Applied Decision Support: Meeting User Needs
A Summary of the 2015 AMS Washington Forum
(April 21-23, 2015, in Washington, D.C.)

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This report summarizes the presented material and discussions of the 2015 AMS Washington Forum (AWF). Consistent with the modified Chatham House Rule that was in effect during the event, the names of individual speakers and attribution of individual remarks are not included in this report, with a couple of approved exceptions where noted. Information about speakers and attendees for internal use can be obtained from the AMS staff. The theme of this year's event was "Applied Decision Support: Meeting User Needs". After opening remarks by board and commission leadership and a keynote from the Secretary of Commerce, the first session of the 2015 AWF focused on this theme.

Executive Summary

This year's eight interactive panel discussions, three special topic presentations, and two keynote speaker presentations, along with the key messages emerging from each, are summarized below.

Session/Presentation	Key Messages
Keynote Presentation	• NOAA's commitment and leadership in the weather, water and climate enterprise will continue with evolution into new approaches for provision of data and services • Announcement of NOAA Big Data Project with 5 key partners https://data-alliance.noaa.gov/
Panel 1: Theme Session	• The public, private and academic sectors are all renewing their focus on data and services for decision support • Development and distribution of tools for discovering and exploiting data are just as important as the data themselves
Panel 2: Hospital Preparedness	• Resiliency to weather and climate events, and their impacts on infrastructure, power, water and sewage, is more critical than ever • Activities are underway and must continue to evaluate vulnerabilities and mitigate their impacts
Panel 3: Marine Transportation	• As sea levels change and traffic increases, technologies for delivering current and accurate weather data are becoming increasingly important • Small changes in water depth or vessel motion as a function of heading can have profound economic impacts
Special Topic: NOAA Satellites, Present and Future	• Commercial approaches to weather satellites and the associated mission data will be an integral part of the future for NOAA • One of the bigger challenges moving forward will be ensuring continued consistency and quality in weather data as roles and responsibilities shift between sectors

Dinner Keynote	• The unique importance of weather and climate impacts to different regions of the country lead to a bipartisan recognition of the need for improving services • Three major challenges moving forward (please see the detailed notes for elaboration on each): get both bigger and smaller; enhance the NOAA enterprise; solve the puzzle of forecasting data being priced and free at the same time
Panel 4: Congressional Staffers	• The weather, water and climate enterprise must continue to communicate scientific basis and needs to the Hill, especially with regard to the recent political dialogue on Earth Sciences • New weather bills are under consideration to help advance the enterprise and provide NOAA with both guidance and means to success
Special Topic: Expert Witness Training Academy	• The William Mitchell College of Law runs this immersive program training scientists on how to testify in court and engage in other forms of debate • These skills are increasingly important given the topics of dialogue within and outside our enterprise today
Panel 5: Rail and Trucking	• The broader community must learn from successes of privately owned railroads in quicker return to service after severe events • Consolidation, standardization and automation of tools are key for enabling the more efficient and consistent use of weather data to guide decisions
Panel 6: Water Resources	• Monitoring and management of water supplies is highly dependent on weather and climate forecasts • Different types of events drive decisions in different regions of the country, but all share the need for more effective data assimilation
Special Topic: Information Needs for Water-Related Extremes	• A case study was presented regarding water rights as negotiated between states (Colorado, New Mexico, Texas and the Rio Grande Compact) • Changing user needs and weather/climate patterns have driven this discussion into the courts for attempted resolution
Panel 7: Climate Resiliency	• The President's Climate Action Plan drives engagement and policy activating all three sectors to build tools for science and communication, which support end users in local government • The Climate Data Initiative supports these goals with emphasis on mitigation, adaptation, and international implications • Engagement of the insurance industry is a game-changer
Panel 8: Federal Agency Leads	• Common themes emerge across NOAA, NSF, DoE and NASA, including the need for interdisciplinary approaches, and increased societal urgency flowing into increased agency responsibility • Data sharing and proper allocation of weather/climate time scales across multiple agencies are key to ensuring resiliency in the future
Student Presentations	• Student representatives from all three participating universities (University of Maryland, Millersville University, and Howard University) provided examples of their work in our enterprise • The future is bright for these emerging leaders, and their engagement in events such as the Washington Forum will allow them to build on the work of the generations that preceded them

Keynote (Secretary of Commerce Penny Pritzker)

This year's keynote presentation was given by Secretary of Commerce Penny Pritzker; this provided an inspiring and thoughtful beginning to the events that followed over the next three days. The highlight of the Secretary's remarks was the announcement of NOAA's Big Data Project.

Keynote Text

Meteorologists affect and safe lives every day. Two weeks prior to the forum we saw the life-saving power of technology in Illinois, when a powerful tornado struck; warnings from the NWS gave people 27 minutes to react, and all families in Rochelle survived. Today, the average tornado warning time has tripled and our accuracy has doubled. Accurate data, forecast and warning communications, delivered effectively through many channels, save lives. We are focused on continuing to build a more weather ready nation.

The Department of Commerce is about trade and investment, innovation, environment, operational excellence and data. Data is the main topic for today. The Department of Commerce is in many ways a data agency. This reaches from the oceans, to the sun, to population statistics and more. Data are not only used to save life and property, but to release more information to protect communities and economic growth. Weather data, in particular, is a multibillion-dollar industry.

The public has ready access to just 10% of NOAA's data released daily. This NOAA information should all be treated as public accessible goods. Data can't serve the public good if it is not accessible. We need to make these data more available. The demand for this information has never been greater. Our climate is changing and the weather is becoming more dangerous. These weather events are damaging our economy. The economic impact of weather and climate events is enormous. In 2013 insured damage exceeded 10 billion dollars for the 6th year in a row. We have to do more to mitigate these effects. This includes continue to build a weather ready nation, more resilient, less vulnerable.

Our service delivery model has not changed since the 1990s, in terms of how we disseminate messages through NWS. NWS needs to evolve into a nimble, innovative agency that reflects the 21st century. We have three central goals that will improve the delivery of weather messages:

1. We must increase levels of support services and communication with customers
2. We need consistency of our products and services so everyone can integrate
3. We must increase the speed of how the NWS can obtain this information

Solutions to this effect include upgrading models as well as the disseminating information systems. Government at the federal, state and local levels need to be involved before, during and after events. NOAA and NWS are not built to create these innovative service and products. Evolution empowers us to transform our information into the great next start up. This is why NOAA is working with the private sector to make this information public.

Toward that end, NOAA is announcing its Big Data Project, a historic data alliance with five major partners: Amazon, Google, IBM, Microsoft and the Open Cloud Consortium. This initiative will lead to open platforms for private individuals and academia to access NOAA's broad range of data. For the first time, this will give the general public an opportunity to mine NOAA data. This will create innovation, discovery, and entrepreneurs, to in turn create new projects. The NOAA Big Data Project website is data.alliance.noaa.gov. With this alliance, the NWS will continue to work with all of us to improve our effectiveness, and America will continue to become a more weather ready nation.

Theme Session

This session began by noting the relevance of this week in environmental history, including Earth Day and the anniversary of the Deepwater Horizon oil spill in the Gulf of Mexico in 2010. The panel was formulated to look at user needs across the public, private and academic realms.

We began with an overview of a new program at Millersville University - the Master of Science in Integrated Science Applications (MSISA) - and its efforts to develop a cadre of graduates with a robust science background together with an understanding of business and applied uses of science and technology. The new program educates students who will be in the nexus of decision support in the future - soundly employing multidisciplinary techniques and perspectives. These students will be the connection between science and the "real world", to make economic and policy decisions. The MSISA program was begun in 2012; it is a multi-disciplinary program with a core curriculum of business, statistics, economics, policy, math, and experience/internship aspects.

For the public sector, we began with the recent consolidation of the National Climatic Data Center (NCDC) into the National Centers for Environmental Information (NCEI). The role of the federal government was described as:

- Facilitate and build a prosperous society
- Expand commerce and industry
- Mitigate threats

Weather, water and climate threats are abundant and likely increasing; it is in the government's interest to increase the amount of stakeholders using government data. Economic theory (Adam Smith's invisible hand) suggests there needs to be more data given to the public, so they are more informed to make better decisions. But this has not always been the focus in the federal government; many intelligent people are building services, but the mentality has often been "build it and they will come." There is a need for a shift in focus, listening to public needs and then churning those new ideas into innovations to keep up with their needs. It is important to first engage with users about their needs and then work to develop sound requirements based on those needs.

NCEI, and specifically its Center for Weather and Climate (CWC), is moving toward a demand side model -- a use-inspired paradigm -- where products and services are maximized for non-scientists. This model requires constant listening to what the public

needs. It involves getting staff and partners out into field -- making them interpreters -- to be able to translate the need into what is realistic for NCEI to do, while having an understanding of government limitations and resource constraints. In this time of flat or declining budgets - we need to eliminate the obsolete - whenever a private sector entity says "we can do this" – we must be happy to hand off. But we need to communicate regularly with stakeholders about such shifts.

People don't want to download big files. Apps are preferable. The most frequently requested characteristics of data are averages, differences, unusualness, trends and impacts - not raw data. Most users want it processed in a way so it is usable for a non-scientific audience.

There are some key questions with data latency. Users need information products with the characteristics noted above quickly. But by providing them quickly, accuracy and quality control can be sacrificed. It is a challenge to find a balance between the need for complete accuracy and distributing information quickly.

The discussion then transitioned to the private sector, where there is a new focus on developing technologies for applied decision support. They are investing in the creation of prototype technology tools in this area.

For example, SAIC is developing an app that would help first responders identify where elderly people may be in need when the power is out. The app uses data from Census and NCEI (formerly NCDC) as well as from METAR, radars and Twitter to get information about where elderly people live and the likelihood of power outages. A map was shown, which was developed from a case study in Texas, using colors to indicate where elderly residents live and the probability of power outage in the midst of a severe weather event. The map on the app updated over time based on changing conditions based on information inputs.

Tools like these are powerful and getting better, and this app only took 2-3 people to put together over about 3 weeks - which is not a huge investment - building it off an Amazon web services backbone. They also have a number of ideas to improve and grow the data that could be inputted to enhance this app - such as data feeds from utilities as well as including real time weather forecasts.

Turning back to the public sector, NCAR has experience and a number of lessons learned related to engaging users - applying cutting edge technologies to address everyday problems across a range of sectors (water resources, homeland security, etc.). The lab is 90% soft funded from many different sources, which speaks to the interest in this area of technology development for decision support.

Many users are still not aware of the range of information that is possible to extract from a weather forecast - a misconception is that the only available info is provided on your television news weather report. Lots of users are happy with "we have always done this in this way" - but they are not aware of potential and what the "art of the possible" is. It is important to build a relationship of trust with users - learn their daily problems and learn their culture - to be able to effectively brainstorm solutions. Sometimes user innovations come from the grassroots and others come from the top --- important to be sensitive to whether a new solution will be seen as a threat or an opportunity. Understand your end users and their level of technical and scientific sophistication.

Evolutionary Development approach - means the end user drives the process - but this automatically means it will take an extended period of time - takes longer, but it means end users actually get what they ask for and get to help design it.

Questions to ask to better understand needs of end users:

• Will the opportunity be taken as a threat? Might emergency managers lose their job?

• Who are the stakeholders willing to work with you?

• It's important to analyze what the anticipated benefits fall under. Economic? Social?

Q&A Session:

Q: How do we reconcile the question of trust - the usefulness and usability of weather/water/climate information to a decision maker versus the accuracy of weather/water/climate information to the scientific community?

A: It is important to listen to users, then provide options - the "art of possible" discussion. Don't need to make promises quickly - dialogue is extended and important. Ex: pilots asking for a lot of raw data - all to get to info about inflight icing - so NCAR said - why don't we give you information on inflight icing directly?

A: It is not just a requirements process - it is an iterative process.

A: Lots of listening and feedback are required ---- agile processes matter

A: Listening to users matters - but those who listen must have the multidisciplinary skills to be able to work effectively with a range of different stakeholders.

Q: Institutional vs individual decisions - how do we provide decision support tools for both?

A: more mention of web graphics

A: BBC changed its icons based on lots of research, but people revolted, they were accustomed to the old ones.

A: Do not have engineers design icons

A: Noted climate data initiative --- also said govt seeks to partner with industry, etc to touch individuals more comprehensively

A: Noted the new icons that are being tested and released by NWS based on social science research

Q: How do we get to a single access portal for info from NCEI (especially for climate and weather)?

A: This is a challenging task. It is hard to build infrastructure for some very disparate data going back to Civil War - some of the giants in industry may be better able to do this than govt - and they will be more flexible. The announcement by the Secretary of Commerce earlier today is certainly relevant to this.

Q: Engineers vs. meteorologists—how do you see the future of weather going to reach higher standard for users?

A: We see changes in education, separating facts from trends. We see ourselves becoming more engineer-like. Students are connecting with staff meteorologists for winter-weather road staff, contractual work for wineries, nocturnal inversions, etc. This used to be what engineers did, and we're picking up on this. This is a lot broader, but more fun. Students are graduating and getting jobs with starting salaries comparable to engineers.

A: We're physicists, engineers, scientists, mathematicians. We all want to advance. We should become multi-disciplinary to be competitive, especially in weather community. This starts at academic level. Meteorologists team with engineers, social scientists, etc. We can understand the problems of engineers and give them data on environment. We need to bring disciplines together.

Q: We are facing large levels of uncertainty in this community. Data is available, but where does the uncertainty lie? TV stations don't express uncertainty often. What do you think the future looks like for probabilistic modeling?

A: End users need calibrated probabilities. Make sure your confidence level is true for end user.

A: Nothing I hate more than people saying I am wrong when I did okay. I started giving percentages for probabilities in my TV forecasts and received better feedback from viewers.

A: Twenty years ago, I was part of MODIS program, developing a product for probability. Hardly anybody used it. Conflicting outcomes in publications. When are you look at QA info? We don't ask data people for uncertainty, but set models to what works best for us. There is a big problem in communicating probability to public.

A: Trying to instill importance of uncertainty to students. It is crucial to know how to handle quantitative uncertainties and give confidence levels.

Hospital Preparedness

The moderator began by focusing on the importance of incorporating the weather enterprise into building hospital resilience to environmental impacts. The government alone cannot effectively handle these impacts alone and require the support of the public, private, and academia sectors. NWS has the ability to partner with the federal government and the public in creating dialog on hospital preparedness.

In order to achieve resilience there is the need to identify the support requirements and solidify the enterprise commitment. The support from the weather enterprise is vital. Consultants can provide crucial information on preparedness and help integrate climate data into facility-specific recommended actions.

