S. HRG. 114–101

WEATHERING THE STORM: HOW CAN WE BETTER COMMUNICATE WEATHER TO ENHANCE COMMERCE AND SAFETY?

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

APRIL 22, 2015

Printed for the use of the Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PUBLISHING OFFICE

97–369 PDF WASHINGTON : 2015

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

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WEATHERING THE STORM: HOW CAN WE BETTER COMMUNICATE WEATHER TO ENHANCE COMMERCE AND SAFETY?

WEDNESDAY, APRIL 22, 2015

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

The Committee met, pursuant to notice, at 9:53 a.m. in room SR–253, Russell Senate Office Building, Hon. John Thune, Chairman of the Committee, presiding.

Present: Senators Thune, Sullivan, Nelson, Klobuchar, Schatz, and Peters.

OPENING STATEMENT OF HON. JOHN THUNE, U.S. SENATOR FROM SOUTH DAKOTA

The CHAIRMAN. This hearing will come to order. I want to appreciate Senator Nelson's willingness to start a little early today and for our witnesses for being so accommodating.

We have to begin the hearing a little earlier than planned due to the Senate floor votes that were scheduled last night for 10:45 a.m. this morning, which is not necessarily a bad thing.

It underscores the fact that the Senate is considering a host of legislative matters, and I think we are up to 155 roll call votes that have already been called so far this year. With the eight that we are going to have today on human trafficking and related amendments, it is going to bring the number of recorded votes up to 163.

I appreciate everybody's flexibility. For the information of my colleagues, we plan to keep rolling during the two floor votes that begin at 10:45, which may require a few of us to alternate as questions are posed to our witnesses, but that is a better alternative than adjourning and then trying to restart.

Increased computing capacity, better models, and more observations have all contributed to dramatic improvements in weather forecasting. Weather forecasts are no longer just a best guess but are reliable enough that emergency managers can preposition assets before major storms and school administrators may cancel classes before the snow even starts, sometimes to the chagrin of parents.

The private sector also uses improved weather forecasts to run businesses more efficiently. Decisions about when to apply fertilizer or how much to water a field can be informed by accurate forecasts. In addition, as our witness today from Schneider Electric can tell

us, better forecasts can be integrated with smart thermostats to help homeowners and businesses save energy and money.

Of course, even with these advances, predicting weather across the country can still present a challenge for even our best meteorologists. This is certainly true in my home state of South Dakota, where Rapid City earned the distinction of having the "least predictable" weather in the nation this year.

Spearfish holds the ultimate weather bragging rights. On January 22, 1943, the temperature was –4 degrees at 7:30 in the morning. Two minutes later, the temperature had climbed to 45 degrees. After briefly hitting a balmy high of 54 degrees, the temperature dropped back down to –4, all in less than a 2-hour time span.

Another issue faced by South Dakotans and many Americans is drought. While we cannot avoid droughts, better forecasts about when we are heading into persistent dry or wet periods can help people make decisions that may reduce the extent of the resulting economic damages.

As we consider ways to continue improvements in forecasting, we should also examine how those forecasts are communicated. This is especially true for extreme weather warnings when there is no time for mistakes.

Advance warnings can save countless lives, but tragically people still die even when the forecasts are accurate. Research shows that certain warnings create more effective warnings. In light of this research, I believe it is time for the National Weather Service to reevaluate how it issues warnings for severe weather.

In the coming weeks, I plan to introduce bipartisan weather legislation. It will focus on improving seasonal predictions so individuals, government, and businesses can make more informed decisions. It will also seek to improve our severe weather warning system so that additional lives can be saved.

This legislation could also improve the "research to operations" pipeline, create a more effective National Weather Service, and enhance satellite governance.

As this committee evaluates opportunities to improve weather modeling and forecasts and the way we communicate about weather events, I look forward to working with my colleagues and stakeholders in the weather community.

I want to turn now to the distinguished Ranking Member of this committee, the Senator from Florida, for any opening remarks he would like to make.

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

Senator NELSON. Thank you, Mr. Chairman. In the early 1990s—Florida, which is quite accustomed, we are a peninsula sticking down into the middle of what is known as "Hurricane Highway" but we had not had a lot of direct hits by the big ones.

Here comes one the first part of the season, middle of August, named Andrew, headed straight for the southern part of the peninsula. Hurricane Andrew ended up being categorized as a Category 4, that is up to 145 miles per hour.

Subsequent analysis shows that it actually exceeded that, so it would be a hurricane Category 5. It spared us because if it had

turned one degree to the north, it would have hit the Dade County/ Broward County line, a highly urbanized area. Instead it went on a bee line for South Miami/Dade County in a relatively, at that point, unpopulated part.

Yet, its consequence was that it took down the entire homeowners' insurance marketplace in the entire state of Florida because of the insurance companies that went bust, and consequently the insurance companies that fled the state of Florida. That was just one consequence.

If it had not been for a courageous local weather forecaster staying on the air and sounding the alarm exactly where the hurricane was going, the devastation would have been so much more in loss of life.

When it hit downtown Homestead, south of Miami, indeed we learned a lot. We learned that a whole new community that had been thrown up that did not have the building codes, it was absolutely ripped apart. In downtown Homestead, Florida, the only two structures remaining was the bank and an old Florida cracker house which was built back in the 1920s to withstand those kinds of ferocious winds.

I remember running into the head of Habitat for Humanity, and he told me that he had a Habitat bumper sticker on his briefcase, and when he would go through the Miami Airport, people would walk up to him and say thank you so much, thank you so much, all the Habitat houses held up, how do you do that.

He said from inexperience. They would say what do you mean, inexperience. He said since we build houses with volunteers, instead of putting one nail, they put 10 nails.

[Laughter.]

Senator NELSON. Forecasting weather is so important to us. We have since put up a G-IV NOAA that flies at the top of the hurricanes. I have been on those missions. They drop instrumented packages called "Sondes" from 45,000 feet above the hurricane, flying at the top of the hurricane, so that you can get measurements. That has improved the accuracy 15 percent.

There is so much more to come. There are so many more satellites that we have to put up. NASA builds them. NASA launches them. NOAA operates them.

We have some folks that do not like climate change around here. The fact is that measuring the weather and the changes in the climate are going to help us with regard to forecasting.

Take, for example, peanut growers in South Georgia and North Florida, they can increase their crop yield and decrease fertilizer if they have better temperature and precipitation outlooks for that coming growing season.

Mr. Chairman, I just wanted to set the table. I am going to stop and insert the rest of my opening statement in the record so we can get on in this day that we have so many competing demands. Thank you.

[The prepared statement of Senator Nelson follows:]

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

Thank you, Chairman Thune, for calling this hearing today.

Devastating events such as Hurricane Andrew in 1992, Hurricane Katrina ten years ago and Hurricane Sandy in 2012 provide stark reminders that the weather is much more than just a topic of casual conversation.

Keeping the public informed of the risks posed by hazardous weather is critical to protecting lives, property and infrastructure.

The National Weather Service performs an invaluable service by providing essential weather, water and climate forecasts and warnings.

I would also be remiss if I did not mention the role NASA plays in building and launching satellites and next generation instruments that give our forecasters invaluable weather data. This important partnership between NASA and NOAA is what brings us the data.

But these agencies cannot do it alone.

Emergency managers, local officials, television meteorologists and private companies all help disseminate weather information on a daily basis.

Accurate forecasts are not only important for day-to-day decision-making, but they are also important for business decisions.

For example, one study suggests that peanut farmers in south Georgia and north Florida can increase their crop yield and decrease fertilizer if they have better temperature and precipitation outlooks for the growing season before they plan their crops.

During El Niño years, farmers should plant peanuts later in the season—and during La Niña years, they should plant sooner.

The science is almost ready to be able to give us more precise seasonal forecasts.

Right now, shorter-term "weather" forecasts can give us a fairly accurate picture of the next two weeks. And long-term "climate" outlooks can give us the likely temperature and precipitation information from about a month to about a year. By continuing to invest in the science of our oceans, the climate and the weather, I believe we can close the gap between two-week weather forecasts and one-month climate outlooks.

The sooner and more accurately that we can warn schools, nursing homes, and hospitals that the "big one" is on the way, the more prepared and resilient our communities will be.

Let me give you some examples of the benefits of improved weather forecasts.

In Florida, recurrent flooding is a major issue. At high tide, ocean water routinely covers the streets of Miami Beach.

Studies suggest that as little as one hour of lead time can result in a 10 percent reduction in flood damages, yielding benefits of $243 million annually.

The newest generation of Doppler radars—called NEXRAD—enables meteorologists to detect the formation of tornadoes *before* they touch down—reducing deaths by 34 percent and injuries by 45 percent.

And by concerted Federal investment, the hurricane forecast has improved by 20 percent since 2008. This remarkable advance in accuracy and precision will absolutely save lives and property.

I want to welcome each of our witnesses for being here today. I especially want to thank Don Hermey for traveling from my home state to give us some insight on how he helps prepare residents of Manatee County for extreme weather.

I look forward to hearing all their testimony on how we can go even further in optimizing weather products and more effectively communicate to end-user communities.

Thank you.

The CHAIRMAN. Thank you, Senator Nelson. I look forward to as colleagues arrive getting an opportunity to question our witnesses. We have a great panel, and I want to thank you all for being here today, and want to officially introduce who these folks.

Dr. Jay Trobec is the Chief Meteorologist at KELO-TV in Sioux Falls, South Dakota. Mr. Trobec has been with KELO since 1985. I personally rely on him to let me know what weather to expect when I am home in Sioux Falls. I know only of a few states in the country that pay attention year round to the weather as much as we do in South Dakota. It is not really weather, it is news in our

state. We deal with it year round, and of course, our very livelihood depends upon it.

Jay Trobec can either make your day or break your heart, depending on whatever the scenario may be. He is very accurate. He is always within a degree or two, only misses them by that far [indicating]. Actually, does a great job. I know he has a national profile on a lot of these issues in which he shares his expertise with people around the country.

Mr. Ron Sznaider is the Vice President for Cloud Services, Weather, at Schneider Electric. I look forward to hearing about how weather data can be used to enhance commerce and safety.

Dr. Kim Klockow is a Postdoctoral Researcher at the University Corporation for Atmospheric Research. She is an expert in risk communication, and will tell us about how people respond to severe weather warnings, and ways we can improve how warnings are communicated.

Mr. Don Hermey is the Chief of Emergency Management for Manatee County, Florida, and probably can share some insights along the lines of those we just heard from the Senator from Florida. I look forward to learning about how he uses weather data to prepare for emergencies.

Thank you all for being here today. We will start on my left and your right with Dr. Trobec and proceed accordingly, and we look forward to hearing from you. Jay?

STATEMENT OF DR. JAY TROBEC, CHIEF METEOROLOGIST, KELO-TV

Dr. TROBEC. Thank you very much, Senator Thune, Senator Nelson, thank you very much for your comments. We would like to thank the Committee for inviting us here today to talk about something that we are pretty interested in at least at this table, and greetings to my colleagues here at the table.

I am a broadcast meteorologist, and that is a profession that just a few decades ago was mostly kindly gentlemen with baritone voices, occasionally accompanied by a weather puppet or animal mascot. I am here to tell you we are not your grandma's TV weatherman any more.

For starters, about a fifth of us are female, 600 of us are certified by the American Meteorological Society, which has verified our meteorological degrees or course work, given us a rigorous written exam, and had our on air work judged by a panel of our peers. Others of us are certified by the National Weather Association.

These days, a television meteorologist is a real meteorologist, with a degree or significant education. We no longer rip and read a forecast from a teletype from the National Weather Service.

We do our own scientific analysis of the atmosphere, and we have the tools—I do not know if you know this, but about 250 television stations actually own and operate their own weather radar.

