Integrated Hazard Information Services Workshop

Discretionary Director Funds Report
October 27-29, 2009

Abstract

With Discretionary Director Funds, the Information Systems Branch hosted a workshop to improve the National Weather Service Integrated Hazard Information Services. There were over 60 participants representing the full spectrum of stakeholders – partners (emergency managers, the media, private sector customers...), social scientists, operational weather forecasters, software developers, and program managers – from diverse organizations across NOAA and the private sector. A short video, "In Harm's Way..." was created to kick off the workshop and show the many diverse players in the Research to Operations process.

The workshop agenda, presentations, reading material, and resulting plans can be found at the website: http://fxa.noaa.gov/NGWT/NGWT_Workshop.html. From the workshop results, we hope to build a flexible, extensible framework which can accommodate existing capabilities as well as allow for the creation of new, state-of-the-art hazard products and tools. Workshop results will feed into NOAA funding proposal documents, a Global Systems Division presentation, and a January 2010 American Meteorological Society (AMS) presentation.

There was both innovation and challenge in bringing all stakeholders together in one room to represent each of their interests; the scope was broad, but the reward is a design that begins to encompass the full range of requirements.

Summary of Outcomes

A major thrust of the workshop was to transition the current hazard program from a paradigm of issuing products to one of decision support. The goal was do define what **information** is needed and in **what forms** to aid all of those who need to make decisions.

Presentations and breakout sessions focused on forecaster and partner perspectives as well as various hazard types – long-fused (e.g. hurricanes, winter weather), short-fused (e.g. tornadoes, thunderstorms), and hydrologic (e.g. flood-related). The roles of social science were discussed and appreciated in addition to the importance of active and continuing communication between the partners and forecasters. There were many ideas for launching, continuing and enhancing these interactions.

From the workshop, it was concluded that hazards information should be stored in a common database. Applications can be written for both ends of the database (input/output) - including possibly from external partners. This will include subscription services, push/pull products, and point-and-click hazards. We need to ensure that legacy products and dissemination systems are retained, as many of our partners and stakeholders will still rely on these for years to come. Menus, GUIs, the look and feel

and help should be uniform and intuitive for all applications. Then from a common database, we can start producing grids and graphics as well as the legacy text products with just a few mouse clicks. We also need to be ready to provide uncertainty information in a variety of ways - grids of numeric probabilities, descriptive text, categorization (e.g., low/moderate/high), best case/worst case/best guess.

We want to make sure that social scientists, forecasters, and partners are included in developing the new products and information streams as we go. Also, we need to make sure policy changes go hand-in-hand with any software development. Rapid prototyping on a national level, incremental development and testbed validation will be part of the implementation plan.

Next Steps will include:

- Implementation Plan: A collaboration between developer organizations (GSD, NSSL, MDL, IRIS team, NHC, OHD) who were previously working independently. We will work toward the same goal without duplicating or competing efforts. The prototype will be implemented incrementally with first and highest priority going to the forecaster tools for creating hazards by integrating the functionality of WarnGen, GHG, and RiverPro. As we develop, however, we will design for the long-term vision.
- Partner Collaboration Plan: The outreach sub-committee of the national Hazard Services team will follow-through on the workshop suggestions to ensure that there is continued and enhanced Partner collaborations.
- Social Science Collaboration Plan: Continued and enhanced social science collaborations.
- Refined Requirements: Enhanced requirements will be incorporated into the PPBES funding proposal process.

Contents

Workshop Structure

The workshop was structured around three breakout sessions designed to give the wide set of workshop participants numerous opportunities to discuss their current and future needs and preferences. We began with a background session of presentations describing the results from previous workshops, the social science interview results and contributions, the current software tools, and new capabilities such as Inter-Regional Integrated Services (IRIS) Database and Probabilistic Hazardous Information (PHI). We also presented a Strawman Design as a starting point and frame of reference for the breakout questions. We set the tone for the workshop by noting that "Warnings are relative to impacts, impacts are relative to the situation." This set the stage for thinking in terms of the Decision Support paradigm. In addition, there were several panel discussions sprinkled throughout the workshop that were extremely illuminating.

In designing the Breakout sessions, there were multiple dimensions to consider to make sure that the broad scope of the Hazard Services problem was covered:

- The full spectrum of stakeholders needed opportunities to weigh in. Forecaster tools, partner needs, software requirements, programmatic issues, and the role of social science all needed to be included.
- Short-fused, long-fused, and hydrological hazards needed to be considered. We employed three service assessment cases (Super Tuesday Tornadoes, Hurricane Katrina, and Pacific Northwest Floods) to help focus on the real-world issues in each of these areas.

Addressing all of these concerns proved to be challenging. In some ways, by trying to please everyone, perhaps some were not fully satisfied. However, the workshop marked an important first step toward integrating the players to produce meaningful and complete requirements, and, in that sense, was a solid success.

Social Science Contributions

Preliminary Research

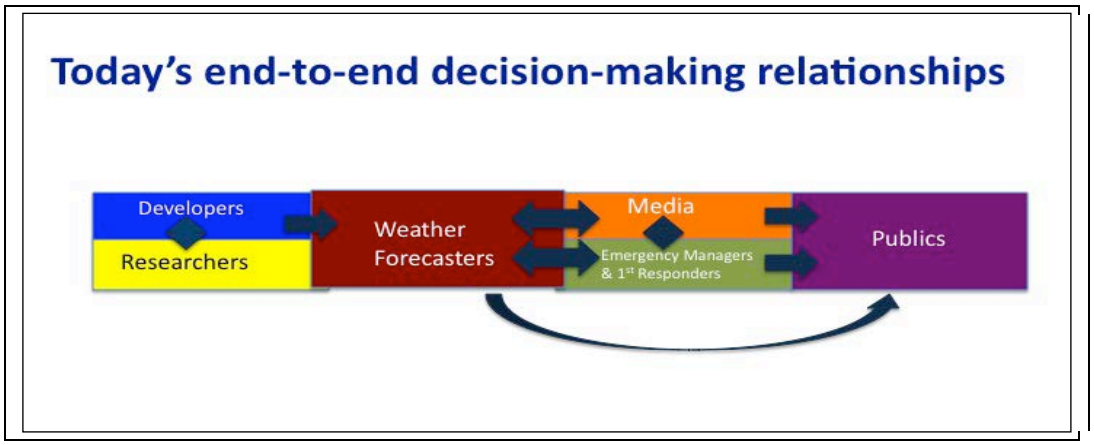
Prior to the October workshop, the Social Science Woven into Meteorology (SSWIM) group at the University of Oklahoma conducted research, in order to gain insight to the relationships between partners, forecasters, and developers within the hazardous weather enterprise. This preliminary research provided insight to existing relationships between various sectors, as well as informed the agenda for the workshop and future related work. Time and space were the main frameworks for this study, which enabled each interview to be grounded in theory, while addressing the following research questions:

- How do spatial/temporal weather information needs vary for different partners?
- How do partners, within in the hazardous weather enterprise (forecasters, partners, etc.), interact/communicate with each other to improve their situational awareness and make better decisions?
- How do partners interact/communicate with those outside of the hazardous weather enterprise (various publics or other end users) to provide the most useful and quality information?

Interviews were conducted with a subset of workshop participants. Data was collected through semi-structured, hour-long conversations with people across the spectrum of developers, forecasters and partners (table 1). Interview questions focused on spatial and temporal needs of the participants in order to better understand the range of time and space scales as they apply to weather information and hazardous weather decision-making. All interviews were audio recorded for further analysis and synthesis.

	Position	Regional Jurisdiction	Major Hazard Concerns
Partners	Manager for information and hydrologic warnings	Denver, CO metropolitan area	Hydrologic hazards. flash flooding, snow melt flooding
	Broadcast meteorologist	Kansas City, MO	Severe weather
	County emergency manager	Galveston County, TX	Tropical
Weather Forecasters	National Weather Service forecaster/information technology officer	Pueblo, CO Forecast Office	Hydrologic hazards, winter weather, severe weather
	National weather service forecaster	Memphis, TN Forecast Office	Short-fuse events: tornado, severe storm
Developers/Manager	GSD meteorologist/software engineer	NA	All hazards
	National Weather Service software developer	NA	Short-fuse events: tornado, severe storm
	National Weather Center program manager	NA	Short-fuse events: tornado, severe storm

Graphics were then constructed from the data gathered from interviews. Graphics were developed to capture spatial and temporal themes form the interviews as well as understand interactivity between various members of the research to operations process. First, we assessed the existing, established relationships between all decision makers in the research to operations process (figure 1).