Objectives for the session were the following:

- To inform the Enterprise (scientific researchers) on hospital resilience
- To increase communication between research community and hospital community about hospital resilience
- To discuss the key challenges hospital resiliency/preparedness
- To discuss how we can best leverage Enterprise assets

History of Events (2001 – 2014): The moderator briefly discussed a history of natural disasters and the cost of damages as well as the legislation that has been passed throughout the years to help deal with emergency weather preparedness and weather/climate change issues

1. 2001- Hurricane $2 billion and 9/11 US patriot act and bioterrorism act
2. 2004- Hurricane Ivan $38 million
3. 2005-Hurricane Katrina $1.32 billion
4. 2008-increased events occurred since this year
5. 2013- President's action plan
6. 2014-White house forum

The moderator concluded by emphasizing the importance of hospital resiliency and the much needed support from all areas of research and legislation to solve this issue in the future. To set the vision, refer to a policy doctrine Fourth Geneva convention, Article 18, 1949 (ratified by the US in 1955). We are natural parties to help protect people, bridging the gap between research and politicians.

*Important Note: Hospitals are the 3rd largest utilizers of energy in the US.

The first panelist described how NWS is approaching this topic. To begin, NWS can provide a wealth of information and tools. Climate data, analysis tools, forecasts, and outlooks can be accessed in order to effectively manage potential risks. In the short-term, forecasts and warnings allow emergency managers to reduce response times. Education and continued outreach can transcend public safety information across communities. However, NWS cannot provide specialized consulting services to every hospital in the U.S, nor translate their forecasts into specific actions for a hospital to undertake. There is a capacity issue and the NWS cannot be the sole provider in weather and climate expertise. Hospital resilience relies on incorporating all levels of governance including the federal level and transparent communication of essential information.

NWS needs to understand the requirements. We need an enterprise commitment to various tasks, figuring out roles and responsibilities, continuing the dialogue with the enterprise to coordinate efforts. The approach begins with conducting Federal level interactions. State and local EM can get federal government provided warnings/forecasts communicated to hospitals. There needs to be more education on available data and tools. NWS can help ensure that current foundational datasets meet health sector needs. Toward this end, NWS recently participated in the National Public Health Week, at which there were 12 executive actions, 14 private sector commitments, 35 deans of schools, a presidential roundtable, and workshops. The speaker emphasized this was one of the first times the clinical health care systems came together with the public healthcare system to share environmental data.

We next discussed the Climate Data Initiative, which features data from NOAA, NASA, the U.S. Geological Survey, the Department of Defense, and other Federal agencies being featured on climate.data.gov, a new section within data.gov. NOAA and NASA will also be announcing an innovation challenge calling on researchers and developers to create data-driven simulations to help plan for the future and to educate

the public about the vulnerability of their own communities to sea level rise and flood events.

The US climate resilience tool kit, which can also be found on the climate.data.gov website is a website (toolkit.climate.gov) developed by the National Oceanic and Atmospheric Administration (NOAA) and other Federal agencies to enable decision-makers to take action to boost their climate resilience using data-driven tools, information, and subject-matter expertise to make smarter decisions. The Toolkit offers information from across the federal government in one easy-to-use location so that Americans are better able to understand the climate-related risks and opportunities impacting their communities and take steps to improve their resilience. All can use the online tool kit and it can be applied to their respective facilities. Also there are case studies that can be used as example and applied to the checklist on the website.

There are five major elements used for the tool kit:

1. Climate risk and communities
2. Looking at the existing facilities and have the codes up to date
3. Infrastructure
4. Protecting essential clinical services for staff, staff's family, physicians, etc.
5. Water sustainability and how water is used on one's campus (hospital or lab facility) and how it is used in the surrounding community.

Also on the website, one is able to click on each one of the elements and be taken to a more detailed page that includes various case studies about climate change and data from other resources. The entire checklist is hyperlinked to the website external sources. Lastly showing a timeline of the climate action plan summed up the presentation and the speaker stated they are in the end phases of the plan, which is now at the point of dissemination of information and get/receive more information from the private sectors about weather and climate data.

A panelist from the private sector then discussed a recent resiliency study. Partners Healthcare contains 33 hospitals located throughout the United States as well as several research labs and supporting infrastructure. Due to the severe damage from Hurricane Sandy, the CEO of Partners Healthcare added climate change to its list of scenarios that impact its future. It has taken a couple of years to figure out the climate issue and to find the best consultant to help the hospitals figure how to properly prepare for natural disasters.

There have been over 40 counties that have been declared disaster zones in New York, Connecticut, and New Jersey. Hospitals are a magnet during natural disasters not only because of injuries, but they are viewed as safe havens for many, which is why hospital resiliency is so important. Partners Healthcare is paying consultants $500,000 to assess current vulnerabilities in their hospitals and research facilities, and their supporting supply chain of electrical infrastructure, water and sewer, and transportation systems so that they can plan for future resilience to all hazards. The consultants will model scenarios for future climate between 2015-2045 (aka "2030") for near term improvements in operations and sustainability as well as 2055 – 2085 (aka "2070") for long-term capital infrastructure designs and practices. Then resilience actions will be

proposed, 2030 actions to be taken are consistent with the climate resiliency toolkit. The plan is as follows (and shown in Figure 1 below):

- Step 1- Collect substantial and accurate information about the temperature, precipitation, extreme events, and sea level of the surrounding areas.
- Step 2- Conduct site-specific modeling: Chose the facilities for focus and assessing the impact upon their key operations, internal support services, key vulnerabilities, and any external system resources necessary for operations. Model over 2 Timelines: 2030, operations focus, and 2070, capital investment focus, for new infrastructure planning.
- Step 3. Address hazards, implement mitigation strategies, and prepare. Promote continuity of business via continuity insurance. However, continuity insurance for hospitals is very expensive, so they need to know what is needed to avoid overpaying.

Questions that need to answered for this plan to be completed properly:

- What baseline climate data will be available in support of resiliency studies?
- How will Partners Healthcare know if the climate simulations by the hospital's consultants are reasonable and likely to occur? What assumptions should they use? How can they validate the simulations and results?

The cost of the site-specific climate modeling is a significant problem and it is also 50% of the study's cost.

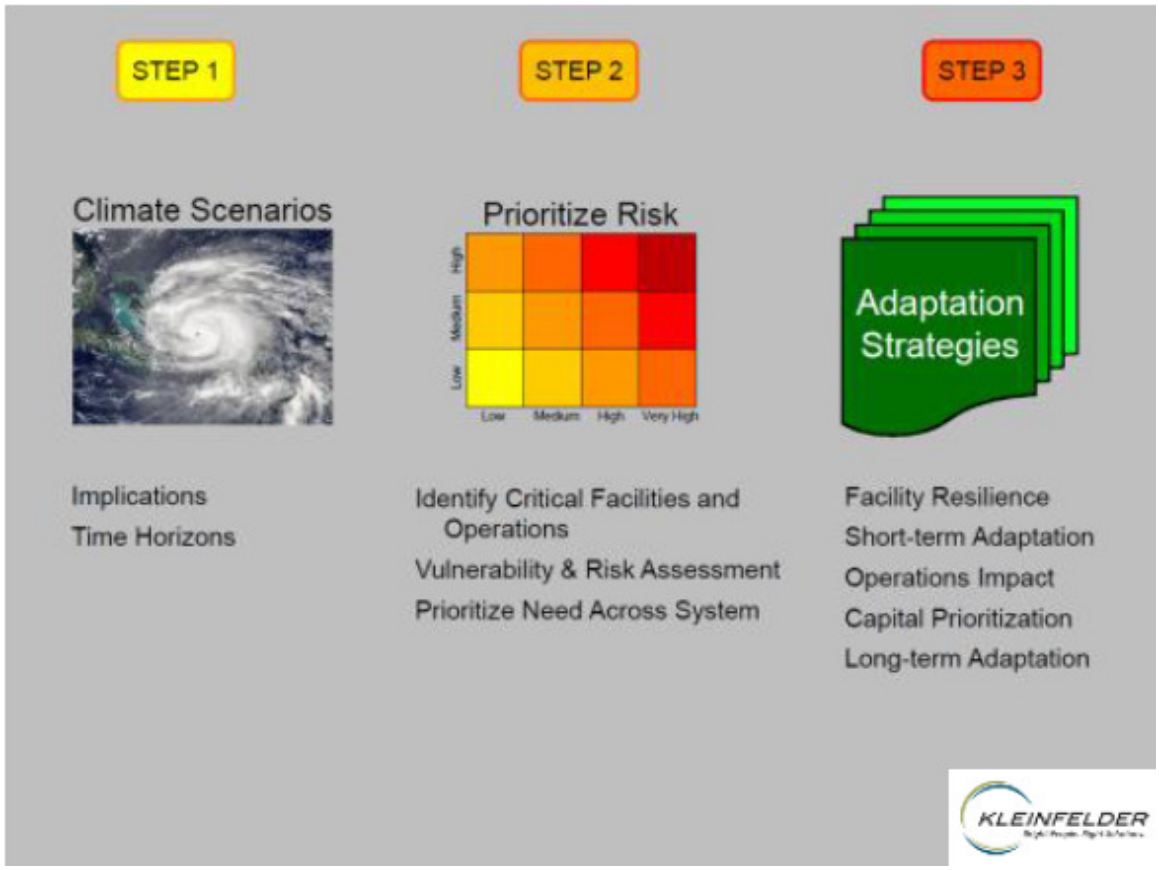

Figure 1. Methodologies for identifying issues and effecting resolutions in hospital resiliency.

A second private sector speaker said the focus of his business is serving the current needs of hospitals from now through the next 1-2yrs. Hospitals can be impacted directly by weather events. With hospitals themselves providing a service to the community, it is a double impact/disaster when the hospital is destroyed. The speaker pointed to the book: "The thinking person's guide to climate change". He said the book discusses a "vigorous debate in climate change", "Schism in the community", "no consensus on climate change". With this message from the book, how can an Emergency Manager trust the so-called disparate information on climate change? The solution is generally to rely on the National Weather Service for authoritative information.

The speaker believes storm-based warning/polygons are best way to get people to pay attention. He told a story of a fire marshal in a town saying tornado sirens shouldn't be in his community because he wants the public to use social media for their warnings. He then discussed building safety via updated building codes that will keep buildings standing when exposed to hazards. We need to stop building pretty buildings, because we need them to stay up. He next recounted a case where hospitals in Des Moines, Iowa are really close together, and in one case, are across the street from each other but across county lines. They are often in a straight line, which makes them at risk for simultaneous destruction with a single storm. Taking a look at the spatial distribution of these hospitals would be good to mitigate risk from a single weather event.

It costs only $166/yr for WeatherCall to do site specific forecasts for a group of hospitals (also the Moore, OK hospital), but due to the budget crunch, the Moore, OK hospital stopped paying for this service. The speaker mentioned the strength of the polygon warnings to help a hospital decide when to close. St John's hospital sustained fatalities and major building damage during a recent tornado outbreak. That hospital was just rebuilt and his company provided free service for 1 year. Safe buildings + effective plans + trained staff + mitigating actions = saved lives.

Q&A Session:

Q: How can we prove the fidelity of our data (calibrated probability) for use in this community?

A: This is much easier for weather than for climate. Getting climate models scaling down to the weather scale to be able to show trends in extreme events in the future is several years away. Starting data: climate can't be validated for years, but can use the historical data. Though probability information is useful, Partners HealthCare needs to prepare for the worst… Will there be more category 2/category 3 hurricanes in their area? They need to know the likelihood of a severe event in the future so that they know how what to prepare for.

An additional answer from the room said historical records are their best bet for right now, as the forecasting prowess isn't there.

Q: PartnerCare is at the leading edge of this type of study. The Federal government has some resources to help decision makers at state/local gov't level. This is not a very mature field yet. We need to find ways to mix federal and private sector resources aligned to specific problems so we can all learn from it. We need documented use cases. Setting up consortium at or with NC State to bring fed and private resources together. They are doing the right thing, but the commenter wishes that it can be done in a way to share with each other for learning experience.

A: There was a verbal agreement to share the data being generated by the Partners Healthcare study.

Comment: The private sector has their hands on lots of datasets that could be useful… would encourage discussions with NIH. There is a commitment from ESRI to host mapping tools. Further partnerships with private sector are welcome.

Comment: Hospitals are operating at different levels. When these plans are being developed, Emergency Managers have to reuse and leverage other plans. The speaker begs for sharing these data in central repository. There is already a unique relationship in 20 facilities in Boston region to collaborate on sustainability and green initiatives. Though they are competitors, they all collaborate on issues such as these.

Comment: You have everything available in Massachusetts, academia, gov't, private to collaborate to help everyone. Implores more data sharing in the community. The issues impact all. We might want to bridge an expanded consortium of more than hospitals in that area to include the universities and other municipal facilities.

Q: Within your sector, the US president is developing action plans, is your sector responsive to Presidential action plans or is it an event that really prompts change?

A: The weather event gives a better appreciation for the activities needed. It is really a confluence of many activities that gets their attention. The FEMA flood maps are being changed, hospitals are paying attention. It is of economic concern for health care in the country, so we need to look at the base causes of the diseases (dengue, lime, other migrated infectious diseases) and address mitigation concerns. There are quite a few physicians in his organization that said the younger generation (their children) are asking what the hospitals are doing to address climate change.

Comment: More physicians are thinking about the larger environment impacts on how and when they treat a patient. There was an example of physicians not wanting to start and stop a procedure when a weather event is coming. WeatherCall says their clients are thinking about it and making decisions based upon weather data.

Marine Transportation

This session offered some unique perspectives on how weather, water and climate impact marine industries and the associated transportation activities. Three panelists provided perspectives in this area.

The first panelist described a private sector perspective related to communications and tracking of both aircraft and marine transportation vehicles. Technologies from Iridium/Ku-band satellite communications were described, and plans for how these can be evolved into the future were also discussed. This infrastructure can be used to distribute weather products to remote users nearly anywhere on the globe. For marine forecasts, this would include wind, temperature, precipitation, storm tracks/intensity, surge, swells, currents, and other parameters of interest.

The second panelist provided a public sector perspective, with focus on NOAA's Physical Oceanographic Real-time System (PORTS), which enables safe, efficient maritime commerce. The value of real-time ocean and meteorological observations was restated, followed by a discussion of trends in the shipping industry – e.g., ships are getting larger and waterways more congested, leading to a reduction in the margin for error. NOAA's PORTS combines data from multiple collection sources and makes them available via satellite broadcast to seaports and users at sea. This has led directly to reductions in accidents at seaports served by PORTS. The economic impacts of changing water levels in ports are enormous – in one example provided (as shown in Figure 2 below), one inch of additional draft can affect millions of dollars of sales.

