these new discoveries that are sort of surprising; in fact, the role of hurricanes changing the balance of currents in the ocean because they bring up a lot of cold water from beneath. When you have a lot of hurricanes in a progression, as we saw several years ago—I think it was four or five in the Atlantic, all lined up right after one another—that has a longer-term impact on the climate system, the so-called conveyor belts of moisture and—or, rather, of heat and energy in the ocean. And that has an impact on the large global climate system.

So, it's not just the climate changing the hurricane, but the hurricane impacting the climate system. And that's something we really have not been able to study, because climate models have not been able to resolve hurricanes. So, without the hurricane in the model, you really are missing an important piece.

But, that is changing now, with the more powerful computers getting to the resolutions, that Dr. Spinrad mentioned, of really understanding what those tradeoffs are.

So, I would say, overall, that the notion of how hurricanes are impacted by climate, and the impact of hurricanes on the climate system, is really in its infancy. We're seeing some early results that are rather compelling, but certainly a lot more work needs to be done.

Mr. NUTTER. Senator, could I add something to that, if——

Senator NELSON. Please.

Mr. NUTTER.—if you would, please?

I agree wholeheartedly with Dr. Droegemeier. And it would seem that, in the legislation that you've introduced to fund additional research related to hurricanes, there certainly are references to climate change in there. From looking at the value there, to the extent that those climate models can be more regionalized, that the resolution can be more tailored to local areas, it would be of greater value to local officials and other private- and public-sector officials in addressing issues associated with climate change.

Senator NELSON. Well, let's say that we have an increase of 1 foot in the sea level. Now, what does your professional opinion tell you is going to happen to the storm surge level and the inland flooding?

Yes, sir, Dr. Wells?

Dr. WELLS. I was—wanted to jump into the last conversation to say—your 1-foot estimate may be quite conservative. One of the things that we do at the Center for Space Research is, we're the lead—principal investigator for the gravity recovery and climate experiment, the two-satellite mission that is really looking, in probably the greatest detail, at the loss of water from Greenland and Antarctica. It's showing—and I think observations are also showing that the rate of relative sea-level rise is increasing more dramatically than some of our previous modeling would have shown, just 2 or 3 years ago. And that estimate, that it may only rise a foot or so by the end of the century, may be off by a factor of 50 percent. We could see a considerably larger rise than that.

I think this has tremendous impact on what we want to do in the future, as we think about what sort of mitigating steps we're going to take, because it's a moving target now. I have friends who are studying barrier systems, that are quaternary geologists, that have looked at everything that has formed since the last iglaciation, and they are seeing evidence that sea level is rising faster than it has in 7,500 years, if this trend continues. Well, barrier islands did not exist along the Texas and Louisiana coasts at that period; in fact; there is some question as whether they could exist under those conditions.

We're getting into a period of instability as this increases. And if we're going to have large, built infrastructure, like an Ike Dike, placed in these areas, we're going to have to ask these questions. If these trends continue, what are the effective countermeasures that we can take? These are tremendous impacts on the coastline, and we—I don't think we have fully comprehended, at this stage, what the future holds as it unfolds. Certainly, the modeling is going to help us determine that.

Dr. SPINRAD. Mr. Chairman, if I can add, there's an important component that has to be introduced into this discussion, as well. In addition to the climate change impacts, we also recognize that there are periods of several decades when we see increased and decreased frequency, intensity of hurricanes, the multi-decadal oscillation. And the—naturally occurring—and the question is, How much of that is continuing to happen? So, as we have the discussion with regard to climate change impacts, we've also got to look at what we believe are the naturally occurring multi-decadal patterns that Mother Nature introduces, herself.

Senator NELSON. Dr. Spinrad, representing NOAA, are you familiar with a satellite, that is sitting on the ground, named Discover, which would give some more precise measurements on climate change? You want to offer your professional opinion about that?

Dr. SPINRAD. I am familiar with that, sir. In fact, I had the pleasure of talking with Former Vice President Al Gore about that particular satellite, just a few months ago.

I think there are clear benefits to the kinds of observations that we would get from a satellite such as Discover. I also believe that we have looked very carefully at our priorities for remote sensing, the satellites that we currently have in the hopper, if you will, to be put up, and the launch schedule; and I believe that we can't afford to compromise that schedule. I think we should have a more

rigorous debate and discussion about how and whether and when we should consider launching that kind of capability, but not if it compromises what we have all very carefully agreed are the needs at hand right now.