This conceptual model represents the current relationships that promoted interaction between different sectors. Double-sided arrows represent two-way interactions and one-sided arrows represent one-way communication. Interviewees provided examples that reiterated these established connections. The broadcaster that was interviewed mentioned how he uses NWSChat and other interactive communication tools to have two-way conversations with weather forecasters as well as emergency managers during a hazardous weather event. At the same time, television broadcasters are pivotal for disseminating hazardous weather information to the public. Through local broadcasting and cable networks, they provide watch, warning and other weather information in a one-way manner. This is just one example of how different types of relationships and interactions are used by the broadcaster to make their decisions about hazardous weather information. Other decision-making positions within the chain of hazardous weather information depend on their own interactive communication to make decisions.

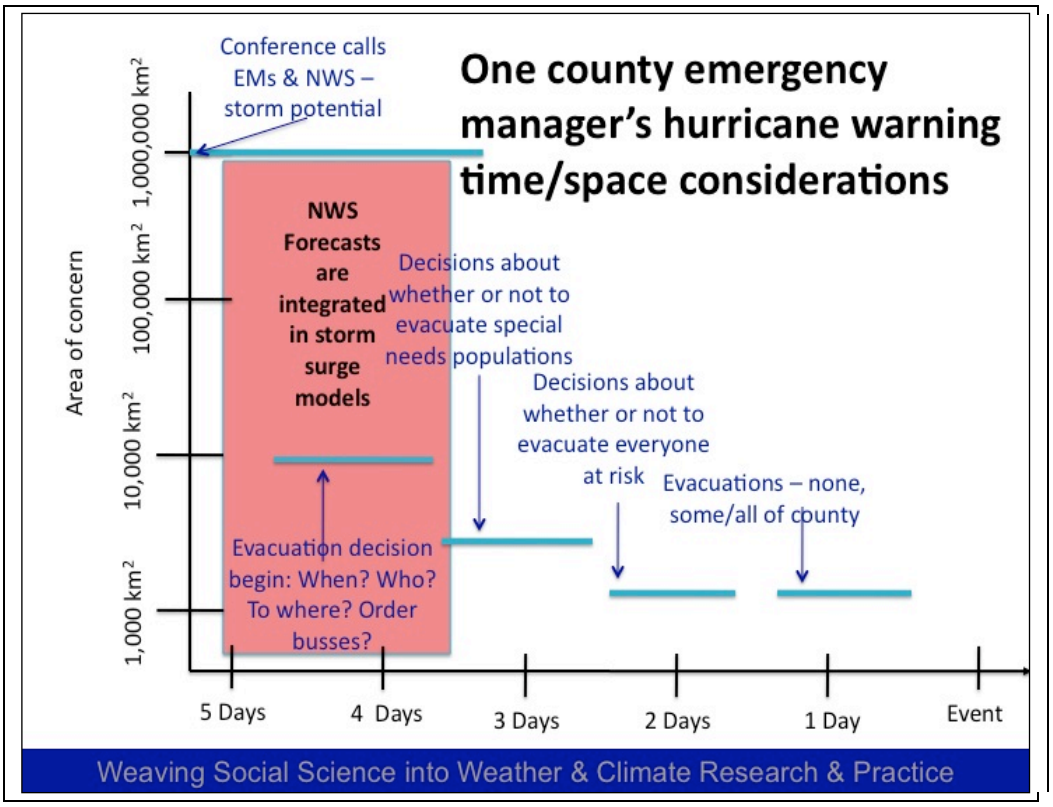
One important finding is that the more quality collaboration and two-way communication between partners, the more confident the decision maker is in his/her information output. Again referring to the broadcaster's response, the close relationship and level of trust that has been established between the WFO and the television station has allowed for interactions that have led to better decisions in hazardous weather events.

Interviewees also identified differences in spatial and temporal needs during hazardous weather events. Table 2 provides examples of some basic differences concerning the ways that different partners are concerned with various space and time scales in hazardous weather and warning situations.

Partner Position	Space	Time
Hydrologic Warnings	Flash flood concerned with fairly small scale drainage catchments	Short time frames for warnings, generally 2-3 hours
Broadcast Meteorologist	Broadcast viewing area,	Generally don't break into

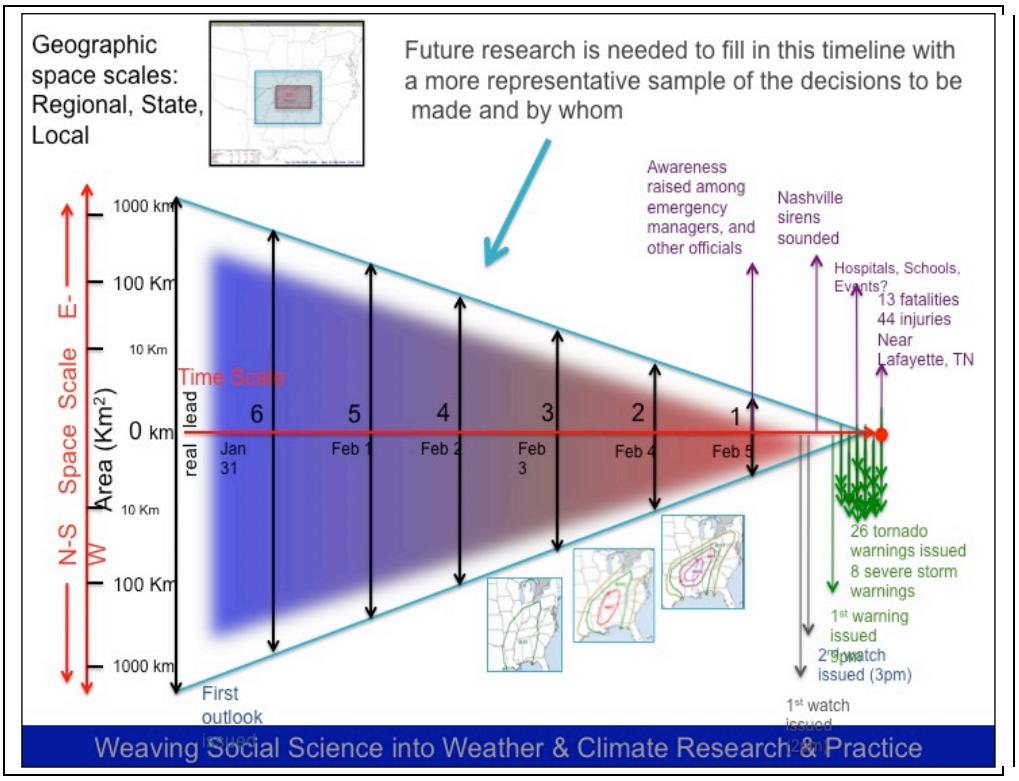
	generally metro area and surrounding counties	programming until the warning is issued, once the warning expires they return to programming
County Emergency Manager	Concerned with county jurisdiction	Interested in accurate information 5 days before hurricane landfall to prepare for evacuations
NWS forecaster/IT officer	Concerned with WFO region	Often there are winter events which tend to have a 4-5 day advisory, watch, warning cycle
NWS forecaster	Concerned with WFO region and bordering regions in severe events	Interested in long term forecasts, however severe events (tornadoes) tend to be quick and warnings are typically around 30 min long
GSD Meteorologist.	Not as concerned with specific time and space scales, rather concerned with how warnings are issued across all time and space scales	
Software engineer	Both time and space are important factors that can mean very different things to different people. i.e. one person my need severe weather information 2 hours before to find shelter, while another may only need it 10 min before	
NWS national center	Important to be sensitive to different requirements for space and time, also different times of the day or year can mean very different things, depending on the place that severe weather impacts	