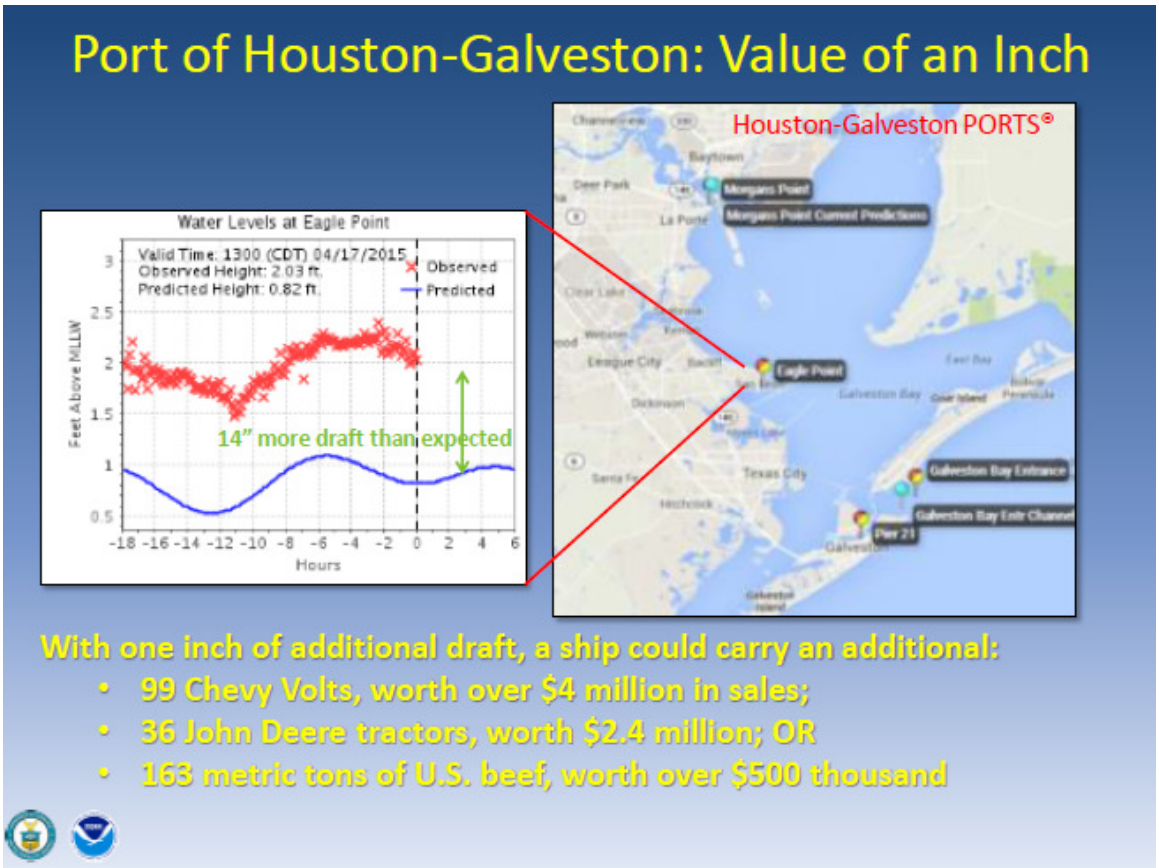

Figure 2. Economic impacts of changing water levels in seaports.

The third panelist provided an international perspective (specifically from New Zealand) on marine weather and decision making. The key parameter in the decision making process is the perception of safety, which can be best presented as risk. The uncertainty in forecasting therefore ties directly to risk as part of the decision making process. Examples of forecasting complex things were provided, e.g., vessel motion (heave/roll/pitch as a function of heading, as shown in Figure 3 below). The panelist also discussed how complex forecast activities can be synthesized into something simple for the users, e.g., naval operations or harbor transits. The takeaway message was to ensure we don't limit the available data for decision makers, and tools are an integral part of that.

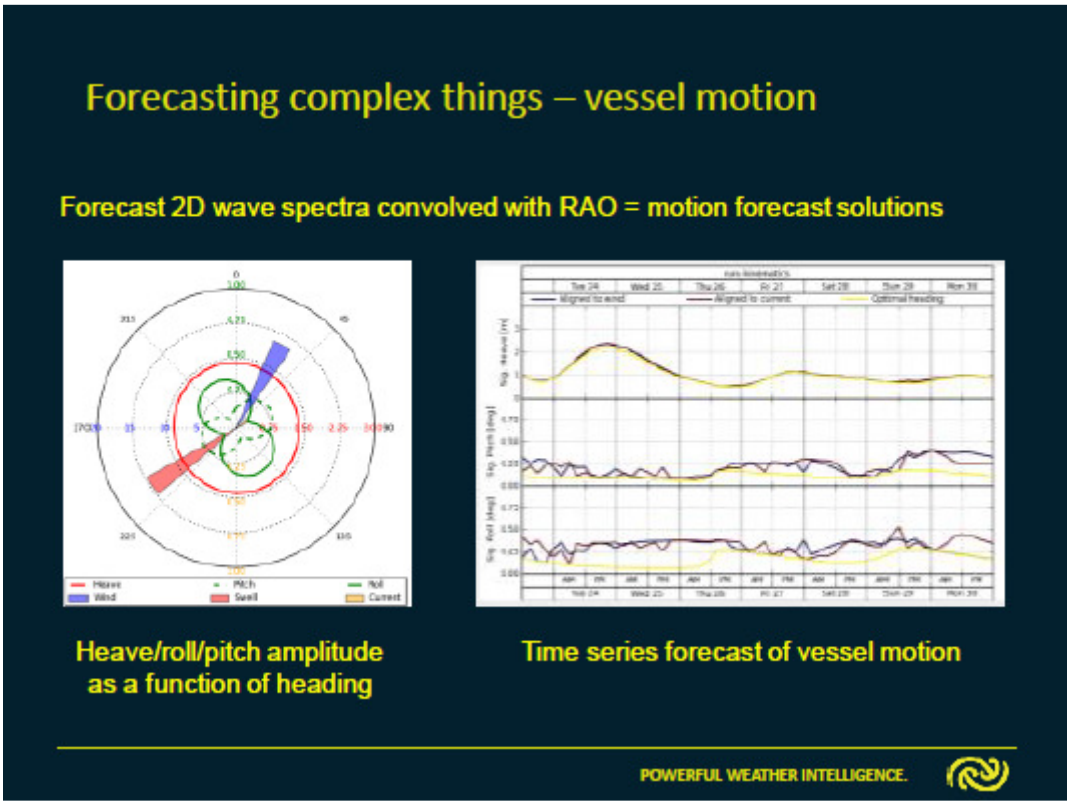

Figure 3. Forecasting vessel motion.

NOAA Satellite Earth and Observation Information: Present& Future

The basic premise of the presentation revolved around the concept of what we have now with earth and observation information and to accurately attain what we need for future data collection. The ideas and visions support NOAAs top 4 mission priorities. The NESDIS mission is geared toward the delivery of accurate, timely, and reliable measurements and to have "2 orbits, one mission", meaning all of the space resources are targeted toward a common goal. This includes future satellites including the POES JPSS 1 to 4 and GOES R to U which are planned until 2038. Currently in orbit

there are 3 satellites and 2 additional backups. The weather observation is interconnected with many other satellites from DOD, EUMETSAT, NASA, JAXA, and other inter-agency collaborations. This complex system has 5 satellites in low orbit with cooperative agreements with other earth observation systems. The 2016 NOAA budget request highlights completing the current set of satellites and includes to start space weather satellite retrieval including DSCOVR and Cosmic_2 sensors. These new satellites will improves NOAA and NASA operations. Current data flows from observation systems go to feed numerical weather models and also provide non-numerical weather products creating a enviromental intelligence in a much broader sense. Additionally, the White House Climate Data Initiative makes the climate data available for the end users to make decisions for adaptation and mitigation practices. Big Data Providers provide the users a working copy of the data, which broadens the capabilities and products of satellite data.

Future work on satellite systems will be broader by capitalizing on innovative technologies and approaches. These include the LEO Earth observing nano satellites and the GEO which includes hosted payload opportunities and possible alternative orbits. These are satellites we can build and possibly supply to meet data needs of the community. The issue then becomes what are the data rights between the data providers and the data users. Satellite capabilities of today allow opportunities for advancement in data acquisition to meet the needs of the weather enterprise community. In order to satisfy this request we need to address how we operate and integrate the commercial data into our operating paradigm (e.g., Figure 4 below). Unfortunately, there is no exact way to solve this. Data are a public good, therefore using data from different seamless sources produces a unique data acquisition but doesn't assure the reliability or quality of the information. If these data products are available from cubesats, hosted payloads, and small satellite network systems, how do we know their accuracy? This is a continuing ongoing discussion with NOAA and commercial policy stakeholders. The question still remains how to make our data products meet the needs of the community. NOAA's Commercial Space Policy will be released 2015.

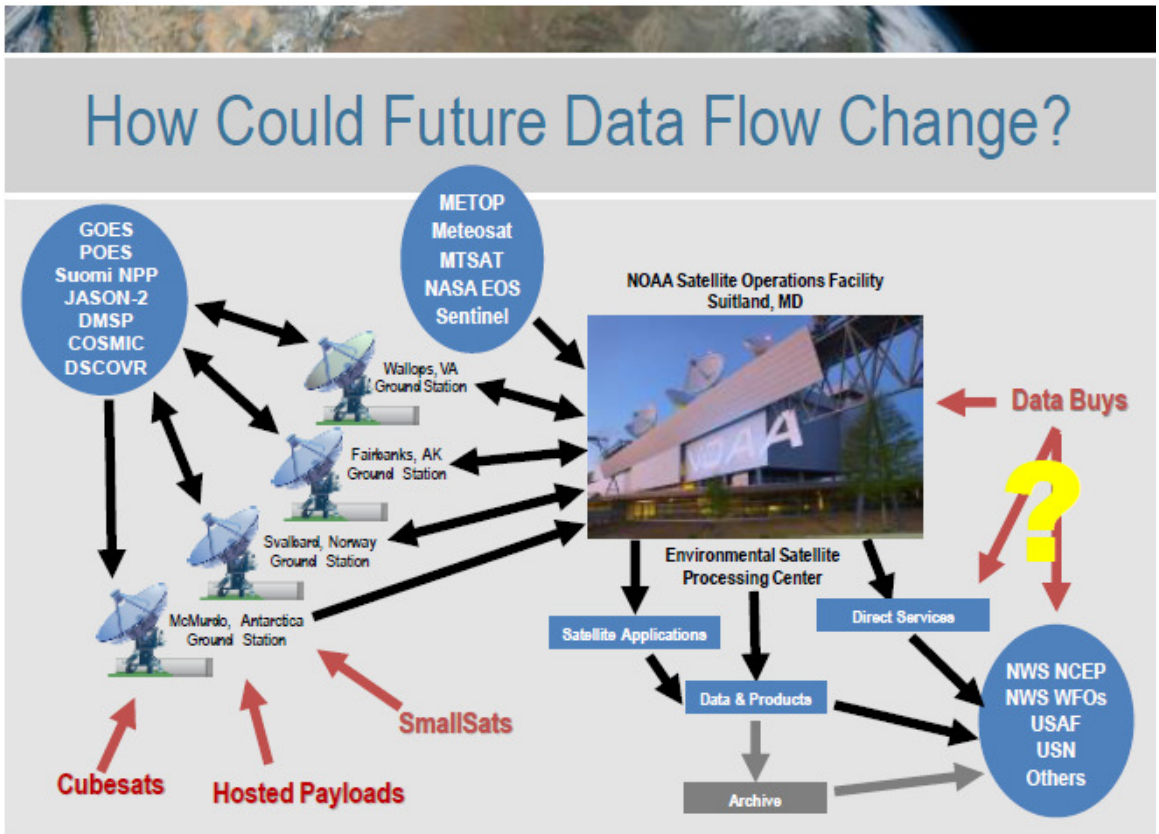

Figure 4. Potential future weather satellite data flows.

Q & A Session:

Q: There is a lot oftime between the conception tophase and the implementation phase. takes Are there any thoughts to compress this time period for satellites?

A: Being able to take different types of measurements rather than one set takes a long time for the evolution of the software and the evolution of the satellite products. Optimizing the use of the data immediately is a goal of the Joint Center for Satellite Data Acquisition. It deciphers changes to software to optimize the measurement types and kinds that can be used in model output.

The transition to the National Center for Environmenal Information (NCEI) was made to secure and make more efficient the function, modelling, and output of data. The change is stressful as it evolves to the reorganization. NCEI and the NOAA Big Data Partnership will be complimentary to each other.

Working with customers to identify data products to the end-users is critical for its success. The issue is to determine what is the best way to make the data available to the end-users. Community engagement has made this valuable to increase knowledge on their needs to make it more efficient. Data efficiency and transparency is the key to the evolution of the satellite system and its efficiency and cost effectiveness.

Dinner Address (Congresswoman Suzanne Bonamici) – Transcript

Thank you for inviting me to address the American Meteorological Society, and thank you for that kind introduction. It's great to be here at the AAAS, which is under the capable leadership of my former colleague, Dr. Rush Holt.

As a Representative from Oregon, I know a lot about the weather. We have our own specialized understanding of weather - particularly sophisticated in our appreciation of precipitation forecasts.

For example, we understand what "rain, changing to showers" actually means. A "constant drizzle followed by intermittent drizzle." We also plan our days around forecasts for "rain with sun breaks." And Portlanders know that the simple phrase, "the mountain will be out" means sunshine is ahead with a clear view of Mt. Hood.

Seriously, in the district I represent- which is very diverse and contains areas that are urban, suburban, rural, and coastal - I see the direct interaction of oceans and atmosphere, and how it affects fisheries, viniculture, hazelnut and berry harvests, outdoor recreation, and more.

I bring this connection with nature, and the way Oregonians have responded to the possibilities inherent in the earth, sea and sky, to my work on the House Committee on Science, Space, and Technology.

As Ranking Member on the Environment Subcommittee, I have been working with Republican friends from Oklahoma--Mr. Bridenstine and Mr. Lucas--for about two years to produce a bill that would help restructure and improve the way NOAA does its weather research.

Last month, the Committee unanimously approved H.R. 1561, The National Weather Research and Forecast Innovation Act of 2015, and I expect that the bill will come to the floor for a vote any day now.