In fact, the National Research Council put out, just a couple of years ago, what they call their "decadal survey," identifying what they, the Nation's premier scientists, believe the priorities are for Earth observations. And we've tried to use that as our guide in defining what satellites we should put up, when, and for what observations.

Senator NELSON. I think we're going to be able to get that satellite up, because now the Department of Defense has a need for another instrument to replace an aging satellite at the Lagrange point, between Earth and the Sun, to measure solar flares and the radiation effects upon the Earth, to warn Earth before the solar radiation gets to Earth. I think, increasingly, we just put language in the Department of Defense Authorization Act, that the Air Force is going to study this, and I think this might be a way that we can kill two birds with one stone.

Let me ask Mr. Nutter, How is the insurance industry addressing climate change? Clearly it has an enormous impact on the insurance industry because of all the property that you insure on the coast.

Mr. NUTTER. It's an excellent question. And at times, I'm proud of the industry, and, at other times, disappointed in their commitment to this. A number of reinsurers have, for a long time, funded research—private research—as well as talked publicly about the need to address climate change. Swiss Reinsurance and Munich Reinsurance stand out as companies that have always been a paragon of being progressive about looking at this.

Increasingly, we see an interest in the industry to better understanding the science, including working with people such as on this panel. The Willis Insurance Group, which is an insurance brokerage, funds academic research through a Willis Research Network. The Institute for Business and Home Safety, which is a companion organization to FLASH, Ms. Chapman-Henderson's organization, as I mentioned in my statement, is now funding a research facility to look at this.

I would hope that our industry in the United States would commit more to research and looking at climate change, because there's no question that the implications of climate change for the insurance companies, but, more importantly, their policyholders, is pretty critical to understand. So, I—a closer relationship between our industry and the community of government and private research is pretty critical.

Senator NELSON. A decade ago, European insurance companies were getting more interested in the effects upon their economic activities more so than were American insurance companies. Are European companies still taking the lead?

Mr. NUTTER. No question about it. Allianz, Munich Re, Swiss Re, Renaissance Re, which is a Bermuda-based company, have all stepped forward to fund research, as well as to promote a better understanding of this. And by that I mean by public research made

available to others and funding research looking at both the health and property, life exposures, related to climate change.

The industry in the United States, historically, has a business model that tends to be a retrospective one. They look at actuarial data, and trend it forward. I would say the Europeans continue to be more progressive than the U.S. industry in trying to understand future events and the impact upon themselves, as well as their policyholders.

Senator NELSON. I want to conclude by asking anybody who would like to respond. One of the problems that we have here in the Senate is the fact that Senators from States that are not coastal States tend to think that hurricanes are not their problem. If they don't come from California, they think that earthquakes are not their problem. Now, we are focusing on hurricanes here. But, that's just a fact of life, and that's human nature.

You all want to suggest, for the record, on a hurricane bill that Senator Martinez and I have proffered, that seems to meet with widespread support, what is it that you would recommend to us as to how we go about getting the attention of these Senators, who are not from coastal areas that are threatened by hurricanes, to support it?

Ms. Chapman-Henderson?

Ms. CHAPMAN-HENDERSON. Senator Nelson, I think, first and foremost, as taxpayers, we all need to be concerned about the impacts of hurricanes, because of the significant economic impacts to all of us. But, on a more practical level, I think you can go State by State and identify impacts that surprise some. One in particular that springs to mind is from Hurricane Ike and the flooding that occurred in Ohio. More than a billion dollars in insurance losses happened in Ohio because of Ike. Similarly, in Pennsylvania, after Hurricane Ivan; West Virginia, after different storms. The hurricanes do not come to the coast and, as you know, stop. They move through and they cause damage throughout the United States. And I think it's, again, one of those things—we're sometimes looking back at that instead of thinking forward. But, I believe we can provide a very detailed analysis, of cases of economic and, societal disruptions that follow hurricanes well inland to places that are not traditionally thought of as hurricane zones—Ohio springs to mind again, because of last year.

Dr. WELLS. Senator, there are national disruptions to the consequences of hurricane landfall in particular areas. You only need to look at the high proportion of all the petrochemical and refining activity that occurs on the Texas and Louisiana coast. And we have not had the event that would create the true distortion and disruption of that system. That's the kind of hurricane that would go up the Houston ship channel, for instance.

Dr. SPINRAD. Mr. Chairman, we've talked mostly about landfall, we've talked about impacts on the coast. I would remind you that greater than 95 percent of the imports and exports we enjoy in this country travel by sea. Saying that a hurricane has safely turned to sea is not quite appropriate when we talk about the impacts on that maritime commerce. Everything we buy—almost everything we buy and sell takes advantage of that. There are excellent stud-

ies that have shown the impact of adverse weather on the cost of goods and products, wherever we buy them, in the United States.