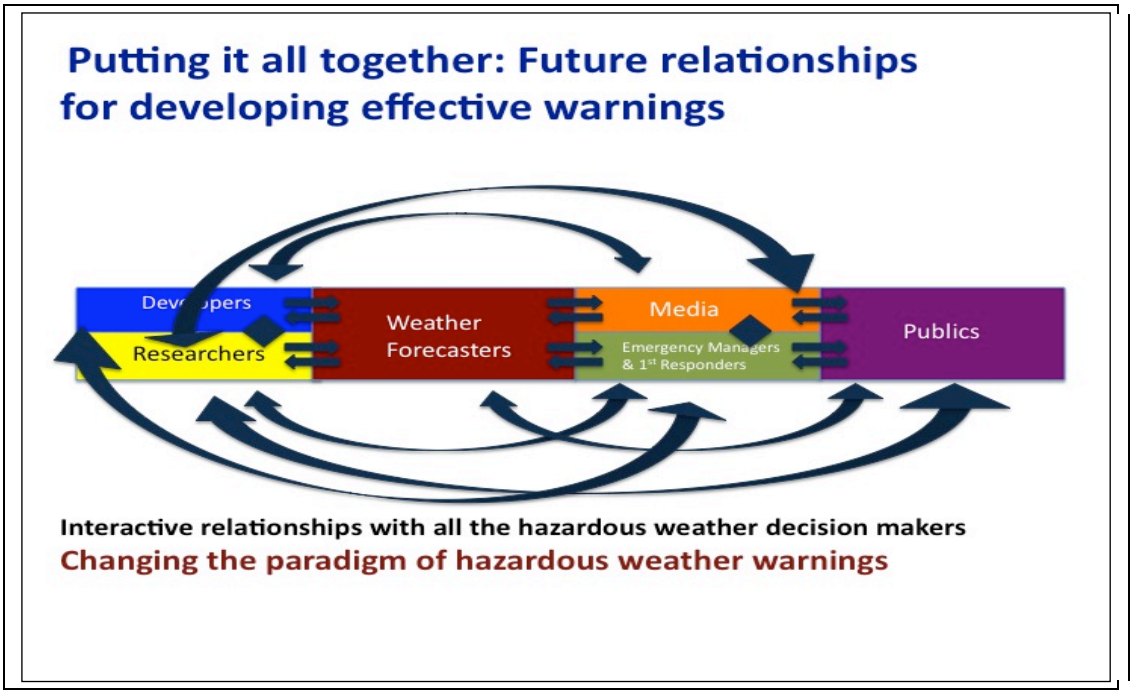
We further synthesized these spatial and temporal components into graphics that represent various interviewee perspectives. From the perspective of the emergency manager that is responsible for county evacuations in Galveston, he is interested in very early communication of storm surge potential. He uses various tools, such as the SLOSH storm surge model, as well as forecast information and interactive conversations via conference calls with nearby emergency managers and forecasters. The variety of information sources allow him to make better decisions about when to evacuate, how to evacuated special needs populations, who to evacuate, what types of transportation to use, where to send people too, and many other decisions (figure 2). This schematic includes the time and space scales of various decisions for the emergency manager during a hurricane event.



Other hazardous weather events have different time and space scale considerations. In a tornado event, the Storm Predication Center (SPC) issues outlooks several days out, but most decisions are not made until a few hours before the actual event (figure 3). In a short fused event such as a tornado outbreak, the relative certainly and/or uncertainty also is scale dependent. As the space scale gets smaller, there is less certainty about the exact location of a tornado. As this diagram also represents, the smaller the

time/space scale the more decisions that are being made. Forecasters are quickly issuing warnings, media personnel are making decisions to interrupt programming and the public is making various decisions about taking shelter. This diagram represents only a very limited perspective of the Super Tuesday Tornado Outbreak from one forecaster that was interviewed. In order to understand more about decision making in this type of a hazardous weather event it will be important to continue to research interactions, communication, and information gathering from various different positions.





Moving forward:

Our preliminary research and this workshop revealed the need to continue to promote interactive, two-way collaboration efforts across all sectors of the hazardous weather enterprise (figure 4). The ultimate goal is to change the research to operations paradigm, away from a top down approach, to one that is truly engaging and representative of all perspectives, concerns and ideas of those involved. This workshop has been a pivotal step in this process with the incorporation of social scientists and partners, as well as forecasters and developers. Future work should continue in this direction with an emphasis on collaboration and partnerships that are sustainable from the first stages of product development, all the way across time and space scales to the moment that hazardous weather impacts a community.

In order to further develop this approach, language, technology and policy barriers will have to be addressed, and all participants will have to be more equally represented.

One vital contribution that social scientist can make to the hazardous weather process, is to continue cross-disciplinary research that encompass all sectors of the hazardous weather warning process. Social scientists are in a unique position to provide insight into various different user perspectives and should also actively engage with the "publics". While this workshop did not address the "publics" specifically, many opportunities to include these perspectives were offered. Various other issues that were addressed at this workshop, as well in past discussions, that call for more research across all hazardous weather partnerships.

- Warning communication and trust factors

- Warning visuals
- Warning dissemination
- Vulnerable groups
- Population densities
- Impact-based warnings
- Responses to spatially-based weather information

There continue to be great opportunities for future research in this field, as we watch a new paradigm emerge in the research to operations process. SSWIM graduate student, Zappa, is particularly interested in studying the social networking of the people involved in the hazardous weather process. Zappa intends to investigate questions concerning whom the partners/forecasters interact with to make decisions? How do they interact? What are the time/space components - relative to the whole process? What are some difference between days with weather events and days without big weather? This investigation will likely implement a case study methodology with a particular focus on one subpopulation (i.e. forecasters, emergency managers, traffic department officials, or a specific public group). Another goal of this work will be to develop the methods for better understanding the social interactions and networking process of hazardous weather decision making. One starting place for data could be USACE-US Army Corps of Engineers, which has OMB-Office of Management and Budget approval to conduct behavioral analysis after disasters (public surveys) similar to the NWS Service Assessments. We could begin mining some of this information from social networking sites. In addition, this work will explore how theoretical frameworks can continue to facilitate this applied research and facilitate a new way of approaching weather related issues, problems, and questions? The growth that has emerged in just the past few years has provided great opportunity for more research, collaboration and a more sustainable future in the hazardous weather enterprise.

Social Science Panel Discussion

A panel discussion with the Social Scientists in attendance was held yielding the following thoughts.

Social science research theories and methodologies are applicable to many elements of the hazardous weather enterprise. The Social Science framework can help with the development of a more inclusive process for the Research to Operations paradigm. Through the understanding of the needs, capacities, and limitations of the various communities in the hazardous weather enterprise (from the local publics to broadcasters, emergency managers, private sector, forecasters, National Weather Service offices, policy makers, software engineers, and researchers) we can establish interactive communication and collaboration to build an iterative, and successful research-to-operations process that accounts for what partners already appreciate about current products and tools and incorporates genuine identified needs for new products and tools.

Social Science Methodologies:

Interviews, surveys, observations, focus groups, and program evaluation can contribute to the ways that we can better understand all of the complex processes of interacting effectively with all sorts of weather.

Social science research related to hazardous weather is multi-dimensional. We can study how the vulnerability of a place influences the preparedness of a community, which in turn impacts how the community and individuals within that community and community officials respond to hazardous conditions. We can also identify factors influence the decisions that individuals make prior to, during and following hazardous weather events, and how they use information from forecasters, media and other officials to make these decisions. Moving along on the chain of hazardous weather players, we study the transfer of information and interactions between different partners. We also assess how information can be interpreted differently depending on various factors such as past experience, geographic location, and many other factors.

Breakout Sessions

Note that all breakout session instructions can be found on the web site under "Workshop Results – Breakout Instructions".

Breakout 1: Forecaster Tools and Partner Wish Lists

Overview: For Breakout One, we had Forecasters and Partners meeting separately to discuss their "Wish Lists". Other stakeholder representatives (e.g. developers, program managers...) were mixed into the Forecasters or Partners groups.

The groups were reminded of the ground rules.