Both the AMS and the NWA hold national conferences at which broadcasters, National Weather Service personnel, and other important members of our public/private/academic weather community meet to share knowledge and information face to face with each other. These in-person meetings are essential because they make our weather enterprise stronger.

Before we can talk about communicating weather or warnings or capitalizing on our weather intelligence, one thing is paramount. We must get the forecast right. We must get the forecast right.

Every day, everyone of us is impacted directly or indirectly by that forecast, and toward that end, we are gratified that Congress has allocated the money to NOAA to increase our computing capacity for our weather models, and we are justifiably hopeful that this will help us close the gap on the European weather model which is widely perceived to be more accurate, unfortunately, than its American counterpart.

What is the broadcaster's role in all of this? Well, we as a presumably familiar and trusted voice, try to skillfully communicate the weather with clarity and meaning to the public. In a way, we are translators, converting scientific language to every day English.

Sometimes it is necessary for us to express uncertainty in the forecast, to honestly let the public know when there is a close call between different forecast possibilities.

When significant weather threatens, as Senator Nelson was talking about, we have to anticipate and react to it. When there are warnings to pass along, broadcasters add value to those warnings by explaining the meaning to our viewers.

For example, if there is a developing severe weather situation, we do things such as show and interpret frequently updated radar images, share reports from trusted witnesses, and broadcast live video images to bring the call of action message home in vivid terms. In sort, our mission is to do what no app can.

As weather communicators, we are beholden to the laws of both meteorological science and social science. As my colleague, Kim Klockow, will tell you, even a good forecast poorly communicated is worthless.

During times of weather crisis, we recognize the need to deliver a consistent message with our governments and private sector partners to speak with one voice. Social scientists tell us broadcasters that when people are confronted by conflicting emergency messages, they either freeze and do nothing or waste valuable time trying to gain additional information, and neither one of those is desirable.

Initiatives such as NOAA's Weather Ready Nation reminds us that hazard preparedness begins long before an event happens, and the Becoming Second to None Report gives us a roadmap for improvement of our weather forecast system.

We will get better even as the atmosphere reminds us that the margin for error is very small and very unforgiving. As we have experienced the last couple of winters, the difference of only a degree or two at cloud level or a degree or two at ground level can mean the difference between nuisance weather and a weather disaster.

I also feel it is important to put today's discussion in just a little bit of perspective. It has been my privilege to attend meetings of the European Meteorological Society, France's International Weather Forum, and events of the World Meteorological Organization. As I talked to my colleagues, my weather colleagues, one thing becomes clear to me, and that is that our weather warning system in the U.S., our weather warning infrastructure, is the envy of the rest of the world.

I think it says something about us as we gather here today to try to make something that is already the world's best even better. Thank you.

[The prepared statement of Dr. Trobec follows:]

PREPARED STATEMENT OF DR. JAY TROBEC, CHIEF METEOROLOGIST, KELO-TV

I am a broadcast meteorologist . . . a member of a profession that, a few decades ago, mostly consisted of kindly gentlemen with baritone voices, occasionally accompanied by a weather puppet or animal mascot.

But we are not your grandma's TV weatherman anymore. For starters, about a fifth of us are female.[1] Six hundred of us are certified by the American Meteorological Society (AMS),[2] which has verified our meteorological degrees or coursework, given us a rigorous written exam, and had our on-air work judged by a panel of our peers. Others of us are certified by the National Weather Association (NWA).[3]

These days a television meteorologist is a "real" meteorologist, with a degree or significant college education. We no longer "rip and read" a National Weather Service forecast from a teletype machine. We do our own scientific analysis of the atmosphere. And we have the tools: about 250 television stations own and operate their own weather radar.

Both the AMS and NWA hold national conferences at which broadcasters, National Weather Service personnel, and other important members of the public-private-academic weather community meet to share knowledge and information face to face with each other. These in-person meetings are essential. They make our weather enterprise stronger.

Before we can talk about communicating weather or warnings, or capitalizing on our weather intelligence, one thing is paramount. I think it is something the entire weather enterprise can agree on. We must get the forecast right. We must get the forecast right, because every day, every one of us is impacted directly or indirectly by the forecast. Toward that end, we are gratified that Congress allocated money to NOAA to increase the computing capacity for our weather models.[4] We are justifiably hopeful this will help us close the gap on the European medium-range computer model (ECMWF), which is widely-perceived to be more accurate than its American counterpart (GFS).[5]

So what is the broadcaster's role in all of this? As a—presumably—familiar and trusted voice, we try to skillfully communicate the weather with clarity and meaning to the public. In a way, we are translators—converting scientific language to everyday English. Sometimes it is even necessary for us to express uncertainty in the forecast, to honestly let the public know when there is a close call between different forecast solutions.[6]

When significant weather threatens, we must anticipate and react to it. When there are warnings to pass along, broadcasters "add value" to them by explaining the meaning to our viewers. For example, if there is a developing severe weather situation we do things such as show and interpret frequently-updated radar images, share reports from trusted witnesses, and broadcast live video images to bring the "call to action" message home in vivid terms. In short, our mission is to do what no app can.

As weather communicators, we are beholden to the laws of both meteorological science and social science. Even a good forecast—if poorly communicated—is worthless.

During times of weather crisis, we have recognized the need to deliver a consistent message with our government and private sector partners—to speak with one voice. Social scientists tell us that when people are confronted by conflicting emergency messages they either freeze and do nothing, or waste valuable time trying to gain additional information. Neither is desirable.

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[1] *http://www.magid.com/node/159*
[2] *http://ametsoc.org/memdir/seallist/get__listofcbm.cfm*
[3] *http://nwas.org/seal/seal-holders.php*
[4] *http://www.noaanews.noaa.gov/stories2015/20150105__supercomputer.html*
[5] *Weather Services for the Nation: Becoming Second to None* (National Academies Press, 2012), page 22.
[6] *Completing the Forecast: Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts* (National Academies Press, 2006).

Initiatives such as NOAA's Weather-Ready Nation [7] remind us that hazard preparedness begins long before an event happens. And the "Becoming Second to None" report sets a road map for improvement of our forecast system. We will get better—even as the atmosphere reminds us that the margin for error can be slim and unforgiving. As we have experienced the last couple winters, the difference of only a degree or two at cloud level—or a degree or two on the ground—can mean the difference between nuisance weather and a weather disaster.

But I also feel it is also important to put today's discussion in perspective. It has been my privilege to attend meetings of the European Meteorological Society, France's International Weather Forum, and events of the World Meteorological Organization. When I have spoken with my weather colleagues from other countries, one thing becomes clear to me: The weather warning infrastructure we have here in the United States is the envy of the rest of the world. I think it says something about us that we come together today in an effort to make the world's best even better.

Senator NELSON. May I say something to the forecaster? Really, I want to underscore the importance of your position. It was that very courageous forecaster, Brian Norcross, at one of the local stations in Miami who saved hundreds of lives by staying on the air, and as people's houses were ripped apart, he was saying get into an inner room, et cetera. Brian was also a certified meteorologist who had a Master's degree in meteorology.

That was the beginning of the new vanguard of which you represent, so thank you for your public service.

The CHAIRMAN. Well stated. Thank you, Senator Nelson. Mr. Sznaider?

STATEMENT OF RON SZNAIDER, SENIOR VICE PRESIDENT, WEATHER DIVISION, SCHNEIDER ELECTRIC

Mr. SZNAIDER. Thank you, Chairman Thune and Ranking Member Nelson. I appreciate the opportunity to testify today. Again, my name is Ron Sznaider and I am the Vice President of the Weather Division at Schneider Electric.

I am here today to provide information on commercial weather service activities and how working more closely with NOAA we can improve weather forecasting in this country.

Schneider Electric is a global Fortune 300 company with 170,000 employees in more than 100 countries and $30 billion in sales. We maintain the largest commercial business to business weather company in the U.S. We employ over 100 degreed meteorologists and have customers in all 50 states and the District of Columbia.

Our weather solutions provide precision weather intelligence to businesses and small government entities. We build very close relationships with our clients so that we can better understand their needs and supply information different than what you typically see in consumer apps on your smart phone.

The techniques that we use have resulted in our weather forecasts being independently rated number one in accuracy eight years in a row.

We believe that a closer cooperation between NOAA and commercial weather services will benefit the science of weather forecasting and the communities who must address the weather challenges of today and tomorrow.

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[7] *http://www.nws.noaa.gov/com/weatherreadynation/*

From our perspective, NOAA's greatest strengths lie in weather and ocean modeling. No commercial weather service is likely to match NOAA in its ability to create these sophisticated computer prediction models.

We also believe that NOAA should remain the authoritative source for the issuance of severe weather warnings for major events such as hurricanes and tornados.

At Schneider Electric, we utilize over 70 different sources of information for our weather solutions, one of which is the NOAA open data model. We then take the NOAA data and add value by tuning and aligning it with specific customer needs.

A few examples. We provide services to most large electric utilities, such as Florida Power and Light, to predict demand changes relative to weather conditions, and also work with other utilities in what is called "mutual assistance" so that they can share work crews for faster power restoration.

In the northern states, we provide specialized road forecasts with specific guidance on which chemicals to use for the best timing and application rates so that it is both cost effective and environmentally friendly.

In the southern states where we have some of the most intense lightning activity of anywhere in the world, we provide weather safety guidance to the PGA Tour and over 350 colleges and universities.

In aviation, we provide specific forecasts for airlines, including a new turbulence forecast that an independent analysis found was more accurate than what the FAA currently uses.

We also deploy weather stations to improve our forecast accuracy. Many of the Committee members may be familiar with DTN and the Progressive Farmer, widely used in U.S. agriculture.

To my right is a map showing the locations of almost 3,000 weather and soil sensors that we have recently deployed in rural America to help farmers make better day to day crop production decisions. The next generation of this sensor technology looks like this [indicating], and the data from these networks could be useful to enhance future NOAA drought and even tornado prediction models.

Last, we provide over 1,000 state and local safety organizations information for uses as varied as advanced planning for urban flooding or prolonged heat waves.

Today, I offer the following recommendations to drive new public/private partnerships designed to help deliver the best weather results to communities and taxpayers.

First, there should be a better and more formal method to exchange knowledge and transfer technology between NOAA and commercial services.

Second, NOAA should place more emphasis on the use of existing datasets from commercial sources.

Third, NOAA should focus on its core competencies of weather modeling and issuance of weather warnings, and let commercial services focus on the downstream utilization of NOAA data into specialized solutions to solve end user problems.

Last, as weather volatility increases, we believe that an increased investment is also necessary to help commercial applications more quickly reach their customers.

I commend the Committee for considering weather-related legislation, and thank you for the invitation today, and look forward to answering your questions along with my colleagues behind me, Jim Block, who is also a certified consulting meteorologist and a Fellow of the American Meteorological Society. Thank you.

[The prepared statement of Mr. Sznaider follows:]

PREPARED STATEMENT OF RON SZNAIDER, SENIOR VICE PRESIDENT, WEATHER DIVISION, SCHNEIDER ELECTRIC

Summary

Public-private partnerships between commercial weather services and NOAA can improve weather forecasting in this country.

- There should be a better and more formal method to exchange knowledge and transfer technology between NOAA and commercial services.
- NOAA should place more emphasis on the use of existing datasets from commercial sources.
- NOAA should focus on its core competencies of weather modeling and issuance of weather warnings, and let commercial services focus on "down-stream" utilization of NOAA data into specialized solutions to solve end-user problems.
- As weather volatility increases, we believe that an increased investment is also necessary to help commercial applications more quickly reach their customers.

Chairman Thune, Ranking Member Nelson, I appreciate the opportunity to testify today on the opportunities that commercial weather services are able to deliver to improve weather forecasting and further the goals of NOAA, the National Oceanic and Atmospheric Administration.