I am going to say a little more about the substance of that bill in a moment, but let me point out that the work the Committee does on weather is, unfortunately, one of the few, of what I hope will be more, bipartisan efforts to pass legislation. Weather is not a partisan issue - it affects all our constituents in different ways.

My colleagues from Oklahoma share harrowing stories of destruction by tornadoes, people in Wyoming just saw a major mid-April snowstorm that closed down I-80, Californians struggle with serious drought, and the southeast has had a series of severe wind and hail.

And although we experience weather differently in our regions, we have found some agreement about how to move forward.

The topic of this year's forum is "Applied Decision Support: Meeting User Needs." I want to suggest three ways where we can make progress as we approach the environmental challenges of the 21st century:

Three challenges:

First, we have to get both bigger and smaller.

Second, we have to enhance the NOAA enterprise.

Third, we have to solve the puzzle of forecasting data both being priced and free at the same time. Let me elaborate.

The first challenge that arose during our work on the weather bill is that forecasting skill has to get both bigger and smaller - meaning we have to expand the temporal and geographic reach of forecasting, while also providing more accurate and localized information. This is very much about meeting the needs of our constituents.

It's time to push beyond the 10 to 14 day weather forecast barrier to provide greater precision and insight into inter-seasonal processes and regional trends. From fishers to farmers to transportation - industries are making multi-billion dollar bets on seasonal trends.

Reducing the uncertainty around the inherent risks in their decisions would not only benefit those businesses directly, but have a ripple effect throughout the whole American economy, to tourism, technology, and countless others.

We also need to get smaller, giving individuals and businesses the most accurate, localized weather forecasting information possible. A truck driver traveling through mountains in the western part of my district should have access to targeted and specific forecast information so he or she can decide whether to push on or take a break.

The development of ever more precise and personalized forecasting products will enhance public safety both for our truckers and the cars and families they share the road with, as well as increase economic efficiency with fewer unexpected weather delays.

These changes are already underway, but I remain concerned that the continuing divisive debate about climate change often stands in our way when we try to make progress on these issues.

I know that AMS and your members have been drawn into this debate in different ways on many occasions.

Let me be clear; I accept the scientific consensus regarding anthropogenic climate change. There is ample room for debate about the way climate change will unfold and what we can do to improve our understanding of how global processes work, but the core consensus is real.

Skepticism is fine, it can inform knowledgeable debates, but when all the leading scholars agree on something as significant as the fact that our planet is on a warming path that will disrupt our society and ecosystems, we need to take steps to avoid, mitigate, and adapt to what is coming.

Even if we conclude that this may represent a low-probability, high-risk event, a failure to anticipate how to deal with it is unacceptable. I bring this up because efforts to discredit this consensus and cast doubt on climate change may lead to decisions by legislators that will inhibit the ability of agencies and researchers to work on ocean-atmosphere questions simply because they are arbitrarily defined as “climate.”

If we stop funding research in that area simply because of its classification as "climate," it can have significant unanticipated consequences on our understanding of weather, in addition to the longer temporal forecast products that the market would support.

The second challenge I mentioned is to enhance the NOAA enterprise. Our weather forecasting bill, HR 1561, can be interpreted as a part of this movement. The bill is full of

opportunities to better connect the forecasting skill needs at the National Weather Service (NWS) with the research initiatives of the Office of Atmospheric Research (OAR.)

The bill has several small pieces that aim to tie NWS and OAR more closely together at the working forecasting/scientist level, as well as connect academic researchers with NWS.

We want to build on the model that has proven to be effective by our colleagues in the Armed Services, who work closely with their research entities to improve their ability to carry out missions.

In the Defense world, the war fighters spend time at the labs, or the scientists go into the field with the war fighters. This improves the ability of researchers to accurately identify mission-critical problems and focus their work on solutions that can be carried out in the real world.

Research initiatives that lack war fighter buy-in do not continue out of the research phase and into prototyping and applications. This model, tightly winding the mission side with the research side, brings cost-effective benefits, and NOAA could benefit from adopting a similar approach.

We spent a lot of time working on H.R. 1561 to make sure it is sound policy, and I will encourage NOAA to begin adopting some of its proposals even before they become law. Of course, NOAA is full of experts who are already working hard to keep our nation at the forefront, and some changes in the relationship between NWS and OAR are already emerging.

I also want to mention that the lack of resources dedicated to NOAA's Satellite and Information Service - or NESDIS - is also something that the Science Committee must commit to addressing.

There have been indications that NESDIS understands that the days of big satellites are gone. We have spent a decade fighting for resources sufficient to finish the Joint Polar Satellite System (JPSS) while searching for the causes of that financially disastrous acquisition.

The lesson for Members of Congress is easy: we do not want to repeat past mistakes.

The technology for building and launching satellites is almost unrecognizable from what it was when JPSS was conceived in the mid-1990s. NESDIS can go smaller, quicker, and cheaper in launching instruments and replacing ailing or inefficient satellites by rethinking what they do.

There may be other options of relying on private providers and non-traditional sources of data that NESDIS can also explore. HR 1561 does a lot to move NOAA toward private sector sourcing of weather data.

To go bigger and smaller, and to support public safety and emerging commercial opportunities, we need to support some transformation at NOAA.

I am confident that they see the potential in doing so and are responding. H.R. 1561 is designed to spur positive change along these lines.

So now the final challenge: pricing free data.

What I mean by this is that we have seen how public weather data can be taken by firms and turned into forecast products that have a market value. From taking the form

of broad public forecasts in the media market like a Weather Channel, or boutique forecasts to meet very specific weather needs in the business world, the result has been the rise of a multi-billion dollar industry. Free data is the root of this industry.

We are at the cusp of a second revolution in commercial weather opportunities. The first revolution was in the "output" of forecast products. This next revolution will be in how we gather raw observational data in new ways.

There are several firms that are ready to respond to a government request for bids to provide satellite-based instrument data.

If the U.S. government begins acquiring forecast-significant data from private satellite providers, it would be a first.

There are several questions about how to do this, but in my mind the hardest problem is how to price the data so NOAA can purchase it, but still release it for free.

This second revolution demands that the government pay for data. For the companies in this space, that data would be their product--which they might want to sell to others in addition to the government.

Establishing a cost for the data that is now free, however, may well strangle the commercial forecasting side of the weather enterprise and that is a consequence I cannot support. We have to find a way to both places a fair value on the data that the government would buy while also ensuring that forecasting data remains free to all.

Not an easy question to answer – but a critical problem we all must address.

Again, H.R. 1561, once passed, will facilitate the enhancement at NOAA, but the other two challenges are largely untouched by the legislation. At present I am working to draft legislation that would begin to focus on meeting the first challenge of going big and small.

NWS has already begun an effort to identify key economic sectors that are particularly vulnerable to weather variability and to isolate key data that could be used to enhance forecasting products to meet the needs of those sectors. I would like to see NWS do more in collecting appropriate data and then making that available to the secondary forecast market to use in meeting customer needs.

We can envision a world where all the data sensors – road, aircraft, satellite, buoys – are collecting information about weather conditions are integrated.

My Subcommittee Chairman, Mr. Bridenstine, is interested in legislating along these lines as well, and I hope that we can make a constructive contribution to meeting this challenge. I look forward to hearing from your members on how we can meet these goals.

I would also ask members of the AMS to share your ideas on solving the third challenge of identifying a solution to how to both pay for data and give it away.

This is a serious invitation for your help. Legislation doesn't always blaze new trails; rather the best legislation builds on the ideas and advice of experts in the field. H.R. 1561 was constructed from a combination of insights from members and hearings, but also from the long string of National Academy of Sciences reports, and expert advice from several industry representatives and meteorologists.

The next bill will build from NWS's existing program and, again, the advice from experts. Solving the data puzzle is likely to be tackled in the same way, and it's

important that we engage stakeholders early in the process so we can develop good policy that is widely supported and that enacts the changes we need to advance our shared goals.

Thank you, again, for the invitation to speak with you tonight. I hope you have a successful conference and look forward to our continued collaboration.

Congressional Staffers

Moderator: Both of you are scientists. How does this training affect the job? Does it make it easier or harder?

Staffer 1: Makes it easier to understand the stakeholder presentations given to them. This makes us more able to convey the meaning of what is being said in these briefings to the members of Congress.

Staffer 2: Ecosystem framework background is an advantage. A systems integrated approach is the most effective. It is an advantage to have a science background about problem solving. Ask a question, get an answer. It's fun. Staffers get to talk to people with very broad perspectives, and process different solutions and ideas.

Moderator: A month ago, the House Science Committee passed the Weather Improvement Act with bi-partisan support. It is a victory when bipartisan support happens on issued like this. What is in the Bill?

Staffer 1: The Bill is able to fix a numerous compounding issues over the years (satellites, NWS, etc), e.g., from the NAS Second to None report. The bill tackles how to improve forecasting and the relationship between OAR and NWS. It supports continual upgrades to systems and capabilities. There are portions related to technology transfer between OAR and NWS. It strengthens existing capabilities.

Staffer 2: Why is this piece of legislation bipartisan? Weather affects everyone and the members care about the weather. It influences everything. Congresswoman Bonamici has been a strong partner, and she wants to restore US leadership in weather. We need robust forecasting apparatus in place and to break down these silos we perceive (OAR and NWS silos, NOAA broadly and weather community). There are provisions try to increase the pace of how research is translated into operations. Because of importance of weather in everyone's lives, it is an easy issue to come together on.

Moderator: What is the most important provision in the Bill?

Staffer 1: Codify transfer of OAR research into NWS. The Pilot Project on commercial weather data procurement, beta testing, etc.

Staffer 2: can't pick out one provision that is most important. The whole thing sends out the message that weather forecasting is important. We need to increase support for this enterprise. It poses a number of challenges to the community. This Bill helps to build a path to accomplish these challenges, creating more ties to weather community, and making us more able to drive innovation and get these resources we need.

Strategies and reporting requirements are important. It forces everyone to get on the same page. All voices get heard. We work towards common goal. We all are passionate about the weather enterprise.

Moderator: Related to the pilot program for commercial data, particularly weather data, what are you trying to accomplish with this part of the Bill?

Staffer 1: JPSS is great, but NOAA has been having problems over the years. We have heard from companies with potential solutions, so we want to test the appropriateness of using the data. We are asking NOAA to enter into contracts to acquire these data and asking NOAA to better incorporate private sector data.

Staffer 2: We want to be more proactive in using these data. We want NOAA to become more cost effective, generate high quality data, so we are encouraging them to try other opportunities to acquire the data in a way that makes sense to both stakeholder groups. NOAA won't stop being in the satellite business. A lot of opportunities exist for commercial entities and benefits of products they will create.

Moderator: With regards to commercial weather data, a lot of data from satellites are seen as a public good. Can you say a little about where the committee sees the line start and end with respect to the public good?

Staffer 1: The bill leaves it up to NOAA to figure it out.

Staffer 2: Agree that these data are a public good and should be available to research community. CRADAs are great. We don't want to choke of this type of partnership. We can overcome this, and this section puts down requirements to think about how they will address this data issue. Companies are often fine with their data being used in publicly available goods and products.

Moderator: There are a number of changes in the Bill this year. Share some changes and why they were made.

Staffer 1: The authorization # and the dates have changed. The Pilot Project section has been expanded. The Mark Trail award has been updated. We massaged in changes related to concerns heard over the last year. Since we are not trying to step on toes, we have addressed many of NOAA's concerns.

Staffer 2: The driving force for the changes was the community. There were concerns that the bill was pushing weather research at expense of climate research. The members did not mean for that to occur, equality of both pursuits was valued. We wanted weather research to be prioritized for easy transition between OAR and NWS. We reinstituted that Mark Trail award to recognize important contributions from the field.

Moderator: Members testified to Congress about concerns of weather being pitted against climate research. Is this a concern? How has this been addressed?

Staffer 1: We took out specific language that gave that impression. There have been several increases in climate funding compared to weather in the last few years, so this is a possible reason for the concern in Congress. This bill tries to balance them.

Staffer 2: The concern is there. We aren't pitting weather against climate. Both are important, but the members want weather prioritized. There are differences in opinion between the members over climate research. There is more concern with climate on the public side. Climate research makes weather and ocean predictions better. All are interrelated. There isn't a desire to try to pick winners and losers. We need all of them to advance to fulfill mission of NOAA. She believes the revised bill has adequately addressed these concerns.

Moderator: The bill is confining in some places. Is there one section that mandates NOAA to conduct certain studies such as OSSEs, OSE, AOA, etc? Is this something NOAA has responded to?

Staffer 1: NOAA will always have concerns. We need to push NOAA to do these things. NOAA will always be concerned, but his job is to guide NOAA. It is important to be prescriptive when it is appropriate to do so, and this was the time to do so.

Staffer 2: Some of these studies are important. The bill will evolve over time. The bill will have to converge with the Senate version. The language will evolve. We will continue to hear concerns from NOAA and the community.

Moderator: A new weather bill is being worked on in the Senate. Are you working with them?

Staffer 1: Yes. There have been discussions and the Senate has a few ideas of their own. It is not clear if the Senate will want a standalone bill or to mix it with the House version. They are on the same page.

Staffer 2: The Senate wants to emphasize certain areas. Good sign that a hearing is occurring, so it is moving there.

Moderator: The AMS Community is excited about the various weather bills and the attention. How to keep the momentum going?

Staffer 1: Come talk to us. Inform us of what is being done, and have some input. Keep doing what you are doing. Good press is key.

Staffer 2: Go have conversations with your representatives. It helps in the long term. Thankfully AMS is an active organization that is not shy, and they appreciate the community. The expertise in AMS is a good reference for them. We are always looking for the next idea, so bring them to us (and our colleagues). The ideas may not make it into legislation but can affect change without having legislation.

Moderator: Are you looking for formal support?

Staffer 2: Of course, we are always looking for letters. It is useful to receive letters from AMS and universities, and other professional societies. We welcome any letters of support to help this get through the house.

Moderator: The America Competes bill has been pending for a few years. The bill has been released for public review. As part of the bill, isn't there an authorization of funding in NSF that will cut geosciences funding >6%, which impacts this field. What drove the cut? Geosciences contains a lot of research. What is the process that went in to that cut, and why geosciences are getting singled out?

Staffer 1: Difficult choices have to be made in light of the budget caps. Emphasis is really on what will spur economic growth, in the private sector.