1) Don't let current technologies limit ideas. People often get caught up on what they can't do because of the current technologies. To get a useful wish list we need to focus on not considering these limitations.

2) Don't let institutional policy limit ideas. Similar to the technology limitations, we should make sure that people are not limited by current institutional technologies.

A. Forecasters

The forecasters were to consider the questions:

- How do you feel about forecasting hazardous weather?
- How do you feel about the current tools?
- What are some limitations of the current tools?
- What are some useful features?

The forecasters were split into three separate breakout groups. The three separate groups then merged into one group to compile a list of wish list features. There were many overlapping ideas among the separate breakout groups and the various themes were highlighted.

- **Integrated situational awareness**

In many severe weather events there are several warnings issued at one time, all of which have different expiration times. One suggestion for keeping the forecaster aware of what is happening in a severe weather event was a post-warning issue checklist. Forecasters agreed that there should be an effective way to manage all of the warnings that have been issued and when they expire. A checklist of warnings issued, and the ones that are still active, and how much time lift on each warning would help to manage the situation. In addition to listing the warnings and when they expire, it would be useful to incorporate

other situational awareness capabilities that could help determine who/what the warnings affect. One forecaster summarized the desire for such as feature:

"We issue warnings to protect life and property, yet we don't have any internal tool to manage those warnings. We need to know when warnings are going to expire, who knows about them, how they're being communicated… Right now, all that information is tracked "in the air"—orally, between forecasters and stakeholders. Each office—each forecaster—does something a little different. There are whiteboards; some forecasters keep a list on paper, etc. And then there are reports from the field, which amount to someone calling in and saying, "Hey, there's a tornado over here," and the forecast office looking through a map asking, "okay, where's here?"

- **County Warning Area sectorization**.

When storm cross boundaries from one county warning area to another, warnings sometimes are not uniform. There are no tools now that can help with the coordination between forecasters and groups within a weather forecast office. The new tool should address how to make it easier to communicate during a hazardous weather event that impacts different county warning areas, in addition to making coordination easier within the weather forecast office.

Another feature that was suggested to help forecast office communication was to have a live, synchronized viewing of proposed warnings. Forecasters suggested the desire to have real-time communication between their forecast office and other forecast offices. A tool that allows information to be live and available for use between all offices during a hazardous weather event would be useful.

- **Workflow**

Currently, workflow is problematic, and needs to be more intuitive. Forecasters expressed that the interface of the WarnGen tool is difficult to use. Even on a very fine-grained level, the interface does not lend itself to developing fast muscle memory. Forecasters identified other tools that perform better, such as Blender. Another suggestion for integrating a user-friendly interface was to create a data-centric display with floating widgets or palettes. Another issue that was highlighted was how to training forecasters to use hazard tools. Currently it is difficult to train for WarnGen, and the various different types of hazardous weather situations. In order to insure that tools are useful and usable for the forecaster, some type of structured testing should be conducted. This testing should include forecasters to offer their feedback in the new tool building processes

- **Viewing Interface**

The new hazard services should include integrated viewing (flexible and user-defined). Forecasters continuously expressed their desire to have an interface with features that can be specified and altered by the user. This would be some type of a "build your own view" for graphical displays. This feature is

very important because it gives the forecaster context of the area for both physical (rivers, lakes, terrain, etc) and social (political boundaries, population densities, highways, etc.) features. One goal should be to make systems more geo-referenced so forecasters can overlay different layers. If these user-defined layers were available in the warning tools, forecasters could issue a specific warning *for that thing*. It was also mentioned that storm warnings should not be drawn according to political boundaries. In addition to physical and social layers, there should be multiple entry points available. The entry points should allow different forecasters to set their own viewing area for space and time. Because each forecaster is different, they wish to have more control over how they initially enter into the hazard services. The forecasters wish to have an interface with a map background of similar quality to Google Earth, with the ability to pick multiple layers.

There should be specified viewing for each hazard. Forecasters discussed that different hazard types have very different characteristics. Because of these differences, data types that are necessary for each different hazard should be predetermined. What descriptive data is must-have (i.e. a severe storm warning needs an area polygon)? What descriptive data is nice-to-have for various hazard events? Geography is also important to consider in various hazardous weather types. What kind of locations and geography does it affect? Forecasters suggested that customers could help to determine these requirements. Also, query functionality should be hazard-dependent. Long-fused warnings should have better query functionality. The *tool* should have threats in motion and propose warnings, such as where and when the warning should be. Lastly, different hazards should have a system of **single utility** with **consistent steps** for describing different hazards**.**

- **Other communication**

Forecasters identified NWS Chat as a useful communication tool that should be expanded. New features should integrate more specific information from the hazards database *(ed. Google Wave?)*. It would also be useful to have a customizable chat crawler (ex: /golf.sized.hail/) in this tool. The tool should help to standardize relationships with regional emergency managers. This would improve **hazard delivery**. Response thresholds could also be useful to communicate and deliver warnings to users.

- **Collecting data**

The data that goes into the hazard service tools will likely come from a variety of sources. There should be “helper” widgets that run forecasters through the process of collecting data. Offices should be able to customize helper widgets: pick which ones are on, write new ones, etc. Also, new tools should incorporate high-frequency model updates. Forecasters should also be able to easily populate and edit the database from short-range models. The initial data inputs should be able to draw from internal products to create **first-guess warning fields.**

- **System Requirements**

Forecasters expressed the need for higher-resolution, scalable, performing systems. They noted specific examples that have different resolution such as aviation, which has a global domain, and Guam. Nested grids of varying resolution, and some kind of bandwidth-friendly solution for progressive data access. Also, forecasters mentioned a Bayesian conditional confidence grid that could improve warnings. The system also should work with the national center's applications. Warning data should be **output in a structured format**. It was suggested to use XML or a similar type of structured output. This could insure that data is useful for partners and other forecast offices.

- **General features of the tool**

Forecasters expressed the desire for a tool that **works well, and works fast**. It should be **integrated and flexible** and allow for seamless transfers between forecast users and between forecasters at different WFO's and NCEPs. Transfer of authority for backup. A default for issuing certain products should be incorporated, and also have flexibility so that a forecaster can change products based on their status. The tools should not be limiting to the forecast process. It is important to ultimately let forecasters do what they are trained to do. It was also noted that every keystroke should be meaningful. Every keystroke of warning should have meteorological reasoning and support delivering interpretation and decision support to customers.

- **Customized outputs**

Forecasters realize that different partners and customers that use hazard warning information use the products differently and have different requests. There should be flexible outputs that address various user needs. This is quite challenging as there are so many different users, and it was also noted that the Weather Service should move away from the business of generating unique information for each class of users. Aviation needs information in a **4D weather cube**. Some customers like **probabilistic** forecasts, while some do not. There should be some type of thresholds established for defining probabilistic weather warnings. To accommodate for the wide variety of users, there should be multiple, customer-driven products for the same hazard. It was also noted that forecasters should have more flexibility to issue some impact-based warnings, rather than based on thresholds. This resulted from the need to have a **smarter context about products**. For example, freeze warnings are issued in September and October, not January and February. Another discussion that the forecasters had was that legacy products should continue to be issued, in addition to new warning products. As technologies improve new ways of warning will be better, but many people still rely on the old ways. It was not entirely agreed on how to do this.

B. Partners

The partners were also split into three separate breakout groups. The three separate groups then merged into one group to compile a list of wish list features. There were many overlapping ideas among partner groups that also were consistent with some of the forecasters' ideas. One overarching theme was concerning how to define the content of the database, and including information from many

sources and stakeholders as well as preliminary information. Another key idea was that new information and products should be discussed with both social scientists and stakeholders.

The partners were to consider these questions:

- How do you feel about the hazards information that you receive?
- How does this hazards information positively inform your decisions?
- How does the hazard information make your decision making more difficult?
- What specific capabilities would make your decision making process more effective?

- **Products**

Forecasters noted that the National Weather Service should make the information more palatable for the consumer. Partners felt that a watch status is not very useful for the general public**.** Partners also felt that products should be able to be processed quickly by users so they can make decisions. Some products now are too slow or difficult to access quickly and make decisions in a short amount of time. Partners had various ideas about what types of information was most useful for them, it was decided that products should offer various types of information including risk, direction, severity, probability and threat. Partners would like the forecaster to be able to communicate what they are thinking, and not be limited to giving products in one standard format.

