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'State of the National Weather Service' Delivered at AMS Annual Meeting

Don Berchoff, Director of the Office of Science and Technology, spoke to a packed room on January 12 at the American Meteorological Society Conference. His presentation was part of the 25th Conference on International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology at the 89th American Meteorological Society (AMS) Annual Meeting in Phoenix, AZ.

This year's presentation discussed goals in a variety of areas, from tornado warnings and hurricane forecasts to climate, fire weather, aviation weather, and space weather services; to air quality predictions and integrated water services.

Berchoff said that our future direction is "to infuse the best science and technology into forecast operations in order to communicate the most accurate information that enables decision makers."

Don Berchoff: Actually Jack was never going to speak at this, because it was a 4:30 session or we needed to have a draw, you know. People were looking at it and saying "Who is this Don Berchoff guy?" So we said let's use Jack's name. We'll get people in here and then we'll will them over afterwards.

No, actually I am proud and honored to be here today. I just came over to the Weather Service in September. Was hired on as the Science and Technology Director and I'm really excited about this opportunity and about what the future holds for the weather community in general. Now we heard today from Ken, he discussed a little bit about NextGen. NextGen, to me, it's a tremendous vehicle for us to grow on within the Weather Service and within the greater weather community, because we are talking about using weather information to improve decision making in our country, it goes beyond just what's going on in the aviation community. We will talk a little bit more about that today. But NextGen is, for us, an opportunity to build on and move further into the future to improve decisions for our country, across a number of areas.

First off I just want to start by reminding everybody what our commitment is. Our commitment is to providing the best weather services possible integrated in a way and communicated in a way that's going to protect and save lives and property and I said a couple of words in there: "communicated." To us in the Weather Service that's just as

important as putting out accurate forecasts. We want impacts to resonate. We want people to take action, we want to save lives. And then the other commitment is "enhancing the national economy." You know many years ago when I came in to the weather business, weather was a cope and avoid kind of mechanism, you know. If people would want to avoid it, maybe you can convince somebody to change their plans but not likely because we maybe would mess up a forecast every other time or so often and couldn't get that, couldn't drive that the desire to change planning and in the process but now we are getting to a point where all weather information is getting so good now that people are actually beginning to plan the weather out to mitigate the effects to exploit it. And when we talk about enhancing the national economy we know how much weather causes our national economy every year and if we just get that weather integrated better in the planning, we could save ourselves a lot of money and that's another focus.

And more appropriately we're going to synchronize efforts. My job as the Science and Technology Director is to find what's best out there in the great community integrate it in a way into our operations, and when I say across the weather and climate enterprise, I am talking about industry, universities, and within our own communities within NOAA itself.

First of all I want to just take a quick look back on what happened in the last year. We know we had a very devastating tornadic year, more than 1,600 tornados which over the last ten-year average, that's above normal. The February Super Tuesday outbreak was really an outstanding forecast done by the Weather Service both in terms of getting an outlook out there two or three days in advance on the potential for these tornadic outbreaks but also in terms of the lead time that we get out on those warnings that particular day. And while we like to pat ourselves on the back for a good forecast, the bottom line is 57 people still perished that day and we need to figure out why that happened. Whether it was the way we communicate the information, whether it was people, you know, took the right kind of action in face of that tornado and that's the kind of work we look on. So we give ourselves a real high marks for accuracy, we did a good job on that forecast. But now we want to look at that also, I want to know why people perished on that particular day and work hard to fix that and mitigate that.

In terms of flooding, we had some very heavy rainfall over the middle part of the country, as you know. We had flooding that was on parallel to 1993 floods over the Midwest. Many people died. I will tell you that, again, the forecasts were pretty accurate. But again, even with accurate forecasts, there were a lot of people that suffered and the question is how do we do better in getting folks to react and do the things they need to do in order to not be impacted in such a tragic way with these floods. And then we had a hurricane season which was a record-breaking hurricane reason. We had a quite a few named storms and really quite a few made landfalls. Six consecutive storms made landfall. Again pretty good forecasts this year on these hurricanes, especially with Ike, and we should be proud of the progress we are making in terms of forecasting hurricane track. Intensity is still a challenge and we are going to talk a little bit about that.