My name is Ron Sznaider. I am the Senior Vice President of the Weather Division of Schneider Electric. I have been involved in commercial weather services functions for over 30 years. With me today is Jim Block, a colleague who is a Certified Consulting Meteorologist, as well as a Fellow of the American Meteorological Society.

Schneider Electric is a global Fortune 300 company with 170,000 employees world-wide, $30 billion in sales, and operations in more than 100 countries. Schneider Electric is a specialist in energy management offering integrated solutions across multiple market segments, including Commercial and Residential Buildings, Industrials & Machine Manufacturers, Utilities & Infrastructure, and Data Centers & Networks. We maintain the largest commercial business-to-business weather forecasting and consulting organization in the United States, with customers in all 50 states.

Our unique weather solution provides precision weather intelligence to our customers who include: the agriculture community, utilities, airports and airlines, professional and collegiate sporting organizations, transportation entities, emergency response providers, and local and state governments. We build relationships with our customers, with a distinct interaction that offers them information different from what you see in consumer apps on your smart phone. We enable decision makers with critical inputs to take quick and effective action to enhance safety and improve efficiencies. The unique technology we have developed improves weather forecasting and has been independently rated #1 in weather forecast accuracy eight years in a row.

Better weather forecasts can have a significant impact on the economy. An analysis by the National Center for Atmospheric Research shows that over 16 percent of the aggregate U.S. economy is sensitive to weather on an annual basis. Additionally influence of routine weather variations on the economy could amount to as much as 3.4 percent of U.S. gross domestic product (GDP). Other research shows that one–third of the private industry activities, amounting to $3 billion, have some degree of weather and climate risk. Our customers are most certainly impacted by weather. For example, in the utility sector, over 75 percent of summertime power outages are weather related, and in the transportation sector about 25 percent of all accidents are connected to weather.

Our challenge, and opportunity, is to provide our Nation with the best weather forecasting. We believe that closer cooperation between NOAA and commercial

weather services can lead to a mutually beneficial partnership, and one that will benefit the science of weather forecasting, the taxpayers, and the communities who must address the weather challenges of today and tomorrow.

We see that NOAA's greatest strength lies in weather and ocean modeling. No commercial weather service is likely to match NOAA in its ability to create these types of sophisticated computer prediction models. We also believe that NOAA should remain the authoritative source for the issuance of severe weather warnings for major events such as hurricanes and tornadoes.

At Schneider Electric we utilize over 70 different sources of information to create our weather solutions, one of which is the NOAA open-data model. We then innovate and develop specialized technology to take the NOAA data and add value by fine-tuning it and aligning it to specific customer needs.

Following are a few examples of real solutions we offer our customers today:

Agriculture: We provide the weather information in the DTN and Progressive Farmer services. We recently deployed a network of almost 3,000 weather and soil sensors at farms, to help farmers make better day-to-day crop production decisions. This intelligence could also be useful to NOAA for future tornado prediction models.

Utilities: We provide services to most large electric utilities such as Florida Power and Light, to predict demand changes relative to weather conditions, and also work with other utilities in what is called "mutual assistance" so they can share work crews for faster power restoration. We also help weather-enable the newest generation of Smart Grid solutions to further optimize the Nation's electrical grid.

Transportation: In the northern states we make road and pavement forecasts and provide specific guidance of what chemicals to use—just enough to do the job so that it is both cost effective and environmentally conscious.

Aviation: In Aviation we provide specific forecasts for airlines, including a new turbulence forecast that can predict the location and the effect of turbulence by aircraft type (*e.g.,* Boeing vs. Airbus). An independent laboratory found that our forecast was 20 percent more accurate with 70 percent fewer false positives than what the FAA currently uses. We believe there is an opportunity to take advantage of this private sector technology in the modernized airspace system envisioned by the FAA with NextGen.

Sports: Parts of the southern U.S., such as Florida, have some of the most lightning activity of anywhere in the world. We provide services to the PGA TOUR for lightning safety, along with weather safety information to 350 colleges and universities.

Public Safety: We also provide over 1,000 state and local public safety organizations with weather alerts and forecasts, for uses as varied as urban flooding to planning for severe heat spells.

Schneider Electric recently published a study in which we concluded that individual weather events are becoming more extreme. But the good news is that there is much that can be done to plan for this increased volatility.

As NOAA looks into the future of weather and the increased intensity of storms and events, cooperation with the private sector is even more essential.

We offer the following recommendations to drive public-private partnerships and help deliver the best results to communities and taxpayers:

1. There should be a better and more formal method to exchange knowledge and transfer technology between NOAA and commercial services.
   - NOAA should be supportive of the creation of working groups or advisory committees with the specialized commercial business-to-business weather companies. This group of private sector organizations has direct interaction with end-user business and community customers, and needs to be treated separately from the consumer facing weather service providers. The focus should be on listening to feedback and recommendations from the commercial sector. An improved working dialog between these two groups that will help accelerate innovation in the private sector, and make better use of the NOAA models and data sets.
   - There needs to be a better knowledge and technology transfer from NOAA to the commercial sector. If the private sector can have clear and easy access to NOAA's technology roadmap, they can plan ahead with their innovations and ultimately maximize the investment in NOAA's R&D, by bringing new solutions for American businesses and communities into operational service.

- NOAA should create a position responsible for interface and technology transfer between NOAA and private sector
- Quarterly meetings should be established between NOAA and qualified members of a commercial steering group to coordinate information exchange

2. NOAA should place more emphasis on the use of existing datasets from commercial sources.
   - If NOAA wants to become a world leader in environmental prediction models, then they should consider all available data sets that can be utilized to initialize their models—including data sets from the private sector. All too often use of new datasets are overlooked if not originated at NOAA, or some other public institution. This is certainly the case with space-based remote sensing platforms, but also applies to surface datasets, such as the Agricultural Weather and Soil Network data put in place by Schneider Electric/DTN. In that example, in order for weather models to be most accurate, it is critical to know the most accurate soil temperature and the moisture fluxes from the soil. Improved weather forecasts for tornadoes, as well as weather prediction for agriculture and monitoring of drought, can be achieved by integration of data sources like this. Furthermore, environmental data from commercial sources can often be more cost-effective to acquire, and available much more quickly.
   - A regular and formal meeting or forum between government and the private sector can make NOAA and other government agencies aware of datasets that have been developed by commercial services, with enough technical detail to allow for legitimate evaluation by government agencies. NOAA should provide honest and objective evaluation of these available data sets for potential use in their R&D.
3. NOAA should focus on its core competencies of weather modeling and issuance of public warnings of hazardous weather conditions, and let commercial services focus on "down-stream" utilization of NOAA data in their solutions to solve end-user problems.
   - The private sector is better positioned to innovate around an existing customer base that leverages many different services from a given company. This customer intimacy better positions private sector companies to develop new and innovative solutions that are in best alignment with end-user needs. NOAA will not realistically be able to provide the same level of operational service that is expected, and will never have the breadth of offers (many non-weather related) that the private sector can provide into a given market segment.
   - Private sector companies do not have the resources or bandwidth to develop and refine the numerical prediction modeling and datasets that NOAA does.
   - Today, NOAA spends too much time and effort on the distribution and attempts to customize its products, at the expense of weather models and observation infrastructure that could ultimately enhance public safety. Encouraging NOAA to focus on its core competencies will ensure that commercial services can make the scientific and operational advances from NOAA translate better into effective solutions made available to businesses and consumers as quickly and as inexpensively as possible.
   - Government agencies that utilize weather information in their internal processes should be required to review and assess feasibility of use of commercially developed solutions if/when superior results can be achieved. Example: Schneider Electric's new generation turbulence and aircraft icing solutions should be reviewed by the FAA for potential use in upgrading national airspace safety. This solution could be further improved by full use/integration of NOAA modeling input.
   - NOAA should acknowledge the commercial weather industry is a viable and critical component to extract value from NOAA R&D activities and bring them to the marketplace. NOAA should not create new decision-support solutions duplicitous to existing commercial offers, but instead should remain focused on improving upstream modeling and improving the accuracy of severe weather alerts.
4. As weather volatility increases we believe that an increased investment is necessary in helping commercial applications more quickly reach their customers.

- NOAA should include commercial services in its research, planning and routine processes, and be willing to invest in measures such as frequent and routine meetings with the private sector to ensure that its R&D output is able to benefit the public as quickly as possible.
- Grants and PPP projects into the private sector could accelerate investment in commercial services and spur new innovation.
- Funding for commercial end-user innovation should be allocated, for specialized and qualified commercial weather companies to compete for, all leveraging and maximizing inputs from NOAA models.
- These actions recommended for knowledge and technology transfer require a very modest investment, but one that can pay enormous dividends for the American public in the form of better and faster alerts and warnings, and improved forecast accuracy.
- Innovation grants should be made available for commercial entities to compete, with purpose of maximizing leverage of NOAA data into superior end-user solutions in a coordinated way.

We understand that the House Science Committee passed legislation that deals with NOAA's interaction with commercial satellites (HR 1561). We hope that the Senate will also examine downstream use of NOAA data, and will focus on collaboration between NOAA and providers like us, who deliver product to the end-user.

We commend the Committee for considering weather-related legislation, and thank you for the opportunity to speak to you today.

The CHAIRMAN. Thank you, Mr. Sznaider. Dr. Klockow?

STATEMENT OF DR. KIM KLOCKOW, POSTDOCTORAL RESEARCHER, UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

Dr. KLOCKOW. Chairman Thune, Ranking Member Nelson, and distinguished members of the Committee, it is a privilege to provide my experience and perspective to you today. Thank you for the invitation.

The perspective I bring to this panel is that of both a behavioral scientist and a meteorologist. My research is focused primarily on how members of the U.S. public understand weather risks and choose to respond to them.

Today, I will provide a brief overview of some pressing issues in weather communications, especially for tornado risk. Our country has made significant investments in weather research, observing and prediction, and the benefits have been vast.

For example, where we once were unable to warn people before tornados touched down, we now offer around 13 minutes of lead time on average. Tornado fatality rates have dropped considerably.

Improvements in the detection and prediction of weather hazards are therefore critical to continued improvement in societal outcomes. That said, it is clear that improvements in technology alone will not resolve all the problems we face in creating a resilient nation. In fact, events with excellent forecasts can still have potentially devastating outcomes.

One event that makes this abundantly clear occurred on May 31, 2013 a day that largely fell beneath the national consciousness but shook the field of meteorology deeply. Eleven days before May 31, on May 20, an EF5 tornado ripped through Central Oklahoma killing 24 people in the city of Moore, seven of whom were children in an elementary school.

The ensuing national media frenzy combined with several evenings of storms to follow left the collective nerves of Oklahomans

shattered. I experienced this personally as I was there finishing my Ph.D. at the time.

Already on edge, matters got out of hand quickly on May 31 when a two mile wide tornado touched down about 30 miles west of Oklahoma City, a metro area of about a million people. Helicopters flying around the storm captured this scene to my right. The top two graphics are from our News 9 helicopters.

Other photographers around the area captured the bottom images of traffic, some people going through flood waters to escape the tornado. Of the people who died on May 31, most were killed by drowning as they attempted to seek shelter from the tornado.

What you see in these images are tens of thousands of people spontaneously fleeing and causing traffic to come to a standstill as far south as Norman, 20 miles away.

The tornado ended up lifting as it came toward Oklahoma City, but if it had not, the number of people killed could have climbed into the hundreds, plausibly reaching the number of people lost in Hurricane Katrina.

The warnings and forecasts, however, were fantastic. While it seems easy to pin this on the tornado that had happened 11 days before, this event occurred against a backdrop of marked shifts in response behaviors of the population in preceding years.

The only way this event could have been caught and mitigated against ahead of time is with at least two complimentary improvements to our weather infrastructure. One is an improved capability to transfer research in social and behavioral sciences and the humanities, including risk communication and decision sciences into meteorological operations, and two, an improved ability to observe and predict the world of people as we observe and predict the atmosphere.