Dr. DROEGEMEIER. Senator Nelson, I think it's a very, very important point, and, in fact, it's why such an integrative research approach is needed to understand these linkages. And some of them are very long term, in terms of goods and services—the supply chain, the resupply, things like the forest industry—some of these are decadal impacts of hurricanes that require massive rebuilding efforts—and shipping of goods and services, reallocation of wealth, if you will, from some part of the country to another. And the sustaining impacts are very long term. And we really don't understand that nearly as much as we should. We can give some excellent examples, as you've heard here, but I think the interactions of all of those different components of our society are something that are very, very complicated, and something we really don't have a handle on.

So, the research you're talking about, I think, by its nature, will build upon these stories and give credibility to, and a deeper understanding of, their impact on our society.

Mr. NUTTER. And, Senator, if I might add, this is a country of shared values, and two of the values that we talk about repeatedly here are mitigation, ways to reduce damage to property and loss of life. And certainly research in this area is going to have an extra effect on other kinds of properties in nonhurricane areas.

The other shared value would be our responsiveness to people that have had a disaster, that have faced that. The government has always been generous incoming in and dealing with temporary housing and disaster assistance and response.

Senator NELSON. In addition to the excellent comments that you all have made to this question of, "Why should Senators from noncoastal States be interested in the damage of hurricanes?" it's also the fact that most of the cost is borne by the American taxpayer, wherever that taxpayer happens to live, because clearly we've seen, in the case of Hurricane Katrina, almost half of the economic loss of that hurricane was borne by the Federal Government in its efforts to try to bring that part of the United States back to life.

I want to thank you all. This has been an extensive and very thorough discussion of the issue. You have illuminated this issue enormously. The record is quite full, and that is thanks to your expertise, as presented here today.

So, thank you.

And, with that, the meeting is adjourned.

[Whereupon, at 11:55 a.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF MAX MAYFIELD, FORMER DIRECTOR, NATIONAL HURRICANE CENTER

Mr. Chairman and Members of the Committee, I am Max Mayfield, former Director of the National Hurricane Center, and current Hurricane Specialist for WPLG–TV in Miami and Sr. Executive VP—Government Relations for America's Emergency Network. Thank you for inviting me to share some of my thoughts on a National Hurricane Initiative. I will address observations and forecasting before giving some final comments.

Observations

The primary observing systems used for tropical cyclone (TC) monitoring are the satellites. Today, several geostationary and lower orbiting satellites provide a wealth of information to modeling centers and forecasters. One of the more useful polar-orbiting satellites is NASA's QuikSCAT which can provide surface wind information over ocean areas including around TCs. QuikSCAT is used daily in routine marine forecasts and has been an overwhelming success with these marine forecasters around the globe. There is great concern for QuikSCAT within the marine and TC forecasting communities because the satellite was launched in 1999 with a five-year life expectancy. The more than ten-year-old technology also has some limitations such as rain contamination in heavy rain bands and the eyewall of hurricanes which prevents accurate wind information there. NOAA has documented surface vector wind requirements (surface winds) during a NOAA Operational Ocean Surface Vector Winds Requirements Workshop held at the National Hurricane Center in June of 2006. These requirements include all-weather retrievals (*i.e.,* accurate winds in rain), reducing time between the satellite passes over a particular point, reducing time from measurement to availability, and others. This could be achieved with today's technology that has advanced beyond QuikSCAT. It would be a fair question to ask NOAA and NASA what is being done in regard to a next-generation QuikSCAT. Although more detailed aircraft reconnaissance is usually available for tropical cyclones that threaten the United States, the QuikSCAT is extremely useful for TC forecasters for storms well out at sea and for those forecasters in other ocean basins without aircraft reconnaissance. In my opinion, the day to day marine forecasting program should more than justify the need for the next-generation QuikSCAT—and the secondary benefits to hurricane analysis make follow-on missions imperative. NOAA has committed modest funds to studies of a next-generation QuikSCAT. What are the plans for going operational?