Staffer 2: Our members saw the bill at the same time as the public, are very concerned and will offer amendments to remove those cuts (it's actually an 8% cut). Cutting geosciences pits different disciplines against each other. There is supposed to be long term support to the science community as a whole, plus increased funding for NSF. The amendments will likely be defeated, but the Democrats will keep fighting. They are very concerned about the cuts.

Moderator: is there something we are doing wrong? Senator Cruz said Earth Sciences shouldn't be in NASA and isn't a "hard science".". The community depends on this data from NASA. What can the community do to stop this troubling trend that looks at geosciences in different ways from the past?

Staffer 1: We need to hear from the community on what is going on in NASA and that part of this committee.

Staffer 2: Colleagues on the space committee have been working on science issues at NASA. Weather is a place where everyone comes to together about priories about earth sciences. NASA and earth sciences is in the constituency for various members, so will continue to work hard on support them. We remain concerned about attempts that lessen this importance at NASA. How can the community help geosciences? This is difficult. Unfortunately, climate research is the face of geosciences in their minds, and it becomes a target. It will be difficult to avoid being targeted. You can continue to broaden knowledge of the other geoscience research areas, and that climate research applies to weather as well and other sciences.

Moderator: I appreciate the openness. These are sensitive questions. Aside from these two bills, are there other legislative priorities?

Staffer 1: There is a good mix of being able to do some weather and oceanic work. Tsunami legislation may get bipartisan support. We are looking at more weather and ocean related issues on the NOAA side.

Staffer 2: Ocean health is a passion for many Representatives. Ocean acidification program reauthorization is important for visibility. Coastal resilience is important as well, as it affects everyone. The National Sea Grant program is also up for reauthorization, so hopefully that will occur. There is interest in water issues, so we will bring USGS, NOAA, etc., to coordinate a federal research plan for water. We need to more fully understand how to manage and use water. The committee cares about it.

Moderator: Is it (water/ocean research support) bipartisan?

Staffer 2: It has been talked about. The water-energy nexus might be where common ground occurs. They are talking about it and working on it. It was first introduced 2 Congresses ago. We have not talked to AMS on this yet, but will share it with the right people for input… not sure who yet.

Moderator: What issues are upcoming that are being pondered for the future. Areas in science policy that might need some attention?

Staffer 2: Ecological forecasting is fascinating. The Habitats program reauthorization was successful, so there is an opportunity to look at new/emerging programs at NOAA. NOAA has mentioned creating a product for heat warnings and more robust services and climate products. We are intrigued about the economic and sector specific forecasts that are being introduced. Interesting stuff is happening that pushes the boundaries.

Moderator: Be honest! What do you see as strengths and challenges for AMS - Weather/climate community?

Staffer 1: The Community itself is a strength and hearing from the universities and others has provided multiple viewpoints on the issues. Keep coming to talk to us.

Staffer 2: We love when AMS members come to talk to us about their work and come with intent. Bring a problem/issue for them to address. We rely on community to point out concerns and problems in how programs are being run, roadblocks that stop progress, etc. Brutal honesty is what we need. Often it is about resources, but there isn't much that can be done in the current financial situation. Bring policy changes rather than resource increase requests.

Moderator: This is interesting. What is the best way to bring these things to attention?

Staffer 2: Send white papers, or come in and walk us through the issue. Come together as community and advocate with one voice. Really think through what you really want with one voice, which is more powerful than individuals. Consistent messaging in the various briefings/papers is a good thing for them. More visits, keep coming. But of course don't overwhelm them. Send small groups and have a long meeting. Talk to other members' offices too, don't just preach to the choir. We get it, but other members don't. Just be more specific on what is being asked.

Moderator: Looking out 25yrs, what should the weather community look like?

Staffer 1: Continue to grow and get stronger. Make the US reach the top spot in weather forecasting.

Staffer 2: NWS and weather research community need to evolve, stay relevant, incorporate technology and push boundaries, and stay cutting edge.

Moderator: On the Climate side, 25yrs out?

Staffer 2: Hopefully we won't be debating the same things we are doing now. Actually work towards solutions - mitigation and adaptation. Keep pushing forward - thanks for the work!

Q&A Session:

Q: When you use the term "commercial weather data" is it just satellite data? Also, AMS has a committee on nationwide network of networks, which is working on surface based networks. Several networks have been created by the academic, private, and public sectors. The vision is to integrate this network. Problem: 1) lack of agreement on central authority 2) make business case in sharing data. Is this program within your portfolio?

Staffer 2: "Commercial weather data" is yes and no. The Pilot project in the bill relates only to satellite data. Broad language is for everything else. Network of network … yes in their portfolio. It will touch many federal agencies. It is lucky to have the environment committee under the Science and Technology Committee. It is a federal science integrator that can be leveraged.

Staffer 1: Science committee is broader and can help. Ditto on commercial data.

Q: Congressional business days is in June. Coordinating water research… what does that look like, especially with agencies outside your subcommittee?

Staffer 2: Science policy committee helps to reach out to other agencies to create this broad strategy. We envision this coordination to happen through OSTP's jurisdiction on water research.

Comment from audience member: Significant weather investments are made outside of NOAA, so not just a NOAA issue. Weather is national problem. The Air Force recently made a decision to stop contributing to US modeling and move to the UK model. This is a significant problem. AMS will try to take action to communicate among all modeling agencies to bring the Air Force back into the fold. We have to be very judicious of all investments made by the government. Thanked them on responsiveness.

Q: Making a business case on the enterprise as a whole to contribute. Reflect on whether or not it has been helpful to have industry and resource/emergency managers come in with AMS or alone to make case for improvements in dealing with big events. Climate change particularly.

Staffer 2: It is helpful when coalition comes in. Observing networks being supported by industry speakers reinforces its value, and the research and products from them. This is the most effective way.

Staffer 1: Ditto. Death by 1000 blows. Bring them with you.

Q: Relating to Highway safety and road weather. The commenter is happy to hear the example provided by the congresswoman speaker last night on the truck driver on the road needing weather information. Is there any conversation with transportation and other communities that the connection is made for a better forecast put to other uses?

Staffer 2: Sector specific products in forecasts. This is an area to start to peruse. There is a lot of opportunity there. Commercial sector would work with these products.

Q: Glad to hear reception of people coming in. All the data are great, but need to operationalize it. How much outbound activity do you have with other committees (health and human safety, etc.). How to keep communication going?

Staffer 1: It depends on what is being done. There is good communication between committees. Sometimes there are joint committee hearings. Markups can be referred to multiple committees.

Staffer 2: Agrees that it is a challenge. Earthquake program demonstrated their joint work between committees to make that happen. Try hard to see impacts and push agencies to have broad vision with other agencies. We don't want to see another agency steal scope from another one. We way need to step in when programs are at odds with each other to point it out and establish relationships.

Q: Extending dialogue to users/impacted user, next Friday is extreme precipitation event with multiple stakeholders. NASA and earth science with 6 focus areas within it. Have you met with NOAA research and NASA research to talk how those programs could be aligned?

Staffer 2: Haven't had opportunity, but welcome it. Have jurisdiction over Earth Sciences for first time this congress, so still new. Colleagues cover that, but will get together. Give us more info on NASA program in particular.

Comment from audience member: New generation of capabilities, satellites through data assimilation into models. Global models do hurricanes 6 days away. Thunderstorms few hours in advance. Thanks their work; it will make a tremendous difference

Q: A challenge not yet discussed… The speaker was the upper air observation program manager back in the days and is now in the private sector. Challenge was replacing with new technology... types of instruments, not upgrades to current systems. Couldn't get entire community to come together to replace them. Congress wouldn't listen on how to replace them because satellites were always the answer. Weather balloons are not the only way. How do we bring together disparate ideas? Satellites are healthy, but terrestrial networks for ground truth and validation are not keeping up. What can we do Congress and community to work on this problem?

Staffer 1: Come in to talk to us.

Staffer 2: Need to get community to speak on the solution. They can't solve it for you. Bring them the problem and solution. AMS should be the forum to hash out for the solution and advocate for changing these things so they have something to act on.

Q: ASOS is 20 yrs old. Hydrometeorological network, etc. all need help. If community can't do it, the Academies report is an idea to explore, but AMS should facilitate.

Staffer 2: Sounds like part of problem is industrial community needs to be involved. Identify what needs to happen in long term. Everyone needs to come together and

really address the problem. Bring appropriate folks together. Prioritize what needs to happen. Then come up and tell us the unified voice.

Q: Doppler weather radar. Any thoughts on the replacement of the radars. Brought up MPAR. WSR88D was successful because it was a joint program. We should have another. Any input on this technology? Insight?

Staffer 1: We have heard about it and know the acronyms. MPAR is still a ways out. But it sounds great.

Staffer 2: Yes. We are aware of the need. Resources will be a challenge.

Q: Network of Network report from NAS was about about 10 yrs ago. "From the ground up…". There is are recommendation for mix of networks to help satellites. The speaker has testbeds. He is running a testbed for NWS in Dallas right now. They need larger spatial coverage. Maybe in time the community can come up with a new testbed.

Staffer 1: Come talk to us.

Staffer 2: If there are great ideas to get moving this congress, the senate bill isn't written yet. There is still time to submit good ideas.

Expert Witness Training Academy

A special session at this year's forum was devoted to educating the audience about an exciting program run by the William Mitchell College of Law: the Expert Witness Training Academy (EWTA). The EWTA provides innovative workshops and training materials to scientists on how best to communicate scientific information in legal proceedings and other adversarial forums. The leaders of the academy, along with a prominent graduate of the course from the weather community, showed a brief video of how the program works, and described the many benefits of this immersive experience, both for actual testifying and for more day-to-day handling of communications and debates between scientists and non-scientists. Full-up simulations of court proceedings are a part of the curriculum, as well as coaching and feedback from expert faculty. The EWTA is funded in part by the Paleoclimate Program at the National Science Foundation. More information can be found at http://web.wmitchell.edu/expert-witness-training-academy/.

Panel Session: Transportation: Rail and Trucking

Hurricanes, tornadoes, visibility, ice, and snow are just a few of the weather concerns in terms of the nation's transportation infrastructure. The importance of weather forecasting is not just on the reliability of the forecast itself but also on understanding its impact. A clear understanding of the impacts associated with these weather events will help save lives and reduce the risk of damage to property.

We began with a discussion of weather impacts on the trucking industry. Truck rollovers are expensive, and in many cases, deadly. An analysis performed by the American Transportation Research Institute (ATRI) of truck rollover locations found

these locations typically occur in interchanges. However, other vulnerable regions can also occur when roadways are exposed to high winds, which can result in blow-overs. ATRI has the largest database of truck position data in the U.S., and these data were used to help assess the impact of the winter storm in Atlanta, GA in January 2014. This event received considerable media coverage, as the impact of the storm was substantial from the perspective of safety and efficiency (i.e., high cost). The operational hourly cost of trucking continues to rise. Currently, the two primary issues in the trucking industry are truck parking and hours-of-operation. Weather has a direct impact on hours-of-operation. The ultimate goal is being able to accurately assess and predict high-impact weather so that the trucking industry can maintain high levels of efficiency, resulting in increased productivity.

A representative from the Association of American Railroads (AAR) discussed the vast network of railroad infrastructure and its vulnerability to weather. AAR is not a government entity. Its membership is made up of major freight railroads in the U.S., Canada, and Mexico, along with Amtrak. These members are responsible for the maintenance of this critical infrastructure (i.e., the railroad). It is anticipated that 20% of gross revenue will be invested in the infrastructure in 2015, with a portion of this being directed at mitigating the impacts of weather. In order to prepare for weather events, there is a need to deploy resources, additional command centers, and enhanced staffing. In any type of weather event, there is an emphasis on resiliency and recovery efforts, which requires input from many sources. Tornado, high wind, and heavy snow events can cause major route disruption, especially in rural areas. Privately owned railroads have generally been better prepared for extreme weather events. In many cases, privately held railroads have demonstrated the ability to return to normal operating levels more quickly due to their capacity to be more nimble and responsive to these kinds of events.

For events that cause train derailment or train mobility issues, Positive Train Control (PTC) legislation mandates controls to be implemented to automatically stop or slow a train in an attempt to reduce certain types of accidents (e.g., derailments due to over speed, train-to-train collisions, etc.). Systems know where the train is, what the signal is about to do, and if the engineer does not react properly. Algorithms in the control system will have the ability to adjust train speeds or in some cases, bring the train to a stop. Copious data from sensors can be stored at railroad weather centers. With this information, one can more easily evaluate response efficiency. A better understanding of weather impacts as they relate to the rail industry will help to refine the adoption and implementation of PTC and related technologies in the coming years.

A representative from the American Association of State Highway and Transportation Officials (AASHTO) discussed weather-related issues that State DOTs encounter and how they solve these problems. The beginning of the presentation focused on the percentage of weather-related accidents, injuries, and deaths over an 11 year period. (23%, 19%, and 17% respectively). Several initiatives that were put in place to reduce weather related incidents were highlighted, as well as their effectiveness (e.g., the Maintenance Decision Support System (MDSS), Clarus, etc.). Emphasis was also placed on the costs of weather associated with industry operations, as well as how this

reduces the funds available for construction and other infrastructure improvements. It was noted that currently snow removal in the United States costs on the order of $2B a year.