To the first point, many decades of basic research have been developed pertaining to disasters, vulnerability, and risk decision sciences, but a field of people trained in physical sciences are unlikely to have the skills to find, make sense of, and apply this work to practice. It is almost literally a kind of foreign language.

We should leverage investments in this human-oriented research including that funded by NSF to increase the effectiveness of our meteorological infrastructure. To do this, we need to incorporate more people with skills in these disciplines and give them a voice in decisions about meteorological practice.

To the second point, it is often said that all disasters are local. Each place in our country is better adapted to certain kinds of hazards than others.

One of the key strengths of the Weather Service is its geographical diversity, with 122 field offices spread across the country, allowing forecasters to have some nimbleness to serve the unique needs of their populations.

To leverage this localness, we need to provide forecasters with information about their people, best practices, and with up to date recommendations for working with our private sector and emergency management partners to promote resilience.

The public safety mission of the Weather Service is achieved through these partnerships. The Weather Service cannot and does not implement its core life-saving mission alone. We should couple

pre-event monitoring with an NTSB like capability to conduct post-disaster assessments so this life saving enterprise is not left to merely guess about how they can do their jobs better when disaster strikes.

Thank you again for the opportunity to provide remarks today, and I welcome questions from the Committee.

[The prepared statement of Dr. Klockow follows:]

PREPARED STATEMENT OF DR. KIM KLOCKOW, POSTDOCTORAL RESEARCHER, UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

Chairman Thune, Ranking Member Nelson, and distinguished members of the Committee, it is a privilege to provide my experience and perspective to you today. Thank you for the invitation.

The perspective I bring to this panel is that of both a behavioral scientist and meteorologist. My research has focused primarily on how members of the U.S. public understand weather risks and choose to respond to them. Today, I will provide a brief overview of some pressing issues in weather communication, especially for tornado risk.

Our country has made significant investments in weather research, observing and prediction, and the benefits have been vast. For example, where we once were unable to warn people before tornadoes touched down, we now offer around 13 minutes of lead-time on average (Erickson and Brooks 2006). Tornado fatality rates have dropped considerably (Brooks and Doswell 2002). Improvements in the detection and prediction of weather hazards are therefore critical to continued improvement in societal outcomes.

That said, it is clear that improvements in technology alone will not resolve all of the problems we face in creating a resilient nation (NRC 2006). In fact, events with excellent forecasts can still have potentially devastating outcomes. One event that makes this abundantly clear occurred on May 31, 2013, a day that largely fell beneath the national consciousness, but shook the field of meteorology deeply.

Eleven days before May 31, on May 20, an EF5 tornado ripped through Central Oklahoma, killing 24 people in the City of Moore—7 of whom were children in an elementary school. The ensuing national media frenzy, combined with several evenings of storms to follow, left the collective nerves of Oklahomans shattered. I experienced this personally as I was there finishing my PhD at the time.

Already on-edge, matters got out of hand quickly on May 31 when a two-mile wide tornado touched down about 30 miles west of Oklahoma City, a metro area of about a million people. Helicopters flying around the storms captured this scene:

Photo credit: KWTV Oklahoma City, 2013.

Other photographers around the area captured these images of traffic, some going through flood waters to escape. Of the people who died on May 31, most were killed by drowning as they attempted to seek shelter from the tornado (NOAA 2013).

What you see in these images are tens of thousands of people spontaneously fleeing and causing traffic to come to a standstill as far south as Norman, 20 miles away. The tornado ended up lifting as it came toward Oklahoma City, but if it had not, the number of people killed could have climbed into the hundreds, plausibly reaching the number of people lost in Hurricane Katrina. And this is in the most tornado-savvy population in the world, with access to the best technology and communication networks. The warnings and forecasts were fantastic. While it seems easy to pin this on the tornado that had happened 11 days before, this event occurred against a backdrop of marked shifts in the response behaviors of the population in preceding years.

The only way this event could have been caught and mitigated against ahead of time is with two complementary improvements to our weather infrastructure:

(1) An improved capability to transfer research *in social and behavioral sciences and the humanities, including risk communication and decision sciences,* into meteorological operations, and

(2) An improved ability to observe and predict the world of people as we observe and predict the atmosphere.

To the first point, many decades of basic research have been developed pertaining to disasters, vulnerability, and risk decision sciences, but a field of people trained in physical sciences are unlikely to have the skills to find, make sense of, and apply this work to practice. It is almost literally a kind of foreign language. We should leverage extant investments in this human-oriented research, including that funded by NSF, to increase the effectiveness of our meteorological infrastructure. To do this, we need to incorporate more people with skills in these disciplines and give them a voice in decisions about meteorological practice. We must also partner with NSF and our academic partners to translate basic research to applications in meteorology.

To the second point, it is often said that all disasters are local. Each place in our country is better adapted to certain kinds of hazards than others. Each place will have a unique history and trajectory with different hazards, and different communication strategies will therefore be appropriate in different places. One of the key strengths of the NWS is its geographical diversity, with 122 field offices spread across the country, allowing forecasters to have some nimbleness to serve the unique needs of their populations. To leverage this localness, we need to provide forecasters with information about their people, with best practices, and with up-to-date recommendations for working with our private sector and emergency management partners to promote resilience. The public safety mission of the NWS will be achieved through these partnerships. The Weather Service cannot, and does not,

implement its core life-saving mission alone (NRC 2003). We should couple pre-event monitoring with an NTSB-like capability to conduct post-disaster assessments (NRC 2012) so this life-saving enterprise is not left to merely guess about how they can do their jobs better.

Thank you again for the opportunity to provide remarks today, and I welcome questions from the Committee.

References

Brooks, H. E., and C. A. Doswell III, 2002: Deaths in the 3 May 1999 Oklahoma City tornado from a historical perspective. *Wea. Forecasting, 17,* 354–361.

Erickson, S., and Brooks H.E., 2006: Lead time and Time Under Tornado Warnings: 1986-2004. *Preparedness and Sociological Issues, 23rd Conference* on Severe Local Storms.

National Oceanic and Atmospheric Administration, 2013: *Service Assessment: May 2013 Oklahoma Tornadoes and Flash Flooding.* Silver Spring, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 63pp.

National Research Council, 2003: *Fair Weather: Effective Partnership in Weather and Climate Services.* Washington, D.C., National Academies Press, 239pp.

National Research Council, 2006: *Completing the Forecast: Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts.* Washington, D.C., National Academies Press, 125pp.

National Research Council, 2012: *Weather Services for the Nation: Becoming Second to None.* Washington, D.C., National Academies Press, 87pp.

The CHAIRMAN. Thank you, Dr. Klockow. Mr. Hermey?

STATEMENT OF DON HERMEY, CHIEF, EMERGENCY MANAGEMENT, MANATEE COUNTY, BRADENTON, FLORIDA

Mr. HERMEY. Thank you, Chairman Thune, Ranking Member Nelson, and members of the Committee for holding this hearing today. I am pleased to be here to address ways in which we can better communicate weather to enhance commerce and safety.

I am the Chief of Emergency Management for Manatee County. I am very fortunate to have an administration and a Board of County Commissioners who make emergency management a top priority.

Manatee County is located on the west coast of Florida, and the City of Bradenton is our county seat. We have a resident population of 340,000, yet we hosted approximately three million visitors in 2014.

Our largest economic drivers include the home of the Pittsburgh Pirates' spring training, Tropicana Orange Juice, Feld Entertainment, Bealls, agriculture, tourism, and a seaport known as Port Manatee.

Our partnership with the National Weather Service and particularly the Weather Forecast Office and that team in Ruskin is vital for the protection of our citizens. They are available to me 24 hours a day, 7 days a week. Decision support, whether it be for severe weather, HAZMAT incidents, general needs to support an outdoor event or activity, they are there for me.

The National Weather Service technical facilities, such as the National Hurricane Center and the Storm Prediction Center, provide crucial information to the entire country. I cannot begin to express my gratitude and appreciation for their ability to distill and distribute scientific data in a manner that our citizens, policymakers, and operational responders can manage.

Emergency managers nationwide rely on the National Weather Service expertise to protect their citizens. Right now, numerous op-

portunities do exist given the proliferation of communication channels and technology, whereas we once lived in an era where people tuned into select television and radio stations for weather information at specific times, they now have the ability to get it anywhere, any time, on their phones and other technology devices.

We have private sector apps from the Weather Channel, Accuweather, and WeatherBug, just to name a few. Within my own jurisdiction, we purchase a number of meteorological devices from WeatherBug.

Through social media, such as Twitter and Facebook, my local government information outreach links to the National Weather Service weather information to further disseminate alerts at our local level with warnings along with details of my elected officials and their local actions.

However, we need to ensure that we have the ability to get appropriate information into the hands of every person who needs it, regardless of their location or any physical challenges they may have. This means increasing the ability to provide location specific warnings that are precise as possible.

We need to consider timeliness and various demographics of our citizens for how and when they receive the information. For example, too much lead time can create disruptions and difficulties for business. This may result in people leaving a safe area prematurely or an unnecessary and significant loss of economic activity. Too little lead time could cause a panic and unprepared community.

We should continue to make sure that any information provided to the public acknowledges the uncertainty of forecasting, and that forecasts are not 100 percent accurate, although it is a goal.

The National Weather Service has had great success in improving its forecast and warning efforts for hurricanes. It means fewer evacuations and saving lives. It also enables us to better place vital response and recovery assets, reduce disruption to areas that have not been impacted, and decreasing anxiety of the public.

That said, we need more information with regard to storm surge. Hurricane related evacuation is based on storm surge forecasting and has undoubtedly saved lives. Similarly, riptides are a serious problem in some areas of the country. We have good bathymetry, but we tend to issue warnings over extremely large areas.

Given that we can now locate individuals precisely to the inch, we have the potential to notify individuals on one specific beach while one quarter a mile away is not notified. This could drastically reduce changes in beach goers' attitudes and marine rescue focuses.

Private sector, including the media, play an important role in providing weather forecasts and alerts. A number of private weather companies exist and provide excellent client service. However, we need to ensure that the National Weather Service is recognized as the best weather agency in the world whose products are the definitive gold standard and are available to all levels of government and to the public.

These advances will require funding for people and technological advances. Giving the National Weather Service the tools and support needed to improve warnings and communications is an investment this country should make.

I thank you for the opportunity to testify today.

[The prepared statement of Mr. Hermey follows:]

PREPARED STATEMENT OF DON HERMEY, CHIEF, EMERGENCY MANAGEMENT, MANATEE COUNTY, BRADENTON, FLORIDA

Introduction

Thank you Chairman Thune, Ranking Member Nelson, and members of the Committee for holding this hearing today. I am pleased to be here to address ways in which we can better communicate weather to enhance commerce and safety.

I am the Chief of Emergency Management for Manatee County and have over a decade of experience in emergency management with the past three years as chief. Manatee County is located on the West Coast of Florida and the City of Bradenton is our county seat. We have a resident population of 340,000 and we hosted 2,916,100 visitors in 2014. Our large economic drivers include the home of the Pittsburgh Pirates Spring Training, Tropicana Orange Juice, Feld Entertainment, Bealls Retail, agriculture and tourism.

Our partnership with the National Weather Service and particularly the Weather Forecast Office in Ruskin Florida is vital for the protection of our citizens. We have weekly weather forecast conference calls and webinars as a matter of routine. They are available to me 24 hours a day and 7 days a week for decision support. I cannot begin to express my gratitude and appreciation for their ability to distill and distribute scientific data in a manner that our citizens, policy makers and operational responders can manage.