Products should also include various elements of severe weather. For example, hurricane warnings warn for winds, however this doesn't tell the whole story, storm surge potentially kills more.

Partners also discussed how products should be disseminated. Ultimately, they agreed that products should to be adaptable and tailored for new technological innovations (i.e. mobile devices).

- **Consolidate Products**

Partners identified that they feel that there are currently too many hazard products for similar weather types. For example products should be consolidated and impact-based when the hazards are similar. Partners also expressed a desire for digitized continuous forecast, which would allow them to track the real-time of movement and evolution of convective weather (push-based update). Future tools should also have the ability to interface with other existing systems and databases.

Conversations also brought up how local communities should be notified about hazardous weather. Some suggestions were made that forecasters may have more involvement in the actual warnings. Along this theme, it was suggested that the forecasters should have the capability to prioritize products for alerting to the local community (i.e. tone products or text products).

- **Accuracy, reliability and consistency**

Partners expressed that data and products should be accurate. In general, they thought that over-forecasting to them was okay, not necessary the general public, however under forecasting was less desirable. Partners also felt that forecasts should be consistent (formatting, graphics, etc.) when viewed from the state or regional perspective, at the local level there could be more room for flexibility.

- **Timely information and communication**

Partners identified that they would like to get forecast information more frequently and that they would like to have more interaction with the forecaster. One partner described this as "getting into the brains of the forecaster". There was also unanimous support for more frequent discussion between forecasters and partners in hazardous weather (some possible ways; blogs, tweets). Along with this theme of communication between the forecaster and partners, was the desire for more timely information. Partners request the early-heads up for various different types of hazards. For a blizzard, a two day announcement would be useful, and for a thunderstorm, two hours. This lead-time information would be more useful if it was coupled with some type of uncertainly information. It was mentioned that the hurricane program has good practices for communication of lead-time and uncertainly in hazardous events. Partners agreed that earlier information was useful, and some advocated for using "best case, worst case, and most likely" situations, which the forecasters would provide. In addition, low, medium, high probability characterizations would be useful for emergency managers. Essentially this is another way to package uncertainty information, rather than attributing a percentage chance of an event occurring. Issues of interaction between the scales of government (local, state, regional) was also discussed, as they require different levels of interaction (i.e. large state can't interact with all WFOs). Often times local communication is established between emergency managers and local forecasters; however there are still problems with aggregation as the communication propagates to higher levels. Partners felt that national coordination is imperative for all widespread hazards, such as winter storms. Ultimately, partners noted that products need social science and other input to improve their communication potential. Graphic products can be misleading, need vetting and research to ensure they communicate the intended message.

- **Evaluation**

Partners appreciated that they were included in the workshop and decisions that were being made about hazardous weather warnings. They also felt that new products should be vetted with users as the evaluation and implementation process progresses. Social science methods and research should be an integral part of the new tool development progresses.

- **Data**

Forecasters expressed their ideas about combining hazardous weather products with other applicable information to provide the best situational context of the product. One way to do this would be to

combine National Weather Service products and data with local history, people's experiences and training exercises. Other conversations of this topic suggested a system that has the capacity to record and archive impact data in a compatible form. This would address questions regarding how people respond to events and different behavior (any level, individual, Ems, etc.) that would be beneficial for social science research. There should be more research that focuses on socially based questions. This would also inform the public reaction sequence, and provide insight to how people act in hazardous weather events (i.e. denial, deliberate, delay, decisive action).

Partners also felt that more interactive real-time data would improve situational awareness. This process would be best supported by two-way interaction between forecasters and emergency managers (or other partners) who could report directly to the National Weather Service about what people are doing on the ground. The real-time data could address questions about where the storm is going, and what the impacts will be.

Consistent with concerns of forecasters about data output, partners thought that and raw and meta-data should be provided from the National Weather Service. Raw data should be provided in a usable format so that partners can use it as they need. It was also agreed that the National Weather Service should be the officiating entity of the data and that all data should be free for the partners.

Breakout One Requirements Summary

Forecaster Wish List

- Integrated Hazard creation tool that retains the specialized features or WarnGen, GHG, and RiverPro with a common look and feel.
    - Make the tool intuitive e.g. provide a customizable helper widgets, multiple entry points for each operation, post-warning issue checklist
    - Integrate situational awareness (current, proposed warnings, GIS, etc.) with Google-earth quality maps and layers
    - A data-centric display with floating widgets
    - Have the ability to create "threats in motion"
    - Collaboration
    - CWA sectorization
    - Interface to aviation 4D data cube
- Improved and expanded products
    - Retain legacy products
    - Standard formats e.g. XML, CAP, HDF5 grids, shapefiles...
    - Multiple products for each hazard and customer-driven products
    - Impact-based vs. meteorologically-based (some disagreement)
        - Think impacts rather than thresholds e.g. what impact will a 20 knot wind have?
        - Smarter context – e.g. issue freeze warnings in October, not January

        - Some thought that the NWS should only be concerned with the meteorology
    - Integrate probabilistic information, define probabilistic thresholds for issuing warnings
        - Possibly produce Bayesian confidence grids
    - Develop a web-based tool to track who's calling and what kinds of questions are being asked
- Improve and standardize relationships with Partners
- Hazard specification – we need to know for each hazard
    - What descriptive data is must-have e.g. a severe storm warning needs an area polygon.
    - What data is nice-to-have?
    - Vet these specifications through partners
- Recommender – propose warnings based on observations, multiple-sensor algorithms, models, forecast grids
- Higher-resolution, scalable e.g. for almost global aviation domains or very large domains such as Guam – nested grids of varying resolution and progressive disclosure
- Seamless Backup – all sites have the ability to backup any other site
- Customizable chat crawler to mine information
- Incremental, iterative roll-out so that high-priority tasks are done first
    - Structured usability testing

Partner Wish List

- Vet products and any new services with Partners and Social Scientists
- Free data-sharing among ALL stakeholders at ALL levels
- Products
    - Need best case, worst case, and most likely scenarios as early as 7days in advance
    - Customizable products – different partners require different levels of information. Need multiple space-time scales.
    - Consistency among messages
    - Too many products e.g. Hard Freeze, Frost. Consolidate where possible.
    - Digitized, continuous forecast of movement (threats in motion) and evolution
    - Include risk, direction, severity, probability, and threat. Prioritize for tone alerting.
    - Early heads-up ala National Hurricane Center (NHC) best practices
    - Messages should be able to be processed quickly in usable format
    - Interface to other systems, be consistent, integrate with local history, people's experiences and training exercises
    - Situational awareness in real time
    - Tailored for mobile devices
    - Determine a method for gathering local storm reports in real time, rapidly "decoding" them and returning combined information to the public in a more assembled, comprehensive format
- Accuracy and reliability

    - Over-forecasting is ok, but under-forecasting is not . There is some question about this -- perhaps a better approach would be for forecasters to forecast what they think, and if a partner needs to be "safe versus sorry", than they can adjust their probabilistic threshold downward – will result in higher FAR just like they may want.
    - Winds for hurricanes don't tell the whole story – include Storm Surge
- Improve and standardize relationship to forecasters
    - Get into brains of forecaster
    - More blog, tweets
    - Follow NHC best practices.
    - Ability to report to NWS to let them know what people are doing "on the ground"
- Need for Social Science to improve communication potential.
    - Record and archive impact data to see how people respond
    - Be aware of public reaction sequence: Denial, deliberate, delay, decisive action.