As a TC nears the United States, the more detailed data from aircraft *reconnaissance* becomes critical. NOAA has two P–3 hurricane hunter planes based at the Aircraft Operations Center at McDill Air Force Base in Tampa, FL that fly primarily reconnaissance research missions although they also account for a small percentage of the operational reconnaissance flights. The U.S. Air Force Reserve Command has ten C–130J hurricane hunter planes based at Kessler Air Force Base in Biloxi, MS that fly most of the operational reconnaissance missions. The NOAA P–3s are equipped with tail Doppler radars that are not available on the Air Force planes. The Doppler radars provide a more 3-dimensional sampling of the TC's circulation that is needed for numerical models to be able to forecast changes in the TC's structure. If this 3-dimensional structure is not accurately measured, how can one expect to accurately forecast it into the future? I am confident that the improved Doppler data obtained from aircraft, especially in the core of a hurricane, will soon be shown to improve intensity forecasting. What does NOAA need to complete the testing of the P–3 Doppler radar data in numerical models? And if this Doppler data is proven to have a positive impact on forecasting, what are the plans to transfer the technology to the Air Force hurricane hunters who fly by far the majority of the operational missions?

One of the true success stories in tropical cyclone forecasting has been the inclusion of the NOAA G–IV jet *surveillance* data into numerical models. This NOAA jet

basically flies in the environment around the hurricane and samples the steering currents that the hurricane is embedded within by releasing dropwindsondes that send back temperature, humidity, wind and pressure as they drop from flight level (usually 43,000 feet) to the surface. Countless impact studies reveal examples of improved model forecasts when the G–IV data are available. At this time, NOAA has only one high-altitude jet. This is a single point of failure. There has been talk of purchasing an additional G–IV or perhaps a G–V. What are the current plans? It is also my understanding that a Doppler radar is being installed on the current G–IV. This may help in collecting 3-dimensional data in the core of the hurricane similar to the P–3s. If the G–IV Doppler data is successfully incorporated into the numerical models, what is the plan to initialize the numerical models every 6 hours with radar data?

Forecasting

TC track forecasts have been steadily improving thanks to better observations (satellite, aircraft, radar, buoys, etc.), more sophisticated computer models, and faster computers. Intensity forecasts have shown little or no improvement. On average, the official NHC intensity forecasts are pretty reasonable but the forecasters have been very honest in saying they don't catch the rapidly changing TCs (rapidly strengthening or rapidly weakening). One of my greatest nightmares is seeing people go to bed at night preparing for a weak hurricane and waking up to an Andrew (Cat 5) or Katrina (Cat 3).

The atmosphere is unbelievably complex and, in my opinion, we will never be able to give a perfect forecast. The National Research Council released a report on "Completing the Forecast: Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts" in 2006. The report states "Uncertainty is thus a fundamental characteristic of weather, seasonal climate, and hydrological prediction, and no forecast is complete without a description of its uncertainty." In my opinion, a single deterministic forecast of a TC can not only be misleading, but it can lead to bad decisions and loss of life. It is preferable to make probabilistic forecasts on TCs. The NHC is to be commended for leading the way this is being done with its probabilistic wind and storm surge forecasts. However, these probabilistic forecasts can be made better by improving computer models and better use of ensemble forecasts. An ensemble forecast is simply a collection of multiple forecasts verifying at the same time. Modeling centers around the globe are using ensemble forecasts. I'm sure that most numerical modelers would say that they could do a better job with more resources. Development of more accurate model forecasts including data assimilation is not trivial. And computing power is extremely important to accomplish improved ensemble forecasting. NOAA has recently established the ten-year Hurricane Forecast Improvement Project with moderate levels of funding. In my opinion, it provides a rare focus on important hurricane issues. I wish there had been such commitment, effort, and funding during my nearly 35-year career at the National Hurricane Center.

Hurricane Katrina has reminded us that a large loss of life is possible from the storm surge. Improved storm surge models incorporating "wave-setup" and "wave-runup" are no doubt being developed. But one should remember that to get a perfect storm surge forecast, one has to have a perfect forecast of the track, a perfect forecast of the intensity, and a perfect forecast of the structure including the radius of maximum winds. Therefore, the storm surge and wave forecasts need to be presented in a probabilistic manner as well. This would also hold true for rainfall forecasts.

I have been quite interested in reading recent media reports on proposed plans for controlling hurricanes. The payoff would be tremendous if man could control hurricanes, and I have never discouraged researchers from thinking of ideas that might work. But we should go very slowly here. Changing ocean temperatures and other proposed ideas, even if they could be applied to the large area of a hurricane, could obviously have unwanted impacts on the environment. And a huge impediment seems to be the inability of telling what man has done and what nature has done on its own. I suspect that every hurricane forecaster will tell you that they do not have a reliable computer model that can be depended upon to routinely give accurate track and intensity forecasts. We have all seen some pretty unexpected changes in a hurricane's track and intensity that were not well predicted by any computer model. If we can't predict exactly what the hurricane will do, how would we determine if a change in track or intensity were due to man's influence or simply what the hurricane would have done without any help from man. I would much rather see funding focused on improving the computer model guidance before investing in hurricane modification.