Weather forecasts and warnings are incredibly important to emergency managers around the country. While emergency managers deal with all kinds of events, the majority are weather-related—and the impact they can have is substantial. Severe weather can drive people from their homes, destroy their businesses, and disrupt their lives in ways both big and small. NWS, has estimated that in the United States in 2014, there were 8 weather and climate events costing more than $1 billion each and leading to 53 deaths. Events such as these leave long-lasting imprints on the communities they hit.

The United States' current capability to collect weather data and provide forecasts and alerts is advanced relative to other countries and our own historic performance. But there is still work to be done. In my testimony today, I will discuss the role of the National Weather Service (NWS) in providing these services, steps the NWS and others can take to improve their efforts, and the role of the private sector in these activities.

The National Weather Service (NWS), an agency within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA's), plays a crucial role in providing weather forecasts and warnings for the United States. The NWS works hand-in-hand with the emergency management community before, during, and after a disaster—providing information and expertise. In 2013, the National Academy of Public Administration released a study looking at the NWS. The study included focus groups with state and local emergency managers, who reported that they saw the NWS as critical partners with whom they communicate with regularly.

The expertise provided by the National Weather Service field offices throughout the country is invaluable, and emergency managers rely on their support. In West Virginia, for example, the NWS's Incident Meteorologists were integrated into the Joint Interagency Task Force for the National Boy Scout Jamboree. They provided information on lightning strikes and storms in almost real time and shared information with the Scout Ops Center so that some of the event could be moved before a major thunderstorm hit. Similarly, the NWS's technical facilities, such as the National Hurricane Center (NHC) and the Storm Prediction Center (SPC), provide crucial information to the entire country—which is then used to protect and save lives.

The improved warnings NWS provides have led to a significant reduction in weather-related deaths and reduced the negative impact weather can have on communities. A great example of this took place in Mississippi in February 10, 2013. The NWS office in Jackson had warned for three days that there was a significant risk of tornadoes in the southern part of the state. At 5 p.m. an EF–4 tornado ripped through Lamar and Forrest counties, including the City of Hattiesburg—which houses the University of Southern Mississippi. Despite more than 2,000 homes being damaged, there was not a single death. The incident was granted a Federal disaster declaration, and when survivors who received assistance were polled they all responded that the advanced warning from the NWS and local emergency managers had prepared them to take shelter.

Getting the Message Out

The NWS plays a crucial role in communicating information and issuing weather alerts and warning—a role it shares with other Federal agencies, state and local government, and the private sector. For the efforts of these stakeholders to be successful, the information produced must get to the appropriate end users: the individuals, communities, and businesses that need to know when a storm or disaster might be heading their way.

Right now, numerous opportunities exist to do this given the proliferation of communication channels and media. Whereas we once lived in era where people tuned into select television and radio stations for weather information, they now have the ability to get it anywhere and anytime on their phone and computer. For example, traditional weather radio and the Emergency Alert System are now supplemented by Wireless Emergency Alerts and FEMA's Integrated Public Alert and Warning System (IPAWS). People can also access information through private sector apps from the Weather Channel, Accuweather, and WeatherBug, among others—as well as social media such as Twitter and Facebook. State and local governments also disseminate alerts and warnings.

All of this has helped important information get into the right hands, and the NWS and others are taking advantage of the opportunities they offer. But there's more work to be done. We continue to see weather-related deaths because people and communities are caught unaware. There are several steps that can be taken to move us forward and ensure we do a better job communicating.

Provide location specific information

We need to ensure that we have the ability to get appropriate information into the hands of every person who needs it, regardless of their location and any physical challenges they may have. This means doing a better job providing location-specific warnings that are precise as possible. For example FEMA's new weather app provides an important service in providing severe weather warnings—but it only goes down as far as the county level. People need even better information.

Consider timeliness

In sharing information, we need to think more about timeliness. We often worry that people don't get enough information in advance—that we don't provide enough lead time, making it difficult for them to prepare or evacuate. But we need to think about the opposite as well. For example, while more lead time is important for large venues like a baseball stadium, too much lead team can create difficulties for business. This may result in people leaving a safe area prematurely or an unnecessary and significant loss of economic activity.

Avoid "over-warning"

It's important to make sure that we don't deluge people and communities with warnings—whether over a given time period or within a specific location. Too many warnings can lead to warning fatigue, where people tune out the information they're sent, as well as second-guessing by businesses and schools that need to be focused on life safety. We also need to keep in mind that warnings are disruptive to business, which may have to curtail their hours and redirect resources.

Be accessible

In providing information to the public, we need to make sure that it is intelligible to the average citizen and not overwhelm people with jargon or inaccessible language. The NWS, for example, should continue to develop terminology that meets the needs of professionals as well as laypeople. Moreover, it is important that while the precision and accuracy of forecasts continue to increase, we help the public understand how the process works. We should make sure that any information provided to the public acknowledges the uncertainty of forecasting. It's important for people to know that forecasts are not 100 percent accurate.

Engage partners

Our partners in the media are crucial to our efforts to communicate information about the weather. Unfortunately, many television and news stations are dedicating less and less time to this—which is troubling given how much we rely on them. We need to emphasize to them that they are part of the solution and reward those who make a concerted effort to help.

Improving Efforts for Some Hazards

The NWS has seen great success in its forecasting and warning efforts for some hazards, such as hurricanes. The improvement in hurricane forecasting accuracy means fewer evacuations, which saves lives and allows us to focus assets where they

are most needed. It also enabled us to better place vital response and recovery assets, reduce the disruption to areas that have not been impacted, and decrease the anxiety of the public. An example of this would be the difference in forecasts during 1999's Hurricane Floyd compared to Hurricanes Earl (2010), Irene (2011), and Sandy (2012). The forecast of Hurricane Floyd in 1999 led decision makers to order evacuations along Florida's Atlantic coast, which has some of the state's most populated counties, and the result was the largest evacuation in the state's history. More than a decade later, forecasting had improved significantly enough that when Hurricanes Earl, Irene, and Sandy took tracks similar to Floyd, the forecasts did not trigger evacuations in Florida.

That said, we need to do more with regard to storm surge. A majority of hurricane-related evacuation is based on storm surge forecasting and has undoubtedly saved lives. But we need to devote more resources to this area. That means more people, more computing power, and more resources—all or which can help increase awareness. Hurricane Sandy showed the crippling impact storm surge can have. As the National Hurricane Center pointed out in a 2013 report on Sandy, the storm caused water levels to rise along the entire east coast from Maine to Florida. This was to catastrophic effect in New York and Jersey. Parts of Red Hook, Brooklyn, for example, were under several feet of water, devastating homes and businesses. In Seaside Heights, New Jersey, the storm famously destroyed the iconic Casino and Funtown piers.

We could also improve our forecasting and warning efforts for other hazards. This year, for example, we saw record snowfalls in the northeast and other regions of the country. Unfortunately, for this type of hazard, the NWS only provides information on snowfall amounts out to 72 hours, which doesn't provide retail locations with enough lead time to prepare for the rush that may occur as concerned citizens hurry to fill their pantries and refrigerators. An extra 24 hours would help avoid the inevitable news stories showing shelves stripped bare, as grocery stores and others would have more time to prepare.

Similarly, riptides are a serious problem in some areas of the country, and we need to devote more resources to disseminating information about this hazard. We have good bathymetry indicating areas where rip currents are likely, and we know when the conditions are right for them to form. But we tend to issue warnings over extremely large areas that encompass points that are not likely to have an event. Given that we can now locate individuals precisely to the inch, we have the potential to notify individuals on one specific beach while one a quarter mile away is not notified. This could drastically change beachgoers' attitudes and reduce deaths.

Finally, flooding is another hazard where we could improve. Flooding is the most costly disaster in the United States. As the Congressional Research Service has reported, over the more than 40 years it has been in existence, the National Flood Insurance Program has suffered six years in which it has issued payouts of $1 billion or more: 1995, 2001, 2004, 2005, 2008, and 2011. We need to see better cooperation among FEMA; its components, such as the Federal Insurance & Mitigation Administration and the National Flood Insurance Program; and state and local governments to increase awareness and warning with regard to floods. FEMA Administrator Craig Fugate testified in 2011 that many owners of flood-prone property choose not to buy flood insurance but then drew on Federal assistance after a flood. We need to do more to make property owners aware of their risks and responsibilities.

Private Sector

The private sector obviously plays an important role in providing weather forecasts and alerts. A number of private weather companies exist, and in many cases they provide excellent services. But the NWS is a vital asset for this country, and we need to make sure that it is provided the resources it needs. We need to ensure that the NWS is recognized as the best weather agency in the world whose products are the definitive gold standard when it comes to life safety information. If they are not and people begin to rely too much on private sector weather providers, we will see conflicting information leading to action paralysis. Moreover, unlike private weather services, the NWS can be held accountable to the public for its forecasts.

Conclusion

The NWS and its partners in state and local government and the private sector provide an important service to the public through their forecasts and warnings. Although emergency managers at all levels focus on all-hazards, the majority of incidents we deal with are weather-related. By having a strong and robust partnership with the NWS, we are able to help our citizens better prepare for future disasters—which allows us to focus our response and recovery efforts more precisely on those

who are unable to help themselves. It can also help improve our Nation's mitigation efforts by ensuring that citizens understand the hazards they face and empower them to take actions to save their life and property.

We are now at a point where advances in forecasting have intersected with advances in technology, and we have the potential ability to ensure that every person who is in the path of severe weather can be notified and take the appropriate life safety actions, something never before achievable. Continued advances will provide us even better opportunities to ensure life safety and reduce economic consequences—which will mean more lives and communities saved from loss and heartbreak. We must ensure that we keep our foot on the pedal. The economic investments our Nation makes in this area more than pay for themselves.

I thank you for the opportunity to testify today and welcome any questions you may have for me.

The CHAIRMAN. Thank you, Mr. Hermey. Senator Schatz, I understand you have somewhere you have to get.

Senator SCHATZ. I am okay.

The CHAIRMAN. All right. I will start asking a couple of questions here and then we will proceed in the regular order.

This would be just a broad question for the panel. If there is one change that Congress could make or something that Congress could do to help advance the weather enterprise, what would that be? Take a minute to think about that. Anybody? Stay out of the way?

Mr. HERMEY. I would suggest just supporting them. The challenge today particularly with some of the technologies. I made a statement about Twitter and Facebook, but if you talked to my children, they have nothing to do with it. They are into Pinterest and Snapchat. The world is changing dynamically as it relates to technology, and we need to figure out better ways to communicate with the different demographics.

In Florida, I also have an elderly population. They still tune to traditional radio and TV. We have to figure out how to best accommodate all those needs out there, so flexibility and the funding to support that flexibility is critically important.

Dr. KLOCKOW. I would follow up to suggest that from a social behavioral scientist's perspective, I want the community to come together to suggest what we should do in detail, but I think one of the things the Federal Government could take a lead in is being an organizing force, helping to galvanize the academic community.

Since the public safety mission is a core fundamental issue in the Weather Service, a core part of their mission, they should take the lead in trying to shepherd all the people who are trying to be a part of that, who are a part of that. I guess like a core organizing competency that is able to do all of that would be useful.

Mr. SZNAIDER. From my perspective and Schneider Electric, we appreciate what NOAA does and have a great deal of respect for them. Having said that, we would welcome a closer working relationship and partnership between the agency and some of the commercial private sectors.

It is my understanding some other agencies have been able to establish sustainable partnerships with peer reviews, stakeholder meetings, working groups, advisory committees and such.

The more we can do that, the better we will all be because organizations like ourselves, we have a very intimate knowledge of some of the problems and how best to communicate the context of a weather forecast. I often say that whether you are running a business or an agency, the way to get things wrong is to sit in a

room and just talk amongst yourselves. The way to get it right is to go talk to the customers and understand and accept what they are telling you.