Partner Panel Discussion to further discuss the Wish List

- Need redundancy – don't rely on just one technology in case one system fails (digital and text products, NOAAPort / weather wire / blogs, Tweet). More technology can be a blessing and a curse. We need to remember to communicate across all cultures, economic and technological levels, and communities, as well as foster human relationships (e.g. between the NWS and partners) that will improve the handling of hazard situations. Choose technology carefully so there are no unintended consequences.
- Partners have varying needs:
    - Emergency Managers and Broadcasters need quick and simple messages -- "Playskool" look and feel -- What, When, Where, What risk. Remember that Emergency Managers are on information overload when deciding the "hit the button." For example, broadcasters don't have enough time to decode VTEC. Also, they need better geographical descriptors and clear labels on graphics.
    - The earlier information can be put out, the better, even if a low confidence is given.
    - On the other hand, Accuweather needs raw data at the "atomic level" to redistribute NWS data and derive products for specific customers. VTEC helps them since they CAN decode it.
    - We need better ways to understand uncertainty information.
- Messages need to address impacts. Instead of forecasting 10 inches of rain, tell us which roads will flood.
- Need better education on preparedness e.g. siren policy.
- Some have issues with overlapping polygon warnings.
- Relating to past events: There was discussion about the pros and cons of having the publics relate the current hazard situation to a past event such as Hurricane Katrina. It could be helpful in assessing level of risk, but could also be misleading, misrepresentative, or trigger the "hype" machine.
- Social Science needs to be included.

- Precision does not equal accuracy.

Break Out 2: Timeline and Process

Overview: Breakout 2 aimed to address the temporal decisions and desires of the partners and forecasters in different hazardous weather event scenarios. For Breakouts Two and Three, groups consisted of a mix of forecasters and partners working together. Using the wish list items from Breakout1, the groups discussed the timeframe of events and decision processes of particular hazard events. Each group created a timeline that was based off the Service Assessment Reports; Hurricane Katrina, Super Tuesday Tornadoes, and Pacific Northwest Floods.

Question: Several questions prompted the discussion. These questions addressed the information that is needed to make the best decisions possible in various hazardous weather events. Questions also provoked discussion concerning uncertainty, partner-forecaster interactions, and spatial representation.

Forecaster/Partner Interactions

Direct interaction with partners that goes beyond the predefined set of products and services (Watches, Warnings, Advisories) is an important part of the National Weather Service mission. This is especially true for high-impact events. Some examples of interactions can include live briefings, webcasts, conference calls, or one-on-one interaction. Partners discussed that direct interaction with partners in high-impact events is something that needs to be planned for before such events occur. For high impact events, direct interaction needs to begin well before the event gets into the warning phase, if possible. In addition, service backup needs to support more than just the defined set of products and services, but also the customary level of direct interaction. While it is important to improve and integrate the application suite that NWS forecasters use to provide predefined products and services, we need to take the same approach with respect to direct interaction as well. Forecasters noted that the interaction with partners should more transparent, telling them exactly what information is known and when it is known. Furthermore both partners and forecasters suggested that more direct interaction should occur graphically. To do more direct interaction with the partners graphically, forecaster expressed the need for more exploration of graphics, metafile technologies. Forecasters also expressed concerns about interacting with partners; and suggested that there they should make sure at that all parts of the National Weather Service Hazard Services Enterprise communicate a consistent message. Forecasters noted that right now, direct interaction with partners is a primary means of giving a sense of confidence in the forecast. As we move toward more probabilities, questions arise concerning how the confidence should be addressed.

Forecasters consistently noted the need for more open communication with partners. The Hurricane program was suggested as a model, they have had open communication with partners, 20 years in the making. Suggestions for improving connections included conference calls and live briefings. These media sources could help to answer questions about: What is the storm doing now? What is the forecast? What are the impacts? These tools also need to be tailored to audience (Emergency Mangers vs. media). It was also suggested to use a funnel approach (national-regional-state-local), as to not overlap information of over space scales. Ultimately both forecasters and partners suggest better collaboration

tools for the Watch /Warning process e.g. Strawman graphical display where everyone is looking at the same thing. (e.g. like the HLT/VTC system).

A. Partners:

Early Information

Emergency Managers expressed that they need information and data as soon as possible, so they can "download" the information and start their decision-making process. They need this information as early as possible for preparing for the event, such as getting supplies from vendors, prior to the public being notified of threats. The partners also discussed how mistakes in the early stages could lead to increased costs for them, if equipment, supplies, transportation, etc. was ordered and the hazard did not end up producing.

Temporal Scale: 4-8 days

How much time for notification for an anticipated severe event? Partners said that 4-8 days was optimal to be notified of upcoming events, the current system is adequate for this. Ultimately they would like to have a general indication of the nature of the upcoming event and its potential. One example of the need for early information: 2-3 models show the potential for a mini-blizzard a few days out, Emergency Managers can then begin to act on stocking supplies and alert agency heads for scheduling (having staff on call, etc.). Again, good two-way collaboration between partners and forecasters could facilitate this early information transaction.

Temporal Scale: 2-3 days

Partners suggested adding hail, wind, tornado and other hazard probabilities at this time. Emergency Managers suggested staging anticipated volunteer spotter locations, start looking at staffing potential with other Emergency Managers in the area, conferencing to acquire information about what supplies and resources available.

Temporal Scale: The Day Before

Partners reveal that they generally use multiple sources of weather information as the event approaches. They also engage in conference calls with FEMA regions, local and regional Emergency Manager offices, and other local partners. They would like to have more flexibility in incorporating these different sources of information to make decisions.

Temporal Scale: The DAY of

The day of the event Emergency Managers put out notifications with text, email, call-in, etc, to inform what's going to happen in 1-hour, 5-hours. They would like to improve the confidence of this information. Also, real-time monitoring with local law enforcement, possible conditions that first

responders might face, text msg or other confirmation from National Weather Service on what Emergency Managers should be looking for at this point.

For the wish list: Partners need teleconference opportunities with interactive graphic and drawing capabilities (e.g., draw on Google Earth), better tools for visuals display (smoothly blend GIS data), they would like forecasters to walk thru information with Emergency Managers using radar or other real-time info as a play-by-play, and means for structuring the conference call process, given the potentially large number of participants at this point, for efficiency and need to transmit data quickly.

Timeframe Suggestions for Products

Partners suggested adding more temporal aspects to make better decisions. One suggestion was to create a looped probability map. During the watch time period, partners wish to see hazards move and change shape with time. They also expressed the need to improve interface, representation, and accessibility of the graphical data for primary stakeholders (e.g., overlay Storm Prediction Center hazardous weather grids on forecast discussions). Forecasters discussed providing real-time mini-maximum envelope of water (e.g. ensemble approach) to give range of possibilities as information for evacuation plans. They understand the goal of giving the best information at the time to partners, no matter when that is. They also noted a few caveats with the approach, such as not everything will be available at all times. They also thought that is would be okay to give a wide range of possibilities to decision makers at long time ranges and zero in best solution with time. Forecasters also should consider how a consistent message could be coordinated beyond the official watch/warning time scale. This being especially important for longer time periods and rapid changes in the event. It is still important to consider the consistency of message, but they could use help translating information to partners.

National Weather Service backup operations need to account for partner interaction and other key contact information (spotters, HAM operators, etc.). The forecasters also expressed the need to place multimedia briefings on down-office's webpage. Ultimately they agreed that backup is not just the basic products/services anymore! Policy needs to reflect the importance of the new information.

B. Forecasters:

Products:

Some forecasters expressed that more of the formal products and services need to carry probability information. It was also suggested that hazard services provide better information about how threats develop over time; in terms of intensity, area of coverage, and probability. There is a need to get real-time reports of the effects of hazards into the system in a timelier manner. Public readiness for an event needs to be taken into account when determining the tone and scope of interactions with partners. Staffing levels in a forecast office need to be consistent with effort required to manage an event. There were some concerns regarding diversity in operational procedures among various elements of the

disaster preparedness community. Even with planning, National Weather Service personnel can spend valuable time getting spun up on those particulars at the onset of high impact events. Forecasters wondered if it should be considered a core National Weather Service mission to deal with this diversity, or should the National Weather Service be involved in Federal efforts to encourage more standardization.

Time: Pre-Event Mitigation

Forecasters had discussions concerning how to prepare for hazardous weather long before the threat exists. Pre-season training, workshops and exercises, ops plans, and networking can facilitate these long-term mitigation strategies. They also highlighted the need for inter-agency coordinated drills, and the need to overcome FCC hurdle (use tsunami tests as a guide). The forecasters recognized the need to understand the needs of the spectrum of partners before the threat and prepare in advance. Suggestions for the pre-event mitigation included; set up in advance ground rules for interactions/briefings to mitigate the time crunch, hold education and public awareness campaigns.