Closing Comments

The biggest hurricane problem that the United States has, in my opinion, is the ever-increasing population and wealth in vulnerable coastal communities. As long as we continue to develop these coastal areas, the damages from hurricanes will increase. And the potential for large loss of life will also increase. Our memories of past disasters are very short. Creating a national catastrophic insurance fund will not solve the problem alone. I have read several reports on such a fund being proposed, but I rarely hear of any linkage to better building. Until we build better and smarter in hurricane prone areas, we are inviting disaster.

I would like to close by sharing an idea proposed by the Policy Director of the American Meteorological Society that I think has merit. When we have an airline disaster, the National Transportation Safety Board (NTSB) immediately sends in a team of experts to the crash scene. The NTSB coordinates and leads the team, but the team includes experts from all the stakeholders—the airframe manufacturer, the airline, the FAA, etc. Although the NTSB findings and recommendations do not carry the force of law, stakeholders ignore them at their peril. The result is an airline safety record that has steadily improved over the years. Perhaps we need something similar for disasters, like a National Disaster Review Board. Most of the reports written on Katrina focused on the response. Response is indeed important. But there are many other parts to the puzzle, such as land use, building codes, communication, education, insurance, preparedness, mitigation, etc. We need the political will that will span multiple administrations to make a meaningful commitment to help change the outcome for the better in future hurricane events.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DAVID VITTER TO DR. KELVIN K. DROEGEMEIER

Question 1. You said that additional research is especially needed in the fields of the social, behavioral and economic sciences, and that such research is relevant to hurricane understanding, prediction, mitigation, consequences and societal responses. While I do not disagree that research into those fields could be relevant in terms of mitigation and understanding the consequences and social responses in the aftermath of a hurricane impact, how, in your opinion, is additional research in those particular fields relevant to understanding the atmospheric dynamics of hurricane systems or relevant to helping us better forecast hurricanes or predict their development and movement?

Answer. For the most part, social, behavioral, and economic sciences do not contribute in any *direct* manner to developing a better understanding of the dynamics of hurricanes or more accurate prediction of their intensity and movement. However, physical evidence suggests that climate change already is impacting, and likely will continue to impact hurricane frequency, intensity and perhaps other characteristics. Given that climate change is a physical science *manifestation* of human behaviors that inherently are social and economic in character, it is accurate to say that social and behavioral science research may, in an indirect but potentially profound manner, impact our ability to predict hurricanes.

Question 2. Would you be concerned that by especially focusing resources on research into the social, behavioral and economic sciences—i.e., on the aftermath of hurricane impacts—we might lose focus and miss an opportunity to make advances in our understanding of the development of hurricanes and their interaction with the ocean and atmosphere and therefore the potential to better forecast hurricanes and predict how they will develop and where they will make landfall? After all, isn't the first line of defense against hurricanes and to mitigating property damage and loss of human fife providing an accurate forecast and timely forewarning to the areas that will be impacted, therefore giving state and local governments, agencies and first responders time to mobilize and coordinate and giving the population enough time to prepare and evacuate?

Answer. No, I would not be concerned because, as noted in the NSB report calling for a National Hurricane Research Initiative, hurricane research should be conducted as a *balanced portfolio* involving the physical sciences, social behavioral and economic sciences, engineering, and other related areas. To date, the bulk of research funding for hurricanes has rightly been directed toward the physical science and engineering areas because, as you note, accurate forecasts are foundational to effective response. This research needs to continue, particularly with regard to rapid changes in hurricane intensity.

However, catastrophic loss of life continues to occur because hurricanes are not being studied in a truly *integrative fashion,* that is, as a *weather-driven* societal problem. For example, only recently has funding been directed toward under-

standing how information about hurricane path and intensity should be communicated, and how the public is likely to respond under various scenarios. Physical scientists can produce the forecasts—but social scientists are needed to understand how to package and convey the information, and anticipate human response. Even extremely accurate forecasts, as were produced in Hurricane Katrina, for example, lose considerable value if they are not communicated effectively, and if response to them is not understood and accounted for in planning. Weather predictions are like seat belts; even though they have the potential to save lives, they can do so only if used properly.