We have a lot of businesses in the communities already as our customers, and we have a lot of context that we want to find a way to better inform NOAA so their research and development efforts can be appropriately targeted for the best results.

Dr. TROBEC. I think something that may be unique in the weather enterprise is we meet constantly to talk about these things in terms of we have the public sector, we have the private sector, we have the academic sector. All three are hugely important, and we are very lucky we have big brains in all three of those sectors. We are always coming together and talking about it.

From my perspective, the thing is whatever you can do to help us get that forecast right. I think we can figure out the back end if we get the front end figured out, when we have times of emergencies, when we have times of crisis, if we diagnose it soon enough and well enough, I think we will be able to handle getting the message out to our public.

The CHAIRMAN. As a follow-up, taking sort of a broad perspective on how the Weather Service alerts people of potential weather threats, do you think we ought to rethink how we structure our weather alerting system? If so, what might be consider in doing that?

Mr. SZNAIDER. I would like to take a first shot at that. Back in the 1990s when the weather radar system was deployed, there was a high level of collaboration in the establishment of what was called NIDS, NEXRAD Information Distribution System.

Four companies competed and were qualified to be the primary gateway for the distribution of information. It was really an effective method of a public/private partnership. It involved the commercial television broadcasting industry and the like.

Since then, things have changed. There is no weather radio. There is social media. There are a lot of things.

My point is there was more collaboration then than today, and we need to get back to that so we can figure out the best ways to communicate the information most effectively.

The CHAIRMAN. What else?

Dr. KLOCKOW. I will follow up with that to suggest that you are sort of talking about what we call the "watch warning advisory system." The way we have structured how we communicate about various kinds of hazards and time, different kinds of products, they all have different thresholds for being issued.

One of the things that we know we have to do better as a community is to communicate uncertainty, and we do not necessarily do that really, really well in the current watch warning advisory system. It is implicitly a part of it but the system is a little clunky, a little discontinuous, and there are emerging technologies that could really challenge that system.

If we think about incorporating uncertainty, we have to maybe do a bit of a rethink, but we should do it carefully because the system is a legacy product, and there are a lot of folks who use the watch warning advisory system when certain kinds of warnings are issued, there are a lot of people that do a lot of things as part of

this system. We do not do anything in a box in the field of meteorology. There is a whole system that is in place.

I think if we are going to rethink that system, it should be done carefully with the needs of all the stakeholders in mind, and we can maybe think about various ways to communicate this information, but it should really be done in concert with everybody who depends on it.

The CHAIRMAN. Thank you. Senator Nelson?

Senator NELSON. Senator Schatz, do you need to go?

Senator SCHATZ. Go ahead.

Senator NELSON. First of all, I want to get back on my accolades to the meteorologists that are broadcasting. We have Bob Ryan who is retired from Channel 9 ABC here locally.

If you have the tools, whether it is through social media, whether it is through the new social media that so many young people are on, if you had the tools to accurately forecast, they could get out the word.

There is a next generation of Doppler radars called "NEXRAD," which will enable you to detect the formation of a tornado before they touch down. It will reduce deaths by 34 percent is the estimate, and injuries reduced by 45 percent.

If we can get this technology, Mr. Chairman, and then push it out to the community, we can do it.

You were talking about human behavior, and you sent out this picture of in advance of Hurricane Rita in Texas, and they are trying to get out. Of course, the roads are just impossible.

I will never forget, we had a hurricane that was headed to North Florida, a place that very few hurricanes hit, Jacksonville. Interstate 10 going west, which was the logical route to get people out of the urban area, was impossible. It crept along at no progress, and there that was the westbound lane. The eastbound lane was totally unused. Well, the obvious thing to do is to have a plan for evacuation of which you are using the eastbound lane and you reverse it, so that all the lanes are going west.

We had to go through that experience in order to wake up to using some common sense.

Mr. Sznaider, everything that is going on in the forecasting on helping farmers, agricultural people, businesses get ready, we have the tools, we have the technology, if we will just employ them.

I am going to stop right there so we can get on to the other senators.

The CHAIRMAN. Thank you, Senator Nelson. Senator Schatz?

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

Senator SCHATZ. Thank you, Mr. Chairman. Thank you, Ranking Member. I have a question for all the panelists, if you would not mind answering briefly. It seems to me based on Mr. Sznaider's testimony that there is somewhat of a lack of clarity or at least it is evolving who does what between the Federal agencies and the private sector and the local emergency managers and all the rest.

Here is the basic question I have. What is it that NOAA does that only NOAA can be doing, should be doing?

Dr. TROBEC. Senator, one of the things—I am just going to talk about say tornado warnings, something like that, that has to be done by NOAA, for a multitude of reasons, mostly because number one, you have to speak with one voice. Number two, NOAA is staffed 24 hours a day. Three, not such a small thing in the warning process, they cannot get sued, which is not a small thing. That is one thing that comes immediately to mind.

Senator SCHATZ. Thank you.

Mr. SZNAIDER. I would follow up with total agreement with that. As I mentioned in my opening testimony, we believe very strongly that NOAA should take the lead in the very sophisticated numerical weather prediction models, as well as being the single source for the issuance of these very important hazardous weather warning alerts.

Having said that, I would also like to echo some of the comments of the other panelists that there is still plenty of room for improvement in those prediction models.

To make a comment to Ranking Member Nelson, in the agricultural community, and to Chairman Thune, there is still limited work being done in terms of specific forecasts for agriculture, for drought models and the like.

Most of our businesses and most of our customers make most of their decisions still in a relatively short time period, 36 hours, maybe 5 to 7 days for planning, and certainly there is some value in longer range outlooks as well.

Senator SCHATZ. Your basic contention is there needs to be better data sharing, and not just hard scientific data but sort of the needs of your downstream customers. It seems to me you are saying that because there is a question of jurisdiction and turf, and a little bit of lack of clarity or at least it is evolving, that you do not have the partnership that you wish you had so you could better inform how NOAA could service its customers at the consumer level, at the individual level, at the institutional level.

Mr. SZNAIDER. Right. The more data sources that are available, even from a commercial source, that go into the models to help initialize better, that is a good thing. For better or worse, we have to find the best solutions for our customers. It is a very competitive environment. We have to today partner with many organizations outside of the U.S. both public and private.

We would much prefer to work closer with NOAA to help them maximize the accuracy of their forecasts.

Senator SCHATZ. Thank you.

Dr. KLOCKOW. To follow on from that comment, I think NOAA can play a really important role, as I alluded to in my earlier comments, in organize and galvanize, in a couple of different ways.

Taking a step back, the social behavioral sciences are numerous, and there are actually a lot of communities of researchers who are learning a lot about how people understand risks and how to communicate really well, but they are not necessarily talking to each other. They do not even know necessarily that they exist across universities or across academic units.

All the research they are doing has relevance to NOAA's mission, so it makes sense for maybe NOAA to consider being a place where they can start to assimilate that, bring all that knowledge together,

and maybe transition, take some of that research in a pipeline tradition and try to make it relevant to what NOAA is doing.

Senator SCHATZ. I like the idea of NOAA as a convener and I think it makes sense, it is the Federal Government, it is the best source of all the satellite data, analysis, and all the rest of it.

I worry a little bit that would eventually result in some mission creep, so I think it is important to do the convening. I think it is important to stitch together the current social science, and I am particularly interested having been in a couple of emergency operating centers when I was in the state of Hawaii in state government, in the impact of social media, both positively and negatively, in terms of informing the public.

I take all of your points. I just wonder whether NOAA is the right convener on that particular question because it strays from where all the expertise actually resides, which is not at NOAA. NOAA has weather scientists and satellite scientists and ocean scientists, maybe not so many social scientists.

Dr. KLOCKOW. That is true, they do not. There is some internal capacity. That is actually part of the challenge. It is a physical science agency. The issue is it is physical scientists who have a life saving mission. How are they supposed to do life saving if they do not know very much directly about how people are understanding, receiving, and responding to their information. It is a good question.

Senator SCHATZ. Thank you. I am sorry, Mr. Hermey, my time has expired by 40 seconds. Thank you.

The CHAIRMAN. Thank you, Senator Schatz. My neighbor from the good state of Minnesota, Senator Klobuchar, whose many constituents also rely on the good Dr. Trobec's forecasts.

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

Senator KLOBUCHAR. Exactly. Whose constituents care a lot about weather, especially when it is 41 below zero without wind chill, and that happened this year.

Thank you so much, and I especially wanted to greet our Minnesotan who is here today, thank you so much, Mr. Sznaider, for being here, and thank you for your work and your real understanding of what accurate weather forecasts can mean for the economy and how to innovate new ways to get accurate data to businesses and communities. It is really critical.

I guess I would lead with you on this question. You referenced a study from the National Center for Atmospheric Research that states that 16 percent of aggregate U.S. economy is sensitive to weather on an annual basis while farming and aviation are examples of industries that are sensitive to weather.

What other kind of industries do you think that you would not expect to care a lot about weather, and what trends has your company seen in how they impact your customers' demand for more accurate information on weather?

Mr. SZNAIDER. Thank you for the question, Senator Klobuchar. I would also like to take the opportunity to invite you to stop by Burnsville, Minnesota. Our operation is 24 hours a day.

Senator KLOBUCHAR. I have been in Burnsville, but not in your operations.

Mr. SZNAIDER. We would love to have you.

Senator KLOBUCHAR. OK.

Mr. SZNAIDER. There are many, many areas where an accurate weather forecast properly integrated into a business, for example, can make a huge economic impact. One of them that we happen to do quite a bit of work on is with electric utilities. Weather is the single biggest variable in the forecast of how much power will need to be generated tomorrow. An accurate weather forecast, even something as mundane as temperature, it matters.

One of our customers, Con Edison, in New York, in a large metropolitan area, if on a hot day during the summer, let's say 97 degrees is the forecast, it actually goes to 100, we miss by three degrees, it could result in half a million dollars of extra expense, just to go out and buy extra power and start up ancillary generators.

Accuracy matters. In aviation, I talked about turbulence alerting, that has potential for fuel savings, because airlines and actually Hawaiian Air uses our service, carrying extra fuel unnecessarily or not enough when they run into turbulence, it is a big deal. It is not only a safety concern but it is also an economic impact.

In agriculture, there is so much more that we can do by taking different datasets and better measurements in the rural parts of the country and then integrating those into better forecast models.

It goes on and on. I will just say one thing real quickly, communication of the information is so important as well. We try to give context and confidence in our forecasts. It is so important.

I think we are talking about the right things, but it does start upstream with a really better forecast.

Senator KLOBUCHAR. Thank you very much. Dr. Trobec, I have certainly seen the power of local broadcasters when we have had the floods in Moorhead and Fargo, when we had tornadoes come. It is an unbelievable thing how many lives can be saved.

I know you travel internationally, and how do we compare in our country with getting that information out there compared to other places?

Dr. TROBEC. We are number one, of course.

Senator KLOBUCHAR. That was called a "softball" question.

Dr. TROBEC. Maybe something I would like to point out, in most of the world actually, the weather presenters are weather presenters, and here we actually have meteorologists who actually do the stuff. More often than not, you are going to find a meteorologist who is there.

Actually, in a number of countries, the weather forecast you see on the 10 o'clock news is actually videotaped ahead of time. That is something that is definitely not done in this country.

Certainly, with the way we do watches and warnings and things like that, it is a whole different situation in other countries.

Senator KLOBUCHAR. Thank you very much.

The CHAIRMAN. Thank you, Senator Klobuchar. The only member of this panel who might be able to beat your 41 below is the Senator from Alaska.

Senator KLOBUCHAR. I do not know, there was a day when International Falls, Minnesota measured colder than Mars.

[Laughter.]

Senator NELSON. Mr. Chairman, I do not even understand what 41 degrees below is.

The CHAIRMAN. Senator Nelson looked at me and said 41 below, and I said you do not want to know. The Senator from Alaska.