Temporal Scale: 2-3 days:

At this point, the Nation Weather Service will check to make sure staffing needs are there during event, to prepare for the hazard day. They also begin to use media for getting the word out, allude to intensity of the anticipated event if needed to raise awareness. For improving the current system, they would like a good way to gauge public readiness based upon time of year/climatology (e.g., “off season” event problem catches the public off guard and, conversely, lack of activity when events are expected) Who’s responsibility is it to train the public about these things? One suggestion was to add a PM Outlook. This could be a graphical, tropical 48 hour outlook (low, med, high), for Katrina it would have identified potential depression over Bahamas.

Also, forecasters requested a way to fully integrate the situation-specific probabilities of the various hazards e.g. wind speed, probability of a Tropical Cyclone event. They also wish for a way to provide this data in a useful fashion, easily accessible and integrated into decision-making software (e.g. Hurrevac). This would lead to improved integrated forecast warning composition software that puts everything in one place so you don’t have to jump around to different applications. Including the capability to incorporate uncertainty information to provide a first guess, hazard-specific Watch /Warning (recommender). To achieve these there needs to be better product planning and design to ensure the intended message is accurately conveyed.

Breakout Two Requirements Summary

- Direct Interaction between Forecasters and Partners.
    - Direct interaction with partners that goes beyond the predefined set of products and services (Watches, Warnings, Advisories) is an important part of the NWS mission. This is

especially true for high impact events. Such interaction can include live briefings, webcasts, conference calls, one-on-one interaction, and could occur graphically.

- This interaction needs to be transparent telling partners what the forecasters know when they know it with consistent messages across the NWS.
- Direct interaction with partners in high impact events is something that needs to be planned for *before* such events occur and well before the event gets into the warning phase, if possible.
- Public readiness for an event needs to be taken into account when determining the tone and scope of interactions with partners.
- Service backup needs to support not just the defined set of products and services, but the customary level of direct interaction as well.
- Staffing levels need to be consistent with effort required to manage an event.
- How should diversity in operational procedures across offices be handled? Nationally standardized vs. ways to address e.g. in service backup.

- Temporal Considerations
  - arly Information / Pre-event Mitigation
    - uild relationships between forecasters/partners before the event.
    - artners need as early as possible, but mistakes early on can lead to increased costs.
    - ive wide range of possibilities to partners at long time ranges and zero in best solution with time.
    - orecasters can prepare: Pre-season training, workshops and exercises, ops plans, networking, inter-agency coordinated drills.
  - -6 days
    - ong-fused events such as blizzards, hurricanes
    - orecaster-partner collaboration increases ability to prepare
  - -3 days
    - horter fused events such as hail, wind, tornado probabilities.
    - egin to use media to get the word out and aid Partners' ability to stage spotters, examine staffing requirements

        - orecasters also looking at staffing requirements
        - ould like a way to gauge public readiness based on date/climatology
        - orecasters want to integrate situation-specific probabilities in decision making software e.g. Hurrevac.
    - he Day before
        - artners use multiple sources of weather information so would like more flexibility in integrating these different sources to make decisions
    - he Day Of
        - artners need teleconference opportunities with interactive graphic and drawing capabilities (e.g., draw on Google Earth), better tools for visuals display (smoothly blend GIS data), they would like forecasters to walk thru information with Emergency Managers using radar or other real-time info as a play-by-play.
- Hazard Products
    - Need to carry better information about how threats develop over time; in terms of intensity, area of coverage, and probability. Examples: looped probability map, real-time minimum-maximum envelope of flooding to aid evacuation decisions.
    - There is a need to get real-time reports of the effects of hazards into the system in a timelier manner.

Breakout Three – Hazards Database

The topic of Breakout 3 was to discuss what needs to be included in the Hazard Information Services database. This session synthesized the outcomes from earlier breakouts as groups considered:

- What information is contained in the database?
    - Area, Hazard, Time, observations, probabilistic risk/threat
    - Other attributes: speed, strength, particularly dangerous phenomena, storm object?
    - Real-time verification to assess uncertainty
- In what format will the data the data be offered? What format is easiest to make decisions?
    - Legacy products, posted to website, web services, interactive sampling
    - Images, graphics, time series, time of arrival, time of departure
    - Platforms: web, mobile
- What types of derived products will be offered to Partners

- How will users retrieve the data?
    - Push vs. pull

The subject of the Hazards Database is somewhat large with many facets. The breakout groups talked about a wide variety of database-related subjects. These were organized into the following categories: Content, Access, Framework, and Outstanding Issues.

Content

Content includes the various attributes of hazardous weather, internal representation of the information, and the variety of data formats in which to view the data.

Hazard Attributes - Most of the groups discussed the list of attributes needed to properly represent weather hazards. The combined list includes common attributes as well as those attributes specific to particular hazards.

General Hazard Attributes

- Hazard Type - e.g., Wind, Hurricane, Tornado, Hail, etc
- Location - grid, shapefile, point, river, segment
- Time and Motion - Instead of containing simply the start and end time of an event, hazard information needs to be represented in the data base as "threats in motion", updating rapidly, and providing high-temporal information about the past, present, and expected futures states of the threats (and uncertainty) from which point-specific times of arrival and departure can be calculated. This information should be seamless across time and space scales. The database should update as rapidly as new information arrives. The concept of treating the threats as multi-scale hierarchical "objects" was discussed, and that these objects could be initiated by a recommender or a human, and if the former, the human could move "over-the-loop" and edit the machine recommendations.
- Severity - strength of phenomena (level of impact) at various times and locations
- Probabilistic Risk/Threat - Numerical expression of likelihood/uncertainty at various times and locations
- Specialized attributes e.g.
    - Calls to action
    - Wind radii and dangerous seas locations for tropical hazards
    - Wave Height/Period and Earthquake parameters for tsunamis
- Observations - measurements, pictures, reports, etc.
- Real-time verification information to assess/communicate uncertainty

Data Formats

It was agreed that regardless of the formats chosen, the internal database must store all the information necessary to fully describe each hazard. The database must preserve as much of the original resolution

and precision as possible so that derived products can reflect that same level of precision, if needed. Some data sets will require some level of quality control.

Geographical Information Systems (GIS) Data

It was strongly agreed that robust GIS datasets would complement the hazards database. Access to rich GIS data offers benefits to forecasters, emergency managers, the public, and private sector - virtually every sector of the weather enterprise. These datasets could be combined with the hazardous weather information to rapidly and accurately assess the impact of severe weather events, providing better guidance to decision makers, first responders, and the general public.

Access

Access includes how forecasters and partners will enter, retrieve and view the data and the desired capabilities of the database and web services.

All stakeholders could access the database and related services. Forecasters populate the database with forecasts and view observations combined with GIS information. The database could also accept input from partners and other stakeholders such as spotter reports and observations. Consumers of the information, such as emergency managers, the private sector, and the public can view the same information in a variety of formats customized to their needs. Access to some data sets may be restricted and regulated by user types and needs. Some suggested that events and hazards should be assigned unique identifiers to speed and simplify access.

Some partners will have the opportunity to be notified when a particular event occurs (push) or can access data at a time convenient for them (pull). A central access location would make accessing the data easier for decision-makers (one stop shop). Data can be viewed in many formats from simple text (XML, SMS, Twitter, e-mail), to graphic (area of hazard, flooded river segment, time-series at a point), or image (severity/risk/impact, probability of some event). We must retain the ability to generate legacy products, providing information to low-bandwidth users, while offering more advanced, innovative products and delivery methods, as well as an API (application programmer interface) to allow consumers to “pull” information in flexible formats.

Framework

Participants discussed the concept of a framework approach to building the data and visualization services. In this approach, a set of data access (database), analysis (algorithms), and data visualization services (e.g., Google Earth) would be developed so that users of the framework could quickly and easily assemble customized views of the data. For example, by combining algorithms that can calculate areas of high risk or impact and rich GIS information, users can build their own views such that decisions can be made more quickly and confidently. Each user of the information gets precisely what they need assess the weather situation.