We continued to see improvements in our warnings for our lead times for getting tornado warnings out to the public. We are working very hard to improve upon these capabilities; we have some technologies coming on the super resolution NEXRAD which is going to provide eight times the reflectivity resolution and two times the velocity resolution. We have been integrating terminal doppler weather radars from the FAAI and have a good program going with that. And those who are going to continue to give us what I would say evolutionary improvements in our lead times. But we still have a lot of work to do in scientific community to figure out how do we dramatically increase those lead times? We will talk a little bit about that.

False alarm rates. Always difficult, because we know if we put out too many warnings and the weather doesn't occur next time around somebody is not I have to take advantage of that warning. Again we've had some slight improvement over the years and with any improvement in accuracy on probability of detection, as you all know, the key is trying to see what you are doing your false alarm rate. The good news is as we have been improving our lead times on tornados our false alarm rate has still been dropping and that's a good thing and we've just got to continue working on that.

Flash flooding is really a good news story. If you look at the trend here, it's pretty dramatic and, I will tell you, I think we can directly attribute that to some specific tools that are now being integrated into AWIPS which is our production system in the National Weather Service. Multi-sensor precipitation algorithms, the inclusion of basin-wide information in our AWIPS that allows us to really understand, down to the basin level, what it takes in terms of precip rates and soil types in order to have severe flooding. And I think that you're seeing some of the output of some of the work that's been done in our hydrology area over the past several years. We are going to continue to see improvements in this area, I think, with work on, again, the super-resolution Doppler deployment and dual polarization which is also going to help us in improving our estimates of precip rates.

The hurricane track forecasting is a tremendous story and I think this year we can all be proud of some of our forecasts in terms of the tracks of those storms that went into the Gulf. Sure, it would be nice to have five, four/five days lead time with perfection and we are working on that, getting those longer-term forecasts more you know accurately narrowed down but at the 48 hour point, again, significant improvement in this. And considering, again, the cost in terms of human suffering and economic impact they think this year we really helped those of emergency managers make some very good decisions about moving the right people in the right places and I think that helped to save lives and protect property.

Where we definitely can use a little bit of improvement is on our intensity forecasting and that's what we hear from FEMA and others, that we really need to have a better handle on category-type hurricane that's going to strike. We all know that the different intensities can mean major changes in the way you react along the coastline. We have some initiatives going on that I'll talk about in the Hurricane Forecast Improvement Program and others that are showing great promise to help us in both research and trying to understand the dynamics of these storms and the interfaces, surrounding interfaces that influence the strengthening of these storms as well as looking at some high resolution modeling and also improved observation techniques to help us in this area.

So with that I'm going to look ahead because this is what science and technology is all about. It's about finding the best that's out there and that's available and to insert that in operations, because that's where the road meets the road, it's how do we get these capability in operations. And that's a big challenge that we have, quite frankly within the community, is getting the best research transitioned into ops and then once we get it into ops, communicating the most accurate information, so decision makers out there can make good decisions and that people will respond the way they need to respond.

We have some pretty ambitious goals for ourselves. Looking at tornados, some folks may look at this and say "One hour lead time on a tornado? I mean, what are you guys smoking up there in Silver Spring?" Well, you know, when you look at some of the some of the work that we are doing in terms of the higher resolution Doppler and the dual pol, that's not going to get us to one hour lead times, we know that. What we've got to get a better handle on if we are going to really ever have an opportunity to hit that one hour goal, and by the way those goals are mainly in the mid-2020 time frame, is we need to be able to forecast initiation and convection better. I think we mostly

understand, we understand to a good degree what areas of convection have a possibility going severe and even producing tornados. It's always these harder issues, breaking caps and other things, where we need higher resolution and more timely data both in the observing front but you know improved simulation and the high resolution models that allows take that data. And with the future of the next generation of geostationary satellites and hopefully eventually with the inclusion of a hyper sensor spectral sounder and with other capabilities that we may be able to bring on board in terms of observations, I think that high latency information that is needed can help us, not only in learning more about the structure of these storms and what causes them to go tornadic before they go tornadic but also to help us in that area of initiation and convection and giving us the lead time so that we then can get begin to anticipate earlier in the process when that convection is going to fire up and then when will it go potentially tornadic. It's a lot of work and effort but I would say that even though it's a very ambitious goal, I think that the science down the road that we see coming on board gives us the possibility to reach that.