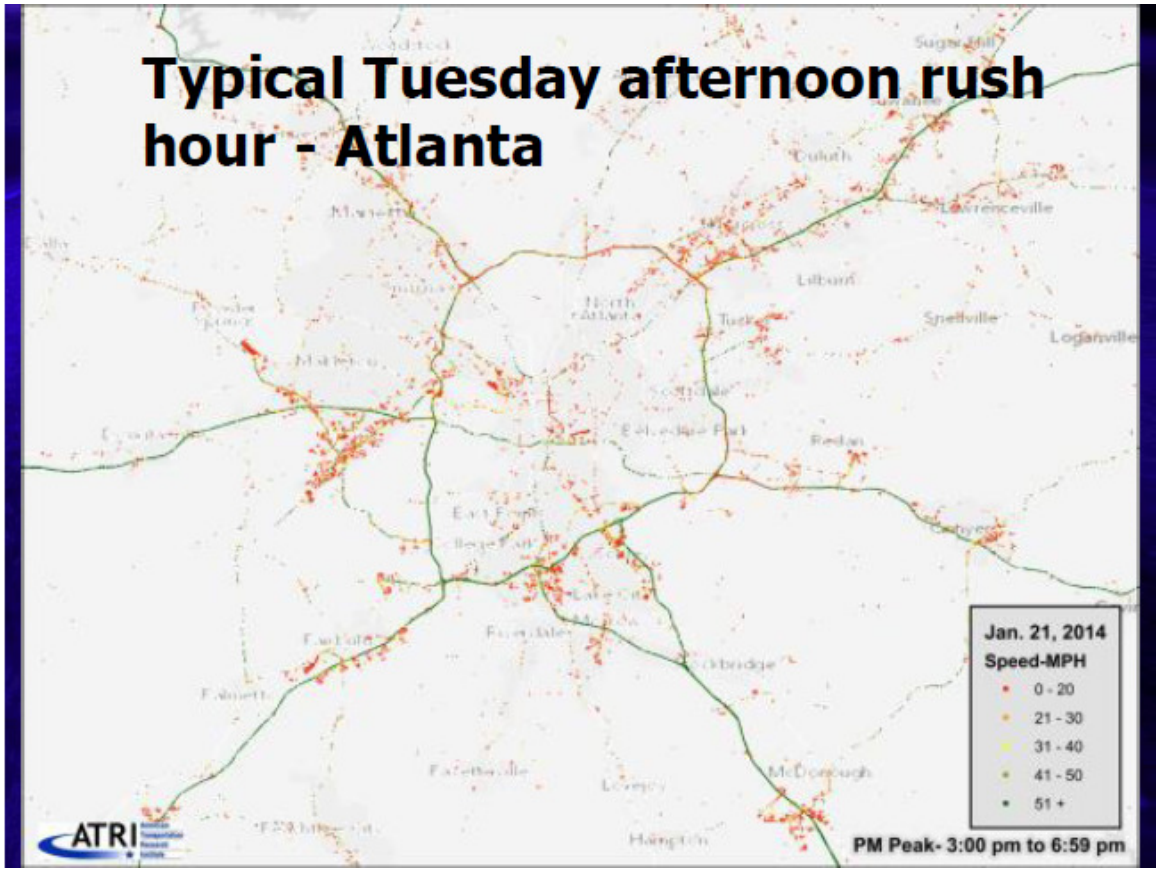

Figure 5. Rush hour traffic monitoring in Atlanta.

The presentation addressed the overload of information that is provided to agencies and how to improve the distribution and communication of the information. Two areas highlighted for improvement included the consistency of the information and the integration of the information. Integration needs to be initiated at both the bottom and the top of government and organizations, with the maintenance garage level being included as well. Moreover, there needs to be consistent and sustainable leadership in this integration process. Right now there are several groups focused on solutions including AURORA and the FHWA; however, it was noted that the money being put into winter maintenance alone is far greater than the amount put aside for research. He went on to also emphasize the importance of timing information in terms of weather-related events (e.g., when precipitation will begin/end, when specific precipitation types will begin/end).

A representative of CATT (Center for Advanced Transportation Technology) highlighted a core issue with data sharing. Every state DOT has a road monitoring system and on a county-level there are numerous operation-centers, none of which have purchased the same system or apply data in the same way. It creates a

transparency issue. CATT laboratory works with different agencies on state and regional levels. Their recent efforts have focused on consolidating data and information from state and local levels to gain an enhanced understanding of various events and their relationships. This has been accomplished using a system called RITIS (The Regional Integrated Transportation Information System). The RITIS platform has the capacity to examine weather data and its effect on roads, as well as other road-related transportation data (e.g., vehicle speeds, lane closures, etc.). The goal is to provide easy, usable, and accessible data to the end user.

Screenshots from the system were shown to demonstrate some of its functionality. In one example, he showed how incident activity could be displayed in real-time. An end user could also examine how an incident may lead to roadway blockage and vehicle backup. Police, fire, evacuation, weather, and other data can also be overlaid and used in an interactive process to further assess an incident, including response and clearance performance. In terms of weather, the system can be used to assess weather-related impacts such as congestion and delays resulting from reduced speed and changes in volumes. Analytic capabilities built into the system allow an end user to output metrics such as delay cost by hour of day. Such cost can be used to ascertain the impact to the economy from the perspective of personal vehicle usage or commercial operations (e.g. trucking).

A question from the audience focused the attention on whether transportation agencies are able to test emergency response plans that are implemented during inclement weather episodes. The panelists stated that they do have access to the data necessary to monitor whether planned transportation responses to these events are successful or not. Due to the length of the presentations, there was not an opportunity to take additional questions from the audience.

Panel Session: Water Resources and Users

A panel on water resources focused on the challenges facing water resource managers, especially in the western states, where drought conditions were described as being so severe in parts of California that they could be described as “beyond exceptional.” The first speaker focused on the current water supply situations of two large West Coast cities: Seattle and Los Angeles. The partitioning of precipitation between rain and snow is important for water resource management. The speaker likened rain to a checking account and the snowpack to a savings account. While snowpacks in both states are far below average, there has been ample rain in the Pacific Northwest, and reservoirs are full. Seattle was therefore described as being long on water but short on storage in the form of water held in the annual snowpack. Water managers in Washington have advised residents not to panic because the rain has replenished the state’s water “checking account.”

Los Angeles, on the other hand, is short on both water and snowpack storage, so they are facing significant water scarcity. Even in normal years, 2/3 of the state’s water supplies come from the northern part of the state, while 2/3 of the state’s demands are in Southern California. There are major transbasin water diversions into Southern

California, but it is costly and energy intensive to move water in California from north to south. Given current statewide water scarcity, the question of how to get sufficient water from the north to the south is especially difficult.

The speaker noted that many of the large urban water utilities are keenly aware of their sensitivities to weather variability and climate change, and they have developed their own highly sophisticated water observations and system simulation models. They also rely heavily on a variety of data and forecasts from the weather enterprise and other parts of the science community to guide their operations. It was argued that improved forecast accuracy would be highly valuable for optimizing system performance.

The weather patterns responsible for the dire 2015 California water supply situation were described by the second speaker, who also emphasized the highly variable nature of the state's precipitation and streamflow records. California is currently gripped in an historic drought, with almost the entire state in the severe to exceptional drought category. California is also prone to floods, and California's average annual flood damages are second only to those in Texas. There is some evidence of an increasing trend in annual 3-day peak flows, for example on the American and Feather Rivers. In addition, floods can occur in the middle of a drought, as happened briefly on the Russian River during the storm of 10-12 December 2014 when over 9 inches of rain dropped over Northern California in 24 hours. Storage in Lake Mendocino increased by 12,000 acre feet in the span of 3 days, but the fact that the reservoir's supply area covers only 5% of that watershed made it impossible to catch enough water to keep the river below flood stage.

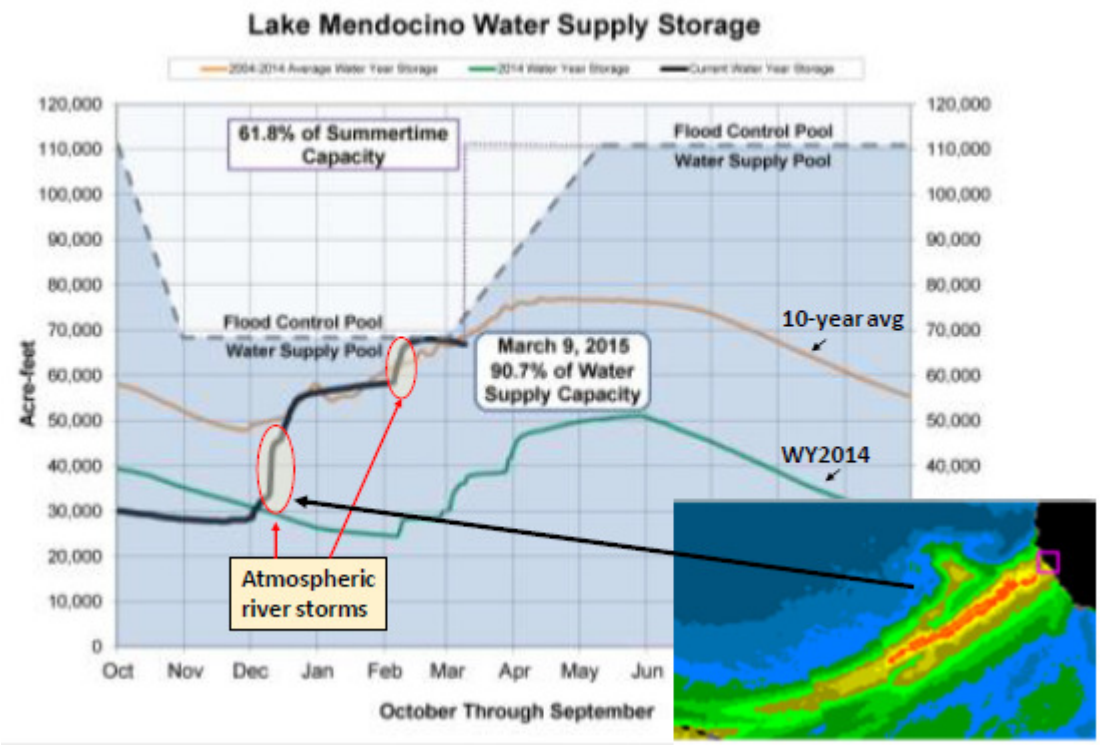

Figure 6. Availability and management of water supply storage over time.

Particular challenges arise from the fact that many of California's reservoirs are operated to provide both winter flood protection and growing-season water supplies. In some cases, rule curves that were developed long ago to define operating procedures for balancing these goals are no longer functioning as intended. For example, the rule curve for Lake Mendocino assumes large inflows during spring and early summer, but those inflows have declined in recent years, due in part to drought, but also due to regulatory actions to protect salmon populations, including reductions in transbasin water diversions that formerly augmented inflows into the reservoir. The current rule curve sets the target for winter time storage at 68,000 acre feet in order to maintain a sufficiently large flood control pool. Filling of the water supply pool is set to begin in March with a goal of reaching the summer-time storage of around 110,000 acre feet by the beginning of May. However the ten year average fill has stayed well below that summer target.

Because strict adherence to inappropriate rule curves can reduce water supply security, an effort is now underway to explore the use of precipitation forecasts to inform reservoir operations. In particular, better skill in forecasting extreme precipitation events may allow greater flexibility to store winter inflows for later use while maintaining flood protection capabilities. Ongoing improvements in monitoring and forecasting the atmospheric conditions giving rise to major floods will help to improve the efficiency and safety of storage operations.

There are significant differences across the western states in the seasonality of heavy precipitation and in the weather phenomena driving extreme precipitation and associated flooding. In the coastal states, most floods result from atmospheric river events in fall and winter. In the Southwest, the summer and fall monsoon drives the heaviest precipitation events, while extreme precipitation in the Great Plains is associated with spring and summer deep convection. Interannual variability in total precipitation is much higher in Southern California and the Southwest than in other parts of the country, with a coefficient of variation exceeding 30% for most of California and above 60% in a few places.

The final speaker focused on the usability of NASA observations for water resource management. NASA's Applied Sciences Program funds projects that can enable uses of NASA Earth science data for policy, business, and management decisions. The program takes a two pronged approach, supporting work on specific applications, and also engaging in capacity building activities in the US and developing countries. These efforts seek to build a cadre of users with the skills and knowledge to access and apply environmental satellite data to benefit society. Much of NASA's work is focused on improving the models. Large data sets already have been generated by many sensors contributing to water cycle studies. Model improvements to allow the data to contribute to improved decisions will entail computational challenges that will take time and effort to address, but given rapidly expanding computing capabilities, the speaker expressed optimism about a coming golden age for the integration of NASA data in resource use and management decisions.

The speaker described the land information system (LIS), which is a flexible land surface modeling and data assimilation framework developed with the goal of integrating satellite and ground based observations and data products with land surface models. Water-related aspects include data assimilation of: soil moisture, snow depth/area, terrestrial water storage, and irrigation intensity. Experimental work on satellite irrigation management support seeks to assist growers in optimizing water use by mapping crop water requirements.

Special Topic: Information Needs for Water-Related Extremes

The Rio Grande flows through Colorado, New Mexico, and Texas before it reaches Mexico. When a river runs through a series of states, as is the case with the Rio Grande, a compact is needed to regulate water appropriation. The Rio Grande Compact was created in 1938.

Before the construction of the Elephant Butte and Caballo dams, the Rio Grande was essentially a storm-water stream subject to great and sudden floods. To address fluctuations and depletions of the river, the creation of the Elephant Butte Dam was authorized in 1905. Construction began in 1908 and was completed in 1916. As the creation of the dam would have many benefits to agriculture, it was financed by farmers who were required to pay back the United States for its construction. A 1906 treaty between the United States and Mexico led to the distribution of water between the two countries.

The Rio Grande Project is a United States Bureau of Reclamation (USBR) project established in 1905 that manages the water resources beginning at Elephant Butte Dam. The New Mexico portion of the project consists of 90,640 acres or 57% of the project, and the Texas portion a respective 69,010 acres and 43%. The division of water, even to this day, is based on these irrigated acreages and percentages. With the construction of canals and laterals in the project area, came a rise in the water table. In the 1920's a series of drains were installed to prevent waterlogging. Financing issues related to repayment and the creation of these drains led to the formation of irrigation districts. The last component of the project, Caballo Dam, was built in 1938 to provide flood protection for the projects downstream and to stabilize outflows from Elephant Butte. Most irrigation releases in this region occur from Caballo Dam. Water is released and diverted, used and reused, but the drains are considered to be the Achilles Heel of the system.

From 1938-2002, the amount of water released from dams and transported to farms was steady, as shown by the D2 curve which represents the historical relationship between releases from Caballo and total project diversions. Now, however, it seems to be diverting off of this trend. During the period of 1951-1978 the Project region experienced a persistent recurring drought. Rio Grande Project farmers responded to short water supply by developing a groundwater pumping capacity. The creation of this system was made possible by the development of the high lift pump and the completion of the rural electrification project, which provided power for the pumps to operate.

The Rio Grande Compact, created 1938, involves each of the three states, Colorado, New Mexico, and Texas, through which the Rio Grande passes, and manages the appropriation of Rio Grande water. A certain amount of water must pass under the Otowi Suspension Bridge in New Mexico. If not enough water flows naturally underneath, more must be pumped. Counter-intuitively, surface water in a large portion of New Mexico is controlled by the Texas Commissioner. The entire Rio Grande Project is included in the Texas portion of the project. The Rio Grande Project apportionment of water between Texas and New Mexico is not included in the Compact. The Federal government operates the Rio Grande Project as a single unit. The government sees its responsibility as making sure that the entire project has enough water, not each individual state. The state engineer of New Mexico, who is also the New Mexico Compact Commissioner, controls the groundwater permitting in the New Mexico portion of the Texas Compact portion.