STATEMENT OF HON. DAN SULLIVAN,
U.S. SENATOR FROM ALASKA

Senator SULLIVAN. Mr. Chairman, thanks very much. I was going to mention, Senator Klobuchar, that in parts of Alaska, 41 below zero is just another day.

I appreciate the hearing. Obviously, this is a hearing the topic of which is very important to many of our constituents, certainly mine in terms of weather, whether it is pilots, hikers, fishermen, accurate weather, and then the dissemination accurately of that weather is critical.

I just wanted to ask kind of a broad question, which is when you look at challenges with regard to doing your job accurately and then that important function of actually disseminating the information to as many people as possible, what do you see as the biggest challenges?

Is it money? Is it satellites? Is it kind of state/Federal cooperation? What do you see as kind of the key top challenges that are inhibiting your ability to do your job better? I can open it up to any of the panelists.

Dr. TROBEC. All right. Everybody is looking at me. I hate to say all of those, but in a way I kind of mean that. There are two primary issues that we have. We have to first get the forecast right, and then second, communicate it effectively. The same thing goes with emergency weather situations. We have to diagnose the problem early and then communicate it to the public, to the end users.

The main issue that we have is getting the forecast right, but actually as Kim was saying, there are always going to be times—there is a reason why the biggest computers in the world are doing weather, because they are incredibly computer intensive.

There is almost an arm's race of computing power going on in the world. As soon as we announce we are going to increase our computing power, the Europeans say they are making a bigger computer, the Japanese.

Yes, we have to keep on top of the technology. Once we get the technology right, people like the social scientists, I think we can figure the rest of it out, but if the raw data is wrong, there is nothing we can do to help the public.

Senator SULLIVAN. Dr. Trobec, are there specific challenges that actually relate to states like South Dakota or Alaska that are very big and yet have highly sparsely populated parts of the state?

Dr. TROBEC. Yes.

Senator SULLIVAN. What do you see as those main challenges? A little different than say Maryland or other places?

Dr. TROBEC. Yes, certainly. If you are talking about a place like Minnesota or South Dakota, the things that are important are totally different. That is why there is a difference in the warning structure. A calm day in South Dakota, western South Dakota, is

30 or 40 mile an hour winds. If you have that going through here, it is a big problem. Everybody has their own things.

That is kind of the unique structure of the weather enterprise is, we get the big forecasts right, then the smaller places, each individual office, that is why you will always see the local meteorologists explaining things because different weather has different impacts in different places.

We have to maximize where we are getting the big thing right, as my colleagues talked about, get the weather models right from the start, then we can interpret how they impact the individual people. As talked about here today, the technology, the ability to do good forecasts impacts economically and socially to an incredible degree. We have to start by getting that part right, and it does involve satellites and radars and all this stuff we have to spend money on.

Senator SULLIVAN. Right. Thank you. Any other thoughts?

Mr. SZNAIDER. One quick comment. We have talked about the changes in how to communicate information, but there are also other changes in the types of weather forecasting that we need to pay attention to. One of them is in renewable energy.

When we talk with our customers in the utility space, it is a challenge for them today that they did not have 10 years ago to understand how much power will be generated from solar panels and from wind that is in residential or on top of buildings.

That is a very difficult forecast, a single group of clouds can come and blow it. More research and development in those areas will pay off in the long run as well.

Senator SULLIVAN. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Sullivan. I am just curious, this is a question for the panel, the way weather is forecasted, we have talked about this quite a bit, has improved tremendously just in the past 20 years, what do you see as the next big forecasting breakthrough?

Is there anything you see out there on the horizon that is a game changer in terms of how we go about doing this from a technological standpoint?

Dr. KLOCKOW. There is actually a lot of really interesting research going on to help connect from where we are on warnings, a couple of minutes time scale, to a couple of hours time scale. It is a program called FACETS, forecasting a continuum of threats.

That will actually pose a really interesting challenge to our watch warning advisory system, because it will maybe offer us the chance to communicate uncertainty about storms happening in about an hour time-frame in a way we never had before.

That is something that is coming in the next years to decade, and it will be a really interesting thing for us to look at from a communication perspective.

The CHAIRMAN. Dr. Trobec, I wanted to make an observation and ask you a question. There have been some notable instances such as Hurricane Sandy, where the European weather model has produced better forecasts than the National Weather Service's model. Notably, the Air Force has just announced they are going to be using the European weather model rather than contributing to and benefiting from domestic forecast products.

I think maybe you alluded to earlier some of the work, observations, and opportunities you have had to see what they do in Europe. Do you believe the European weather model is better?

Dr. TROBEC. Yes.

The CHAIRMAN. If so, how do we close the forecasting gap?

Dr. TROBEC. You are talking about the Air Force now going with the U.K. Met Office, it is a different model, but it, too, has been found to be superior. Even at my television station, we have used the European model for many years, maybe even one of the first ones in the U.S. to pay attention to it.

One of the big things is the computer people tell us is the initialization process is the first thing you do in an computer model, it is the hardest part, and what it involves is taking the atmosphere at any given moment at every location on Earth and changing it into numbers. You are changing this stuff we cannot see, the stuff we can barely feel, into numbers.

If we do not get that right, everything becomes incorrect after that. The most important thing is initialization. You have to get all the atmospheric conversion to numbers, you have to get the numbers in the computer. One of the things they do, from the experts I have talked to, the initialization process is much more intensive computer-wise, and I think that is an issue, and that is why I think we are going to do better now that we have more computer capacity, because we will be able to use some routines and include some other parameters.

In a nutshell, that is why it is. They have had bigger computers, and it is a lot easier to do a lot of stuff, particularly in weather, if you have a bigger computer. That is why I say it is not an accident that you look at every one of the biggest computers in the world, and they are doing weather modeling because it is so intensive, weather and climate modeling I should say.

Mr. SZNAIDER. Just a very quick follow-up on that, I wholeheartedly agree that the initialization, getting the information to start a model, extremely important. That is why we advocate that there be an honest objective analysis of other sources that are available of information from commercial platforms, whether they be satellite or surface, land based systems, to maximize the initialization of the U.S. models.

The CHAIRMAN. I think we have a vote. Senator Nelson, do you want to ask another question?

Senator NELSON. Yes, just a quick follow-up.

The CHAIRMAN. Then Senator Peters from Michigan.

Senator NELSON. Before Senator Peters. You cannot get it right unless you have the numbers, and you cannot get the numbers unless you have the instruments, whether they be on the ground or up on orbit.

For example, we have had one satellite that measures the temperature at the ocean's surface, which is also a major component on trying to get the direction of a hurricane. We have to replace it. NOAA has to in this case have the budget in order to do that.

The good news is that NOAA has a real scientist, Dr. Kathy Sullivan, an oceanographer who happens to be a five time flyer as an astronaut.

Some people get this mixed up in the political discussion of climate change. Well, we have to get beyond that and look on saving lives and property on weather forecasting, and then realize the trends in fact that are happening in climate change.

In the last 100 years, the sea has risen in South Florida nine inches. You cannot wall it off like they can in Holland because Florida is on a porous limestone of Swiss cheese limestone, so the more the saltwater rises, the more it intrudes into the land and pushes down the fresh water.

I can count me as one Senator who is all for giving the Weather Service the instruments they need. I want Senator Peters to have a chance, so I will stop.

The CHAIRMAN. The Senator from Michigan, Senator Peters.

STATEMENT OF HON. GARY PETERS,
U.S. SENATOR FROM MICHIGAN

Senator PETERS. Thank you, Chairman Thune, and thank you, Ranking Member Nelson. Thank you, Ranking Member Nelson, because for the questions I was going to ask, that was a great lead into, as I am now the new Ranking Member of Space, Science and Competitiveness, something I know you are very passionate about, as you know, and I will direct this to the panel.

In a recent hearing that we had for that subcommittee, there are some folks here in Washington that believe NASA needs to focus on a core mission, which is planetary explorations, mission to Mars, and they were saying we should move away from Earth sciences, and the investment in NASA on Earth sciences.

Certainly, as I reminded and as Senator Nelson did, too, we reminded other folks on the Committee that as wonderful as our solar system is, Earth is still the most important planet in our solar system, and to my knowledge, is the only one that humans are actually going to be able to live on, so we need to continue to study Earth, and NASA provides platforms for you to do your work and for others to do their work in an extraordinary way. We need to continue to fund Earth sciences as part of NASA.

How important is it to you in your work for NASA to continue to be able to launch the satellites and to be a partner with you on your mission, and should we continue to make sure that NASA, in addition to you having the resources for your exploration, NASA has the ability to supplement Earth science research in this country?

Dr. TROBEC. I would just say as an operational forecaster, in what I do every day, that is one area—meteorologists and climatologists are kind of like cousins, we speak the same language. This is one area we are absolutely united as an entire weather enterprise. That is huge.

As Senator Nelson was talking about, the sea surface temperature, it is not only important for seasonal forecasts, but for day to day forecasts. The ocean is a driver of our weather across the entire planet.

I think as a weather enterprise, we would say bravo, Senator Peters, get us the tools we need from an Earth science perspective, we would appreciate it.

Senator PETERS. Right.

Mr. SZNAIDER. I agree. Again, as we were saying earlier, the more data, the better. The spaced-based platforms, very, very important, whether they be government or commercial platforms. There are some good ones out there on both sides, as well as on the surface.

I think it is really, really important, and again, the economic impacts of a good weather forecast are just going to continue as we are seeing some more volatility in weather. That trend is beginning to show itself. We need to get it right even more often in a more challenging environment.

Senator PETERS. Anyone else?

Mr. HERMEY. I am not a scientist. Wherever the data comes from, I am all for it, but I also would like to have the people particularly at the Weather Service and at the prediction centers that can help support me and be that arm of the scientists so we can make better and informed decisions for our citizens.

Senator PETERS. Right. Thank you. We have a vote.

The CHAIRMAN. Thank you, Senator Peters. Feel free, I want to ask one more question. You can go vote and we will wrap this up. We will keep the record open for questions for the record if anybody has any, submit them within a two week period.

I want to ask Mr. Sznaider one last question, and we do, as mentioned earlier, rely heavily on the weather. We are a state where agriculture is the number one industry.

It is day-to-day obviously we have talked a lot about, but these seasonal predictions, I am wondering how could you incorporate some of these seasonal predictions into your business model, and what impact would that have for your customers if we were better able to do that, start to evaluate wet seasons and dry seasons further in advance?

Mr. SZNAIDER. Thank you for the question. Very briefly, today, most of the decisions on the production side with weather are short term. An application for a typical farmer of ours that has 1,000 acres, if they do a pesticide application or something like that, and it rains on it too quickly, they will lose the effectiveness of that, and it might be like $6,000 to $7,000. That happens all over the place.

Having said that, there is interest in having a more reliable and higher skilled seasonable outlook, to begin for planning purposes. Certainly, commodity pricing is a big part of a farmer. This is big business, and it is important not just to grow the crops but be able to get a return on that investment.

Having a better outlook, a longer term outlook, would be helpful. I just hope it is not at the complete expense of the continued investment necessary to continue to improve the short term as well. If we can find that balance, it really makes total sense.

The CHAIRMAN. Good. Thank you. Like I said, if you could respond to questions for the record as soon as possible, that would be most appreciated.

Great panel, great discussion. Thank you for participating. Thanks for the great job you do. Our weather enterprise does a terrific job in this country, and I know coming from a state where weather is so important and we have wide variations in the weather, our folks, Jay and team, do a great job.

We just want to see if there are ways, as you said, if we can improve. Obviously, the biggest room in the house is the room for improvement. We are always looking for ways to do it, do it even better.

Thank you all for being here. We are going to go vote. This hearing is adjourned.