Decision Support Panel Discussion

After the Breakout sessions, we held a panel discussion on the topic of Decision Support Services (DSS) to address the question: How will the NWS transition from a paradigm of issuing meteorological products to one of decision support? On the panel were John Ferree (program manager), Darone Jones (NWS societal impacts and IRIS promoter), Lisa Vitols (social scientist from Canada), Andy Bailey (Forecaster), and Chris Sorensen (Emergency Manager). Each panel member gave a statement and then the floor was opened for discussion.

- John- We need more effort into perfecting our ways of communicating, but how do we do that when we're busy? We're already staffed up to the max for an event – everyone had slept at the office. With our current staffing how can we handle high impact events? The concept of task-sharing among offices has been rejected, so how do we staff up for DSS?
- Darone – IRIS – We've got to realize that we're part of the process, not the end of the process. We must share, collaborate, work together – pay attention to the world around us instead of dictating what the world should be. How can we use the information networking to make our products and services better? That is DSS – we're part of it, not IT.
- Lisa – In the Weather Service/Public dialog, it often happens that the Weather Service says "we have a product" and the Public says "but I don't need that." You have tons of data and you need to listen to the user of the information to find out what they need. Get them involved – use social science to do this. Canadian Weather Service is different – I look at not only societal impacts, but how they want it portrayed. There are many consultants available. Use them to try and understand – make it about services and not products. You are public servants.
- Andy – These are cool things that are being developed, but it's not congruent with what I'm being asked for by my Warning Coordination Meteorologists (WCMs). You (the developers) are way-smarter than I am, but I have an understanding of what my customers want. Don't take for granted that you know what the public wants. Most don't care or won't go to the basement because they're watching Oprah – they have the optimist view. We're not asking what they want. I've been struggling all week with this. The human interaction is what people want.
- Chris – I feel like I'm on Day 3 of language immersion. I still don't know what I don't know about products and services and what the NWS can do for us. This is a starting point for becoming more interactive with my local office. I do intend to become more involved with what's going on.

Ensuing discussion points:

- Continuing and increasing interaction with Partners and Social Scientists – brainstorming ideas:
    - Build on successes: Can we take these models and apply them to other areas?
        - Fire Weather where Twitter and monitoring reports are used for decision support.
        - National Hurricane Center goes with corps of engineers to do assessment, asking the public. They do a hazard analysis using geo-located surveys -- what tools were used? How did people behave? Build on the service assessments. How did you make a decision? What would be valuable next time? Valuable for training, planning.

        - Pleasant Hill WFO -- Office workshops involving social scientists with surveys about “Where do people get their information?” Also, can dispatch social scientists to events.
    - Standardize: There's a lot of this interaction going on now at the local levels. We need to standardize it across the NWS so that 122 offices don't have to re-invent the wheel. There is a tug and pull between local relationships and a seamless national look and feel. To fund this, we need recognition – a political reality.
    - Possible Action Items:
        - Leverage WCM's knowledge of partners. Start a list server/Wiki for WCM’s to record their needs. Team could review and incorporate into requirements process.
        - Social scientists could design a template -- Put together a half-day meeting with stakeholders then put that information into IRIS. We've got the technology, but we need a better way to get the information.
        - Let the partner speak with WFO, and through the incident, ask what helped. Stay engaged with your customer.
        - Attend partner meetings to listen AND get feedback on ideas.
        - Query IRIS database to learn about partners.
        - Use NWSChat so EM's can interact with NWS during an event.
        - There is a great diversity in our partners and many of them and sub-society are unsophisticated with no infrastructure, twitter, internet connection. We cannot forget that segment of society.
        - Build relationships in off-time BEFORE an event.
        - Keep quarterly reports of what people are calling about and what they want. IRIS could help with this.
        - Monthly meetings with stakeholders – an advisory board.
        - Develop web page to record calls that come in, categorize them and run statistics – connect it to IRIS (IRIS web).
    - How much interaction with NWS Partners needs to be personal contact vs. putting out information? Continuous personal contact takes a resource from the office.
- Developing Forecaster Tools for Decision Support
    - Need to integrate current disparate applications –WarnGen, GHG, and RiverPro.
    - New ideas – people are starting to think about some of these datasets in terms of Lagrangian -- follow the hurricane / follow the storm.
    - Need implementation plan to engage all stakeholders and developer organizations.
- Policymakers must be in the loop. Can't let policy hold us back, but also can't let software drive policy. Need to collaborate. Policymakers across programs also need to talk to each other to have cohesive policies.
- With Database and Products, we can address legacy and future needs.

Issues Identified

- Warnings are relative to the degree of impact (2” snow in Raleigh vs. Denver) and impacts are relative to the situation (Bronco’s football game vs. local kids soccer match)
- Probabilistic information vs. simple areal coverage maps
    - How well do the partners/publics understand probabilities?

    - How would it vary for different hazards e.g. hurricanes, tornadoes?
- Consistency between the forecast grids and warning database must be maintained.
- Impact-based descriptors vs. quantitative information: “wind-blown snow will likely produce 5-foot drifts making roads impassable” vs. “8 to 12-inch snowfall anticipated, accompanied by 45 mph winds” or “6 feet above flood stage “ vs. “flood levels will approach those last seen in 1993”
- How can information be rapidly assembled and distributed in what format for different information needs; e.g., TV weather announcer disseminating to the masses vs. solo motorist deciding on heading for high ground*?*
- How to handle multiple threats issue when many hazard phenomena are associated with a single storm event (flooding, tornadoes, large hail, straight line wind) and varying intensity over time (degenerating/regenerating cells within a single squall line)
- Warnings must follow the storm and storms don’t follow geo-political boundaries
- NWS' challenge is in developing an “all purpose” warning message that is succinct and clear enough for multiple audiences/purposes; low-end (“when does event begin and end?”) vs. high-end users (“need to know specific grid data points”)
- Does the NWS need for consistency in reporting and messaging restrict desired flexibility for disseminating the information about individual storms and in relation to specific public events? Example: alerts policy requirement that messages be 140 words or less.
- Polygon overlap, county areas being clipped out, other geographic-based anomalies can compromise forecasting/warning effectiveness; is the template too unyielding?
- What’s the optimal match between use of existing technology vs. state-of-the-art new; conference group expresses discomfort over this transition
- Conflict between staff workload management during significant weather events and the possibility of too much reliance on automation (losing human judgment factor) as a solution.

Conclusion

Hazards information should be stored in a common database which will serve as an information bridge between all the stakeholders in the Hazard Services enterprise. This will include legacy products, subscription services, push/pull products, and point-and-click hazards. We also need to be ready to provide uncertainty information in a variety of ways.

We want to make sure that social scientists, forecasters, and partners are collaborating on the development of the new products and information streams. Rapid prototyping on a national level, incremental development and testbed validation will be part of the implementation plan.

Next Steps: See Workshop Report Power Point for more details.

- Implementation Plan: Developer organizations will work toward the same goal of prototype implementation with highest priority going to the forecaster tools for creating hazards by integrating the functionality of WarnGen, GHG, and RiverPro. The prototype will be designed for the long-term vision.

- Partner Collaboration Plan: The outreach sub-committee of the national Hazard Services team will follow-through on the workshop suggestions to ensure that there is continued and enhanced Partner collaborations.
- Social Science Collaboration Plan: Continued and enhanced social science collaborations.
- Refined Requirements: Enhanced Hazard Services requirements will be submitted through the PPBES process for funding.

Future work

- Coordinate with Aviation NextGen 4D data cube project so that we reduce duplication of effort.
- Security Issues will be challenging and must be budgeted in.
- Need to engage more researchers in the enterprise.

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Planning Team:
Carl Bullock
John Ferree
Eve Gruntfest
Tracy Hansen
Tom LeFebvre
Brian Motta
Ashvin Mysore
Jim Ramer
Sal Romano
Kevin Scharfenberg
Greg Stumpf
Joe Wakefield
Susan Williams
Monica Zappa

Additional report contributions:
Tom Filiaggi
Mike Turner