In the 1970's, the USBR began to suffer a series of budget cuts and political setbacks that ultimately relegated it to specifying only the releases from the Caballo Reservoirs and forced the two irrigation districts to manage the diversions: the Elephant Butte Irrigation District (EBID) and the El Paso County Water Improvement District (EPCWID). The independence of the two districts from the USBR increased further when EBID paid off its construction loan in 1979, and EPCWID paid of its loan in 1980. In 1997, the USBR filed a quiet-title suit in federal court and EPCWID filed a cross-claim alleging inequitable allocation of project water by USBR because of groundwater pumping in New Mexico. In the late 1990's, an era of dispute resolution began. The three parties: EBID, EPCWID, and USBR sat down to negotiate, but the negotiations fell apart by 2000. In 2001, the Attorney Generals of Texas and New Mexico had their state legislatures involved.

Formal negotiations collapsed and remained dormant for the next six years. The districts and technical representatives, however, met under the auspices of the National Science Foundation Science and Technology Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA). In these meetings, two critical negotiation points emerged: carry over storage and New Mexico groundwater pumping. In 2006, EBID proposed a new curve called D3 to replace D2. D3 tied EPCWID and Mexico allocations to project releases and predicted the amount of project water that EPCWID and Mexico should receive annually in releases. To summarize: the EPCWID wanted carryover storage and protection from the impacts of excessive groundwater pumping by EBID guaranteeing that they would receive the D3 allocation. EPCWID received both. EBID wanted D3 as the basis for allocation of project water and the right to provide the EPCWID allocation in the manner of its own choosing. It received both. In 2008, 14 New Mexico and Texas farmers signed the operating agreement, thinking it would end the dispute, but it did not.

After the signing of the operating agreement by the farmers, the Attorney General of New Mexico brought a series of lower court cases in an attempt to abrogate the operating agreement because it provided too much water to Texas. Carryover storage would provide Texas with additional waters. In 2013, Texas filed suit in the Supreme Court of the United States alleging four points: 1. Once reclamation releases EPCWID Project water into the Rio Grande from the reservoir, south central New Mexico

residents intercept the water as it flows down the river to the state line. 2. The interstate agreement was created to support the interstate project system in supplying water to users in south central New Mexico and far west Texas. 3. There was a Compact violation even though the Compact does not make a specific allocation to the State, and this violation has occurred since 1938. 4. Although it has adjudicated its water rights in the Project in 2006, the decree and the Certificate of Adjudication issued cannot have practical effect unless New Mexico ensures the deliveries of EP No. 1's allocation to the state line.

New Mexico asserted that the Texas claims were not truly Compact based claims. Those issues were before the Federal District Court in New Mexico and the Adjudication Court in New Mexico, and those cases should be allowed to proceed. They claimed there is no New Mexico-Texas state line delivery obligation. New Mexico also asserted that Texas arguments relied upon faulty assumptions and that the Pecos River Compact and the Rio Grande Compact are similar in these requirements. New Mexico said that the Rio Grande Compact does not have a "1938 condition." A purpose of the 1938 Rio Grande Compact was to free New Mexico and Colorado for growth and development.

At the time of the 2015 AMS Washington Forum, these Rio Grande conflicts remain unresolved, and are likely to be so for the foreseeable future.

Panel Session: Preparedness and Resilience Efforts Under the President's Climate Action Plan

Representatives from the Administration informed the Enterprise on the expanse and depth of the President's Climate Action Plan (2013). The Climate Action Plan (hereinafter "CAP") is an engagement-policy that activates the federal, private and academic sectors to build science and communication tools that will support state, local and tribal communities in implementing short- and long-term solutions to climate/severe weather impacts.

A cornerstone of CAP is the Climate Data Initiative (hereinafter "CDI"), which opens federal data to spur innovation to enable all sectors to create user-specific tools. To further support CAP's goals, the Administration is working with the social science community, drawing on its knowledge to "translate" science for non-scientists. The Administration is also working with the property and casualty insurance sector, which has the potential to link incentives to resilient actions. With weather-related disasters costing an estimated $500 per person in the United States, there is an urgency to give people information that moves them beyond fear and that provides a level of confidence that their new actions offer hope and protection of the storms that are yet to come. Below is an exploration of how CAP, CDI, and specific partner engagements are making this happen.

The Climate Action Plan (2013) is the result of the President's personal interest in climate coupled with growing evidence of more frequent catastrophic storms (e.g., Hurricane Sandy which exacted billions in damage and displaced many people).

CDI has three major pillars: Mitigation (i.e., carbon cutting), Adaptation, and International (particularly concerning an upcoming Paris Meeting December under UN

Framework; and recently established U.S./China targets). The Council for Climate Resilience overseas implementation of CAP, and is co-chaired by the Office of Science, Technology and Policy (OSTP), Security Council, CEQ, and Office of Management and Budget (OMB). Thirty (30) agencies are involved, answering the call to develop inter-agency and public/private partnerships to create a more resilient country through novel approaches.

Five (5) Working Groups are the pillars to achieve CAP's intents:

- Climate and Water Resources
- Infrastructure Resilience*
- Internal Federal
- Data and Tools
- International**

*The Quadrennial Energy Review (QER) is a guiding policy on infrastructure resilience to address the strength and rebuilding needs of the nation's aging infrastructure, which carries an estimated $2 Trillion investment to upgrade or rebuild. The QER remains open for public comment. Explore the above link to submit comments.

**The International pillar primarily focuses on the UN Framework Convention in Paris (December 2015) and recent U.S./China agreement on greenhouse emissions.

Climate Data Initiative

The Climate Data Initiative (hereinafter "CDI") spawned the creation of the "Climate Resilience Toolkit" (CRT) and is part of the Department of Commerce's Open Data Initiative which was announced by Secretary Pritzker's keynote at the AMS Washington Forum. The Initiative is spirited to open government data to the private sector for the purpose of spurring innovation to address climate resilience. There are presently 250,000 users, 500 datasets and over 50 commitments from private sector organizations. The focus is to provide usable information that non-scientists at the tribal, state, and local levels can use.

CRT was NOAA-led and chaired by OSTP. CRT is an actual website with case studies along the themes of: ecosystems, energy infrastructure, food, transportation, water, and health. The content provides training courses on climate change, adaptation and planning, as well as online courses from external users. The modules are a product of single agencies, inter-agency, or public/private/academic partnerships.

Communicating Science and Involving the Game-Changers (Insurance Sector)

Complex sciences require translation, while maintaining the accuracy and precision, for decision-makers. AMS Policy Statements were noted as being influential and important for policy makers. For tribal, state, and local decision makers, social science was highlighted as most beneficial and necessary.

The Administration recognizes the market forces that can also be critical game-changes in the adoption of climate resilient actions. Thus, a spotlight is placed on the

property and casualty insurance sectors. In December 2014, Mr. John Podesta, then Senior Advisor to the President, Dr. John Holdren, Director of OSTP, Dr. Kathy Sullivan, Under Secretary of Commerce and Administration of NOAA, and Mr. Craig Fugate, Administrator of the Federal Emergency Management Administration (FEMA) met with 12 chief executive officers (CEOs) of leading property and casualty insurance companies. Through dialogue, the Administration learned that insurers are interested in data ("severe convective events" was particularly mentioned) to improve risk communication with policyholders. The insurers also vocalized a strong desire for stronger building codes, which will dovetail with infrastructure mitigation. It was stated "science from our community will help to defend this proposition". In return, the Administration is working with insurers and reinsurers to have them share their vulnerability data, which has historically been kept in-house and proprietary. Stay posted for advancements on this topic.

Other partnership-specific discussions involved Tribal Leaders through OSTP's State, Local and Tribal Leaders Task Force. Through this Task Force, The Administration commissioned a report by 26 Tribal Leaders which was received in December 2014. The President is currently working on the recommendations that included requests for information on sea-level rise, precipitation (to inform on where to build or rebuild) and the provision of experts/technical assistance to parse through data online.

Precipitation and flooding are repeated common concerns among many decision-makers. The Administration is taking historic action with the federal agencies, and improving the link between flood risk and flood rates. The latter falls under the "Guidelines for Implementing the Federal Flood Risk Management Standard". This is an historic step of this kind in 38 years. The Standard is open for public comment. Explore the above link to review and contribute.

Our field knows the complexity in resolving precipitation risks; communicating it can be additionally problematic. Thus there is interest to improve visualization for user communities. Of particular note are advances in 3D visualization to display drought, coastal erosion, flood risks and landslide hazards for tribal, state, and local communities.

The discussions from this Panel reflect that the Administration has a vision and implementation plan to promote climate resilience. It involves an all-hands-on-deck approach from the federal to local decision-maker. A key link in this chain is accurate science that is properly translated into words and visualizations as well as supported by market forces to re-tool society to think and do differently than in the past. The Enterprise is greatly needed to make this reality possible.

Q&A Session:

Q: How can our community support "quality assurance"/data fidelity, particularly of climate data with long lead-times and uncertainty?

A: The Administration recognizes this task is a huge challenge, and offered the advice that it will be key to communicate what we do know with the best accuracy; and to pair communication with solutions.

Q: Climate information can inform or sway financial markets. How close is the country to handling the "financialization" of climate risk?

A: Changes are indeed informing the market now. SEC disclosures already embrace this as does Moody. On the flip side, companies are also demanding climate resilience from communities as a pre-cursor to investment. More changes are yet to come as we move forward.

Q: What technical assistance or support is being provided for individuals who are making partnerships happen?

A: The Administration recognizes that sustaining partnerships is absolutely essential. There are not many resources, at present to support this, but this may change soon. The President's Budget FY 16 has provisions for a "Climate Resilience Corps" (modeled after the Peace Corps) which will support young individuals to work in the U.S. to support resilient initiatives. In addition there are the "Silver Jackets" that support U.S. Army Corps of Engineers (USACE) initiatives by providing back-of the-envelope calculations to move ideas, in a framework way, forward. Lastly, the Rockefeller Foundation's Resilient Cities Initiative does provide support for "connectors".

Q: What investments are being made for climate education, and what steps are being taken to help kids "fall in love" with big data?

A: Climate education funding and planning are in the early stages. There is a lot of interest to reach the K-12 community. The Administration's "100Kin10" program will education 100,000 Science, Technology, Engineering and Mathematics (STEM) educators in the next 10 years. The teachers will work with NOAA and NASA to receive cutting-edge information and guidance. In terms of reaching kids on the "big data", there is clear evidence that children are already grabbing on and using "big data", as evidenced by the use of ESRI's "story maps" by K2-4 children.

Q: Is there a need for climate certification?

A: Yes. Certifications reflect professional standards, which will give confidence to consumers or users of data. The Association of Climate Change Officers givers climate certification.

Q: The Administration's Climate Resilience Plan is bold and needed, however, what provisions are being made to provide resources to enable sectors that are critical for community continuity but seldom have high profit margins, most notably hospitals, to afford climate resilience while they have to zero their books for today.

A: This is a critical challenge, and the Administration sees that improvements to building codes and perhaps insurance may help.

Panel Session: Federal Agency Leads

The Federal Agency Leads Session brought together representatives from NOAA, NSF, DOE, and NASA to share perspectives on budgets, initiatives, opportunities, and

challenges. Several common themes emerged. There was a reiteration of the need for an interdisciplinary approach with respect to climate and weather–related activities. There is an increased sense of urgency coming from society, and in some cases, additional responsibilities assigned to individual agencies. Therefore, it is increasingly important for agencies to be able to share data, to have a clear idea of what timescales within the weather to climate spectrum each agency should be focusing on, and how to meet commitments of mutual interest within the budget constraints of each agency. Resiliency was a term frequently used during the session. Resilience with respect to the weather, climate and water geophysical system is increasingly important in areas that include the environment, human communities, businesses, and the overall economy. For example, currently 98% of all products that come to the US are shipped through ports and 45% (or $6.6 trillion) of the GDP is generated in coastal counties. Therefore, data observations, models, predictions, forecasts, and resilience planning for coastal areas must be an area of continued and increasing focus. Each of the agencies represented appear to have relatively stable budgets. The speakers outlined continuing and new programs and initiatives that illustrate a concerted effort to address the challenges that the nation and the international community face. This includes the continuity of important existing efforts, such maintaining the consistency of global satellite observations, as well as initiating new efforts focused on dealing with the impacts of weather and of climate change. In addition, some of the agencies have had an increase or shift in responsibilities. This is a challenging time with respect to budgets, environmental conditions, and increasing interest and scrutiny from the public and government officials, however, the overview that this panel of agency representatives provided gave insights into the positive ways in which the nation is rising to those challenges.

The first panelist expressed excitement that the commission was focused on weather, water, and climate and stated that one major objective for the future is to connect weather with the ocean community. The panelist then stated the main focus of their talk, which was resiliency as it relates to the environment, the community, and the economy. Coastal resilience was the first example provided. Population along the coasts has increased over the last few years and now approximately 40% of the population resides in coastal areas. This presents a challenge to the resiliency of coastal infrastructure and water quality. We also need to be mindful of disasters such as intense storms that continue to degrade the infrastructure.

NOAA's approach to facing these issues is becoming a data agency that provides decision makers with environmental intelligence. The data involved in this intelligence encompasses models and forecast on several special and temporal scales. Several examples of how that data is currently being utilized were mentioned by the panelist.

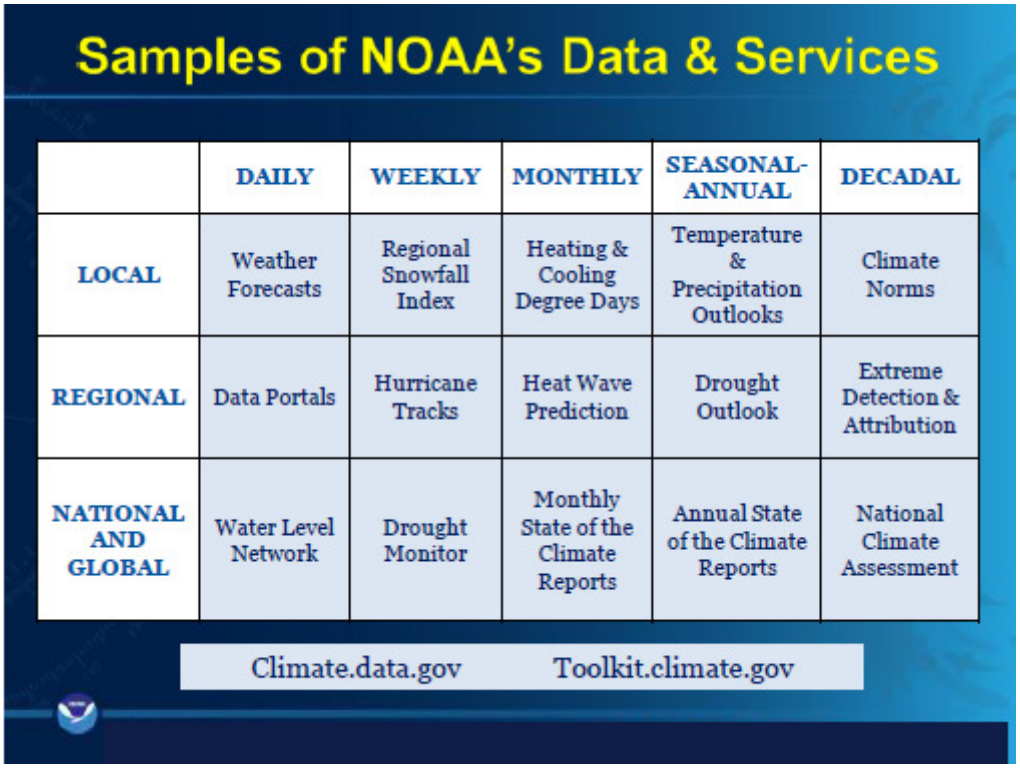

Figure 7. NOAA data and services available over different spatial and temporal scales.