[Whereupon, at 11:05 a.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. BILL NELSON TO DR. JAY TROBEC

Question. Weather information is only valuable to the extent that it is communicated effectively. You have to know your audience to know how to give them the relevant information at the right time to make decisions. For example, describing a hurricane to a Floridian with hurricane shutters and a generator is one thing. Describing a similar storm to someone from New York would be very different. What kind of miscommunication have you seen and how has that harmed communities in decision-making?

Answer. Thank you for the question, Senator Nelson. The single biggest source of misinformation is social media, and broadcasters and the National Weather Service have both invested time countering weather misinformation distributed through outlets like Facebook (see *http://www.nws.noaa.gov/om/notification/pns11martin.txt*). We have seen an increase in the number of people who claim on the Internet to be weather experts—whether or not they have any meteorological expertise. Even amateurs or college students with some meteorological background have been known to go public with outlandish long-shot "forecasts" on the Internet. They are irresponsible and harmful. We know that even the best and brightest in the weather enterprise can make a high-end forecast that is erroneous or poorly-communicated to the public (*e.g.,* "Sandy," Atlanta's "snow-pocalypse," or the non-snowstorm in Philadelphia in January). Two thoughts: (1) We must find a way to speak with "one-voice" when it comes to high impact weather events, those events which result in significant lifestyle and economic effects. Conflicting information results in people taking no action, or delayed action that can result in undesirable outcomes. We must convince the public to seek and accept only reputable weather information. (2) We must continue to improve the forecast. During the hearing, I mentioned the need for increased computing resources in hopes of closing the gap on computer models produced by other countries (that, sadly, outperform American weather models). We also need to utilize government AND private sector and academic brainpower to make forecast improvements. If we don't get the forecast right, nothing else matters. One success story impacting your state is the steady improvement in hurricane track predictions in recent years (see *http://www.nhc.noaa.gov/verification/verify5.shtml*).

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. CORY BOOKER TO DR. JAY TROBEC

Question. New Jersey has more than 20 cities with populations exceeding 50,000 residents. Urban residents of New Jersey would greatly benefit from forecasts that address the unique qualities of urban landscapes. The National Academy of Sciences has suggested that existing weather models should be adapted to include higher spatial resolution and mesoscale modeling in order to increase the accuracy of forecasts in urban areas. What are the biggest observational and informational gaps that need to be filled in order to optimize urban meteorology? Are there any efforts within the weather industry to encourage data sharing or training of various end users on how to utilize existing weather data? How can existing weather data be better utilized to create, practical, ready-to-use products for urban end users?

Answer. Thank you for the questions, Senator Booker. The NAS suggests, in Weather Services for the Nation: Becoming Second to None (*http://www.nap.edu/openbook.php?record__id=13429*) that gaps in weather data should be reduced. The report specifically suggests actions such as installing local radar systems in places where coverage by the national radar network NEXRAD is inadequate—such as in urban areas or the mountainous west. But the overarching issue is the desire for increased density of weather data.

The bread and butter of modern forecasting is computer modelling. Every time a computer begins the modelling process, it does so by assimilating the entire atmosphere (every level of altitude every place on Earth) and turning weather into numbers. The better the data, the more accurate the computer's forecast of future weather conditions is likely to be. Where there are gaps in data, the computer fills in those gaps using mathematics instead of actual observations. This can result in forecast errors—and in computer modelling, forecast errors are greatly magnified with each time step into the future.

There are many different types of data input into the models (radar, satellite, weather balloons, and surface observations, to name a few). Again, more is better, especially in densely populated areas such as yours, in which a there can be big differences in weather (affecting thousands of people) over a relatively short distance.

Urban areas can be impacted by the density of the output of computer modelling as well. The spatial resolution (density of forecast grid points) has improved over the years. American models (NAM, GFS) are now calculating weather conditions over points approximately 12 km apart (with "experimental" models running 4 km resolution). The higher the resolution, the more precise the forecast would be expected over smaller areas (such as urban centers). Increased resolution comes at a price—in order to double the resolution of a computer model, you require approximately an eight-fold increase in computing power.

There are many training opportunities for end-users to learn how to better utilize existing weather data. Meetings and workshops of national organizations such as the American Meteorological Society and the National Weather Association provide numerous training opportunities involving state of the art and up-to-date science and research. One issue that seems to arise every year within the government is travel budgets. But I assure you that at these meetings there is valuable education taking place that has a beneficial impact when local meteorologists return to their home locations. While online educational opportunities (such as COMET/MetEd) have also improved in recent years, there is still no substitute for the effectiveness of the eye-to-eye, in-person meeting.

In the Second to None report, there is significant emphasis put on the need for involvement of the private sector to improve the weather enterprise. One thing the Congress can do—through oversight—is ensure that NOAA take actual advantage of the private sector, as the NAS suggests. My impression is that this remains an area of unrealized potential. Many very intelligent meteorologists have been drawn into the private sector in recent years, and NOAA would benefit from their expertise being utilized in urban meteorology issues.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO DON HERMEY

Question 1. How does Manatee County make sure that residents with special needs—like our homebound or senior Floridians—are considered and accommodated during an emergency or severe weather event?

Answer. Manatee County has a long standing special needs shelter program. The program includes a registry process which is managed by Manatee County Emergency Management. The Florida Department of Health in Manatee County supports the shelter with clinical staff. The registry process allows for clinicians to evaluate and organize for the supplies and materials that support our special needs clients in a shelter setting. The Manatee County Transportation Division and Emergency Medical Services Division assist with transportation to our shelters. The state of Florida has also created an early prescription refill mandate (Florida Statute 252.358) to assist those needing early prescription refills. This program is established in all 67 counties within the state of Florida. The program is currently being expanded to include a statewide registry. The information collected under the special needs shelter program is also extremely valuable to support and validate our overall emergency planning efforts for all segments of our community.

Question 2. Weather information is only valuable to the extent that it is communicated effectively. You've got to know your audience to know how to give them the relevant information at the right time to make decisions. For example, describing a hurricane to a Floridian with hurricane shutters and a generator is one thing. Describing a similar storm to someone from New York would be very different. What kind of miscommunication have you seen and how has that harmed communities in decision-making?

Answer. We have both international and Northern visitors as well as local residents with no direct storm experience who must be educated. I have seen old adjusted pictures posted on social media which are correlated to current events. The

ability of any information regardless of its validity going viral is of paramount concern. This is both challenging and harmful as local emergency management agencies and National Weather Service Offices work to maintain and disseminate credible information. We have to work harder to establish the National Weather Service, National Hurricane Center, Storm Prediction Center and other services as the credible source for our country. Local National Weather Service Office personnel are an extremely important component of this communications process—they know the local geography, and population demographics—they can effectively translate the meteorology to local emergency managers who can apply it to their long-standing public information process. More visitors and residents die each year in Florida from non-tropical weather events such as rip currents and lightning. For example, in June, 2012 after Tropical Storm Debbie, two men are safely pulled ashore. In a second incident that same June of 2012, a family of five was swept away. Four were saved and one later died ((Kimela Walker, 41 from Alabama) Natalie Watson, Times staff writer, Monday, June 16, 2014). According to the Florida Department of Environmental Protection, "297 people died in Florida because of rip currents between 1999 and 2013." Another example of communications challenges would be the historical alignment of hurricanes with wind speed, which may or may not be a good indicator of the potential storm surge, and definitely doesn't tell you how much rain it is going to drop, or how many tornadoes it is going to spawn, etc. Although I don't recommend the NWS get away from scientific vernacular, we need to be cognizant of the impact those words have and develop products in a way that truly illustrates what will happen. We know that a large, slow-moving tropical storm could have greater consequences than a compact, fast-moving Cat 2, but the Cat 2 is certainly going to get more attention.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. CORY BOOKER TO DON HERMEY

Question 1. As NOAA is starting to distribute hurricane inundation maps this year, would it be valuable to have these maps transmitted by an improved Emergency Alert System to cars with HD Radio/navigation receivers that can display them?

Answer. These maps are experimental and new. We need to foster education. We have not experienced an evacuation using this new tool for a proper evaluation. There are also some discrepancies between these tools and the local evacuation maps. The system will need to be managed in a safe manner. We do not want to cause motorists to not pay attention to the road or discredit local emergency information or instructions. Perhaps it could be more effective to tell a driver that they are located in an evacuation zone as determined by their local emergency management official, and direct them to the proper evacuation route. Car displays may also be the proper venue for things like flood warning and tornado warnings, as drivers may enter those areas unaware, and giving them that life safety information in a way that provides actionable recommendations.

Question 2. In addition, would it be valuable to have these maps transmitted by an improved Emergency Alert System to smartphones that have TV reception capability and map apps? The ATSC is in process of defining a new digital TV system (ATSC 3.0) that would be better at broadcasting to smartphones.

Answer. I agree there needs to be multiple venues to disseminate information. Resolution of data also needs to catch up to the various display systems. The establishment of a strategy with providers, end users and local decision makers becoming involved in the process may assist as technology expands. With all new venues, there needs to be a concerted coordinated effort with educational instructions on what actions the public should take to protect themselves and their families.

Question 3. As both of the above methods would not require mass public downloads from the Internet, would they be a desirable alternative to only depending on websites?

Answer. Effective warnings require multiple distribution venues to meet the demands of the various citizen demographics. Reliance on a single distribution method raises a concern for saturation and missing various demographic populations. Emphasizing "push" notifications like Wireless Emergency Alerts (WEA) and Emergency Alert System (EAS) that don't require the user to take a pro-active action to access or download ahead of time may be more successful for the intended targeted group.

Question 4. New Jersey has more than 20 cities with populations exceeding 50,000 residents. Urban residents of New Jersey would greatly benefit from forecasts that

address the unique qualities of urban landscapes. The National Academy of Sciences has suggested that existing weather models should be adapted to include higher spatial resolution and mesoscale modeling in order to increase the accuracy of forecasts in urban areas. What are the biggest observational and informational gaps that need to be filled in order to optimize urban meteorology?

Answer. Urban meteorology is not my area of expertise. Understanding higher spatial resolution and mesoscale modeling is why I rely on the weather community and the National Weather Service. I understand that local observations of the lowest levels of the atmosphere are needed and research is underway. Perhaps new smaller radars that work in concert with the current and future national radar network can contribute to providing more data. From my perspective, the informational gap is the ability for people to understand what is forecast to happen at their exact location. If GPS can tell them when they will arrive, if they can get notified of a package arrival, can a weather forecast give pin point accuracy from block to block? I believe there is a need to migrate from large geographical weather modeling to specific details at the personalized level.

Question 5. Are there any efforts within the weather industry to encourage data sharing or training of various end users on how to utilize existing weather data?

Answer. I cannot speak to efforts within the weather industry. As an end user, I commend the National Weather Service, NOAA and the Storm Prediction Center for my emergency management team's education. My team and I have attended a number of their weather classes and educational trainings on their new products. Their outreach is paramount to solid decision making and information dissemination from my county level to our media. I would request enhancing funding for both technology and people so they may remain at the forefront of forecasting technology. Efforts to increase the number of course offerings nationwide should be considered. They also need the ability to deliver products in formats that allow 3rd party users to utilize and manipulate the data for interesting products that the private sector develops. If they are undermined as the definitive source for the raw data, we will have a difficult time getting the public to take action in the event of conflicting data.

Question 6. How can existing weather data be better utilized to create, practical, ready-to-use products for urban end users?

Answer. Enhancing coordination and communication with users to develop products and services will assist end users. Supporting additional staffing in the National Weather Service to assist with educational outreach to not only emergency managers, but also to behavioral scientist, traffic engineers and others will foster practical, ready to use products. We all want the best, most up-to-date, accurate, and useful information possible. Emergency managers want the public to understand the consequences of the weather, and want the ability to provide the public with actionable information that will help them protect their lives and property.

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