In terms of hurricanes, we are again a very robust goal of 50% reduction in forecast tracking intensity errors by 2020. So you know we know how expensive it is, we know how costly it is to our economy when we cannot narrow down an impact area and we are very dedicated to that, not to mention to get to narrow down the area we have to evacuate folks and in getting to do it several times in one summer is a very difficult challenge. We have, we just got a $17 million supplemental that's actually going to quadruple our forecast budget for hurricanes and we have a robust Hurricane Forecast Improvement Program that's going to be heavy in research and also heavy in improving modeling and in our observing systems. We'll try to take our take this forecast capability to next level. We did some research this summer and actually used some outputs from Texas in hurricane Ike using some of these capabilities that we are working on in this Hurricane Forecast Improvement Program and the results were very encouraging, significant results. So we think that we are in the right track and we think that the research that we are going to be able to enable with this influx of money as well as high resolution modeling that we are working on, will help us do get a better handle on the tracking intensity.

Climate services. Big, big push right now for obviously for obvious reasons, all good reasons. We know that climate change is significant in our national security in understanding how the weather and the climate will impact some significant areas like energy, agriculture, water management, and health. Right now the National Weather Service is very focused on inter seasonal climatology and as you know and as you are aware now NOAA is looking at the development of a climate service which will also help us in our inter-decadal following and tracking of climate change. We are working very hard in this area to try to improve our inter-seasonal forecasting using multi-model ensembles, reanalysis from the past, and looking at a climate test bed. We recognize that getting accurate inter-seasonal climatology forecasts out is critical to the energy sector as we embark on the challenges that we have in trying to reduce our dependency on foreign oil and to grow our own internal alternative energy sources here in the States.

Fire weather services is a growth area where we are now, we actually have teams that go out to the field and augment emergency managers on the fire lines. We've had documented cases where the inputs of these teams have saved lives by quickly integrating wind changes, forecasted wind changes, and moving fire officials and fires out of harm's way. We're working very hard on improving our simulation of local observational data, a lot of work being done with our partners in NOAA Research out in the Earth Systems Forecast Lab out in Colorado. We are working hard on coupling fire model weather coupling where we are not just taking weather information but we are looking at terrain, looking at state of vegetation and other things to incorporate that information and to get the best possible forecast for that, any rapidly moving or

developing capability.

We are also looking at improving our observational capabilities for detecting fires before they are known to exist out there, so that we can jump on those opportunities to get those out and get that information out.

Today you heard a lot about aviation weather. Ken Leonard is, you know, a partner. I consider him a friend working very closely on how we develop this data cube. Jason Tuell is the point man in Weather Service for this and to me the weather cube is really the future of our business. You know, looking, if we are going to move beyond this era of cope and avoid to exploit and mitigate, we need to make our information available in formats to the other governmental agencies, to other private industry partners out there so they can grab that information and insert that into their decision-making whether it be through automation, through development of algorithms and decisions tools, and this information has to be easily searchable and easily obtainable.

There is a lot of complication associated with this cube, such as the governance and what not. But this is the future and this is where we are going in supporting aviation weather services. And I throw one another thing out there, and this is this idea of initiation and convection. Again the FAA and the weather community know that one of the major challenges we have in reducing delays is associated with convention, and if we could figure out a way to forecast that initiation 30 minutes ahead of time, what that will do for the air traffic system is just amazing, in terms of saving money and resources and directing traffic well ahead of time so you are not work operating in crisis mode and you can have a smooth transition, into seamless, you know, velocity and travel in and out of airports.

Air quality. A big area, that's a big focus over the last several years. We now put out forecasts for smoke and ozone across the lower 48. We are working to implement smoke forecasts up over Alaska and also in Hawaii. And in the future we're looking at implementing particulate matter prediction over limited domains in order to improve our forecasting of air quality which is critical for health in our country. And we are looking for improved capabilities for predicting emissions, aerosol formation, and the deposition of particulate matter. Leveraging the EPA's networks out there and leveraging local and state agency networks in order to assimilate that information we need to improve our forecast capabilities.
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Integrated weather, water services, another key area. We know that water quality is becoming a major area for which we need to be concerned about. We are developing forecasts now for entire water sheds, looking at soil moisture, water quality, and also improving resource protection capabilities along the estuaries in the coastal areas. This is an area that we see growing over the next several years.