Resiliency is also instrumental in big business. The panelist mentioned that insurance and reinsurance agencies want to be more resilient, know uncertainties, and drive down risk. Ocean data and prediction tools will do this; therefore, NOAA is working with these agencies to meet their goals.

Four examples that highlighted the importance of the relationship of resiliency and business were provided. The first example was the $111 million shellfish industry on the West Coast and the threat that ocean acidification poses to the production of this industry. The hatcheries on the coast need to be provided with real-time data to be abreast to acidification episodes so they can time their hatches accordingly. The second example provided was ecological forecasting. HAB and beach hazards pose an annual threat of $82 million. Mitigation processes need to be in place to reduce the human health issues associated with these threats. Current communication between businesses, such as tourism businesses and fisheries, is needs to be improved to maximize the efficiency of these processes.

The third example provided by the panelist was the maritime shipping industry. Currently 98% of all products that come to the US are shipped through ports and 45% of the GDP is generated in coastal counties. This equates to $6.6 trillion, as well as many jobs and wages. Our infrastructure is not where it needs to be to optimize our maritime shipping industry. There is also a need for pilots to have real-time information about port conditions so they can coordinate arrival times that minimize risk. Houston-Galveston PORTS is a product that currently gives this type of information, but the need for these data is growing.

The last example highlighting the like between resiliency and business was water prediction. Flood damage has cost $8 billion dollars and has led to many losses of life, while the ongoing California drought has cost $2 billion. Improvements in water level predictions and uncertainties are needed to minimized these costs and reduce risks.

The panelist ended by posing the following question: "Can the ocean enterprise look like the weather enterprise?" Currently, the weather industry private sector is valued at $3 billion. The ocean enterprise private sector is not there, but has the potential to grow and expand.

The second panelist highlighted information about what NSF is currently doing, as well as the current budget outlook and political landscape.

The discussion began with GEO research initiatives. PREEVENTS is a new FY2015 part of NSF's Risk and Resilience activity (worth $23.5 mil) and is focused on examining how we predict and respond to natural hazards and extreme events. PREVENTS will also help us understand prediction models and will connect the geoscience and social science disciplines. This initiative will start with community workshops.

The next initiative emphasized was INFEWS, which is a new interdisciplinary investment to study the food, energy, and water nexus. The panelist also highlighted SEES, a NSF priority area which continues the sustainment for these investments.

Next, the current budget was discussed. The table below shows the monetary request for several sectors. Geoscience requests are up 4.7%, but this will depend on appropriation. Congress has provided guidance with regard to handling the budget.

Sector	**FY2014 Budget (millions)**	**FY2015 Budget (millions)**
Atmospheric Chemistry	18.4	18.4
Phys Dyn. Met.	22.9	22.9
Paleoclimate	8.2	8.2
CLD	21.8	21.8
NCAR	95.2	98.2

The panelist then discussed the challenge in relaying the importance of investing taxpayer money into the geoscience. There have been NSF budget increases in math & physical sciences, engineering, computer info sciences, biological sciences, but budget cuts for geosciences and social sciences. In accordance with the America Competes Act the NSF total budget is up 3.4%; however, the GEO budget is down 8% and social sciences have received a larger cut. This is a new experience for the NSF. The recent move by the US Air Force to drop the WRF to switch to the U.K. model was also discussed, and the panelist remarked that this switch would also have an impact on the budget.

The presentation concluded with the panelist bringing two new research projects to the audience's attention. The first, VORTEX-SE, is a new project in the southeast aimed at studying tornadogenesis. NOAA's OAR received $5.2 million for FY2015 in support of this project and NSF will be a collaborator. VORTEX-SE will be managed by the National Severe Storms Laboratory. The second project is the use of the A-10 Thunderbolt

aircraft to study severe storms. Modifications are in process to allow the aircraft to penetrate the storms to collect data for atmospheric research. These modifications are being completed in conjunction with the US Air Force and are expected to be completed by late CY2015 to early CY2016.

The third panelist provided an update on the DOE's budget and current goals.

One issue that was immediately brought to attention was how federal agencies will respond to the rapidly changing field and stay in line with constantly evolving technologies.

The DOE currently has a stable budget of ~28 billion. The DOE spends much of its time focusing on updating plans for long-term investments when considering funding for atmospheric and climate research. Five years ago there was a focus on developing a strategic plan and in 2012 a plan for a specific mission was released. The mission is to advance the predictability of the climate system by obtaining higher resolutions for statistical analysis. Extreme weather events require higher resolutions of about 10 km or less and the DOE is driving towards that.

Another major focus of the DOE mentioned by the presenter was the resiliency of energy infrastructures. In order to assess the resiliency there has to be an accurate view of what risks facilities are exposed to in lifetime, which will require models to represent extreme events and changes in extreme events.

The panelist then discussed the DOE's role in the Climate Action Plan. The DOE plays a major role due the technology it is able to access. Much of the focus is placed on Risk Assessment Models for coastal regions, and heavily populated regions. Coastal regions are of specific interest because much of GDP is generated in coastal counties. Investment in risk assessment models is required to sustain GDP is in these communities, which includes investments in research in sea level rise, extreme storms, etc.

The panelist concluded by discussing the three major components of the strategic plan proposed in 2012. The first component is the shift of field activities to long-term experiments. There that has been a study of permafrost in the artic launched as well as another study in the tropics. There is a desire to launch another project in CY2017/2018 and workshops will be held over the next year to advance this.

The second component of the plan is the introduction of a new model, ACME, to the family of US climate centers. This model is similar to CESM, and was actually created by taking code from CESM and modifying the code so that it would blend well with the next generation of computers. In the future codes for models that predict other systems, such as the water and carbon cycles, will have to be rewritten so that they will run smoothly with this next generation of computers. There is also a need for a finer resolution. A human component has been added this month, and an Impact Adaptation and Vulnerability (IAV) workshop will be held this winter. The presenter stressed that this process (modifying code) will not be an easy task.

The third component is the implementation of a major data infrastructure. NNSA and the Light Sources at the National Lab want to create umbrella that will host multiple

data systems in collaboration with NASA. This will be a big challenge as the community has multiple databases that need to be conjoined.

The last panelist reviewed the status of the current budget for NASA and highlighted ongoing and future projects within the organization.

The panelist began by assessing the Earth Science budget and stating that it shows a steady level. There is an increase in the budget for FY2016 compared to FY2015 due to long-term responsibility for monitoring altimetry, sustainable winds, and solar irradiance. Earth science research has increase, in particular a significant increase in applied research. There has also been an increase in the InVEST program. The organization also wants to maintain a sustainable land imaging program.

The panelist then briefly reviewed the missions that are in action, missions that have recently been launched, and missions that will be launched in the future. There have been five launches between February 2014 and January 2015 and there will be 11+ launches up until 2022. SMAP had the most recent launch, which occurred on January 21, 2015. Satellites that monitor the hydrologic cycle such as SWOT and GRACE were also emphasized. The panelist stated that continued development of launched products is needed, and that is would be beneficial for a science panel and a user panel to review some of these products.

The panelist also called attention to the fact that NASA host open data that is shared throughout the world and mentioned that they would like to lead other nations in that aspect. The administration is also proposing long-term measurement mandated missions. The audience was proposed with an important question: What is the right balance between innovation and sustainability?

The panelist concluded by mentioning several long-term projects:

Multi-component programs through 2030: TIR-FF, LandSat 9, Land Imaging Technology & Systems Innovation, LandSat 10

PACE Mission: Observing coastal regions and different implementation approaches to see improved signals on coastal regions.

EVS-2 suborbital mission 2016-2022 budget is $162 mil.

EV-2 investigations include aerosols, ocean melting Greenland, atmospheric tomography, marine ecosystems, and atmospheric carbon transport. NASA wants to coordinate more with other countries, such as Greenland and Euro Space Agency.

Q & A Session:

Q: Panelist 3 was asked to elaborate on ACME.

A: The DOE wanted a model that would port easily with the architecture of the new machines. CESM would not be able to do so easily. The panelist believes that NOAA is not too far behind in this updating process and hopes that the models will eventually converge again.

Q: Panelist 1 asked to comment on where the line between the government sector and the private sector of the ocean enterprise lies.

A: This idea is new and it needs to be discussed sooner rather than later by both sectors. Each sector will have to provide data, information and services. There needs to be a seamless intersection that everyone can agree with.

Q: For every satellite, there needs to be adjustments for systems. What are your thoughts on that? Should every satellite have assimilation?

A: We need observationally driven modeling. Reanalysis needs to be performed as often as possible and on as much data as possible to ensure that the data are consistent. We must also build the user community. The applied sciences program tries to line up partners before launch so people are tuned in as soon as possible. Next month in Silver Spring there will be SIGNUS operation meeting.

Q: NASA has seen commercialization over past couple of years. What have you learned in the process? How can weather community learn from NASA's commercialization?

A: This is a new process so there is much to be learned. Users love data sets, which can cause commercialization to work. There is a challenge in maximizing use of data nationally and internationally while keeping private data policies. It is very important from a research perspective to do things in a way that will support research community to do its job, as well as encourage partners to make data continually available.

Q: What programming language should we tell students to learn?

A: Panelist 3 first stated that they did not know the answer, but they have spoken with university atmospheric science departments and these departments have talked to the university computer science departments to find a solution.

Panelist 1 believed that there needs to be an interdisciplinary effort to find the solution.

Panelist 3 also stated that there needs to be an effort between the community, computer science departments, and computer developers to train students entering the community to use specific languages and software. ACME was used as an example.

Q: We are making many great efforts, but is our portfolio too big? Does the volume of projects and ventures make it difficult for agencies within the community to communicate and focus?

A: There is a need for interdisciplinary approach as far as climate system and weather. We need to put human drivers and behavioral sciences into our approaches to simulate the plant.

There should be a national conversation about how to make earth system science work and we should integrate our agencies to be on the same page. The community has challenges and financial pressures and we are not doing a good job managing conversation about the nature of the challenges and the importance for national security and prosperity. We need to improve and integrate our approach to Congress and the public.

Some changes that occur now were not happening as little as 10 years ago. Society now wants to know the future of everything. A sense of urgency has been created with big the issues and society wants to know how close to tipping point. The President's Climate Action Plan needs road maps to address this sense of urgency with climate. Why does it take science so long to go into system? How do we accelerate this? This acceleration process can be achieved through private-public partnerships, international technology developments, and brainstorm sessions.

Student Presentations

A new development at this year's forum was the inclusion of small time slots for students from participating universities to talk about their respective studies and projects. One presentation was given by one or two students from each of the participating universities (University of Maryland, Millersville University, and Howard University). An example of the content is shown in Figure 8, where weather impacts on retail store performance were investigated. All of the presentations were of good quality, and the plan is continue incorporating these into future Washington Forum events.

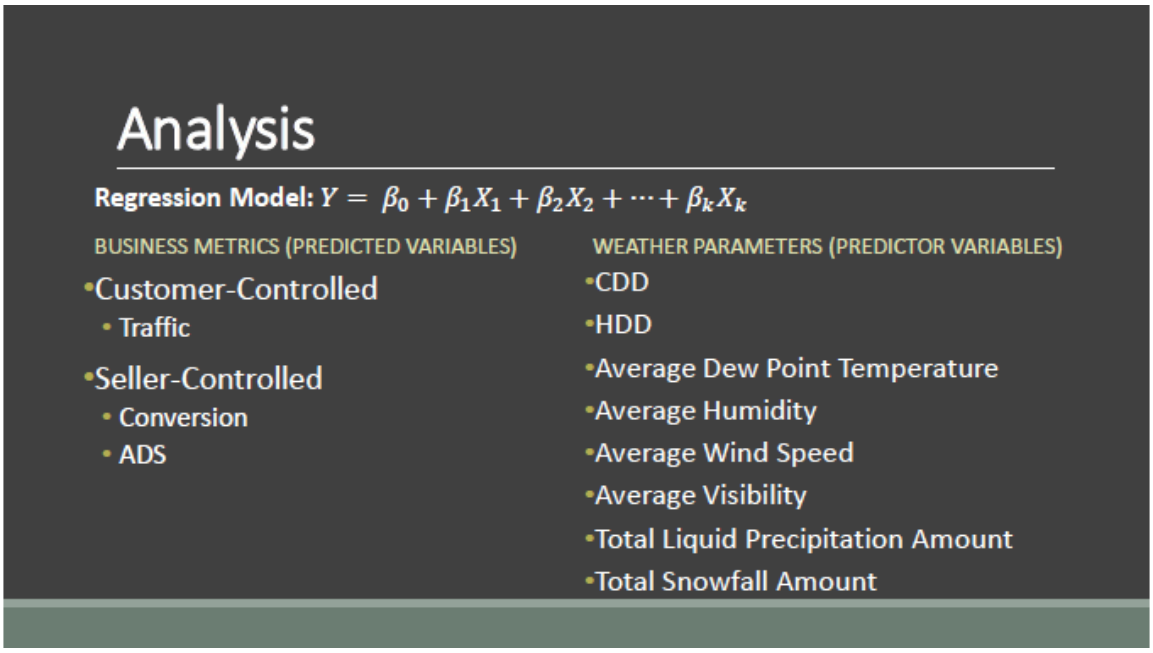

Figure 8. Example student presentation (Tim Loftus, Millersville University).