Coastal inundation and flooding. We have worked very hard to improve modeling of storm surge along the coast coastal areas and our basins. We now have something called Slosh which is a tool that we use in order to help improve our forecasting of those storm surges. We are also beginning to do a better job of linking basin-specific forecasts, developing basin-specific forecasts, and developing tools to do that, and we are seeing those improvements right now across the border.

Another area that we are focusing heavily on is space weather. We all know that space weather can have significant impacts to our national security, our communications, and our economic systems. We are working very hard right now to improve our observations, our observation networks, research, and our modeling efforts in order to better understand space and to get better lead times on the kind of space storms that impact our systems. We want to integrate, make sure we are getting that information well integrated so we can take mitigation action to protect satellites, to protect electrical

systems, and communications and, again, GPS is a major thing that can be impacted by space weather. Also, we're working very closely with the international community to improve this.

The big, the next big event in science and technology at the Weather Service, we are in the development of a science and technology road map. That's a road map that we are going to look 15 to 20 years in the future and try to better provide guidance to the greater weather enterprise both in universities, in industry, and within our own NOAA on where to focus on research thrusts based on where we are going with our services and our operations in the future. Next slide

This road map is going to look at several different areas. It's going to look at our service requirements, our private and service requirements, and look at our gaps. It's going to then look at each service requirement through the lens of an enabling capability like observations, data assimilation, models. The main goal here is we want to have synchronized solutions to our enabling capabilities. We want integrated solutions that will serve multiple product and service areas, to try to be more efficient in our resource allocations. We are also we are going to be bringing our research partners into developing this road map both within NOAA and in universities and its going to be closely tied to the strategic plan that we're working on right now at the Weather Service. But ultimately our goal is to try to have more efficient and effective development of science and technology that's integrated and synchronized so we get more bang for the buck and that could be implemented quickly and seamlessly in to operations, and this is one area we are focusing on and also is we are looking at our whole program of how we transition research to operations and trying to look at how we can improve that and streamline that.

So we are striving to achieve a lot. The road map is going to look at integrated observing strategy, you know. We want to look at how, not just satellite data, what satellite data provides us, but what does satellite data coupled with the next generation radar capabilities, coupled with higher resolution information in the upper air from profiler or other data--how do we get the most bang for the buck and how do we meet the requirements we need in order to improve the warnings that people depend on so greatly and to help us in our economic prosperity. We are going to work hard on finer scale models. We are now looking at the next generation potential global models that are being worked. We are also looking at the predecessor to the RUC. We are moving heavily into ensembles and looking at ensembles for helping us with measuring uncertainty in our forecast outputs, post-processing capabilities in the ensemble realm for bias correction and in maximizing the outputs and ensuring the outputs are stable. Higher computing power, we need a lot of computing power to run all this. Better microwave sounding capabilities and the 4-D data cube to help us pull this data together and share it in the most efficient and effective way for anybody out there that needs the data.

And we are dedicated to providing better communication of forecast uncertainty; we are getting our arms around this issue of forecast uncertainty. You know there are many government agencies and many private industry entities out there that seek to have knowledge of the degree of certainty in the forecast so they can make better risk management decisions. We need to figure how to communicate that and how to do that.

Social sciences, big component of our push in the future. We need to understand how people listen and assimilate the data we are providing them and ensure we are getting the right response. But not only from that side, but also in how our forecasters are going to evolve over time as they have to manage this vast amount of data. What kind of systems are we going to develop, what kind of interfaces for them? And we are looking at improving our dissemination technologies and delivery applications as we

move into this decision-support system paradigm that we are moving with.

So big questions remain also. You know, I think this is an exciting time because there is really an opportunity for a revolution in the way we do our forecast business. You know, with all this data, what is the right mix of the forecasters and this automation and how do you deal with this volume of data? How do forecasters, if we go to a probabilistic output, how the forecasters deal with that information and communicate that in the way that is useful? But, most importantly, as I go through this presentation, how do we afford and how we prioritize all these priorities? And that's one of the challenges that I am taking on is figuring out, again, how do we get the most bang for the buck and still bring us the best science and technology has to offer into the Weather Service, to improve our outputs.

I know that part of that is in the partnerships out there, with the university community, with the industry out there, with the research labs. We are reaching out and we intend to have everybody have an integral piece of the development of the science and technology road map as we move out here in the next year. Thank you.

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