Final Report

NWS Hazard Simplification Project: Engagement at NOAA's 2016 Hazardous Weather Testbed to Collect Feedback on Prototypes Developed at the 2015 HazSimp Workshop

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Eastern Research Group, Inc.

Arlington, Virginia

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Eastern Research Group, Inc. (ERG)

ERG provides environmental, social science, and engineering solutions to climate, weather, and coastal management issues. Learn more at *www.erg.com*.

NOAA's Office for Coastal Management "Coastal management" is the term used by communities and organizations striving to keep the nation's coasts safe from storms, rich in natural resources, and economically strong. The national lead for these efforts is NOAA's Office for Coastal Management, an organization devoted to partnerships, science, and good policy. This agency, housed within the National Ocean Service, oversees major initiatives that include the National Coastal Zone Management Program, Coral Reef Conservation Program, Digital Coast, and National Estuarine Research Reserve System.

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Acknowledgments

The project was conducted as part of the National Oceanic and Atmospheric Administration's (NOAA's) 2016 Hazardous Weather Testbed (HWT) at the National Severe Storms Laboratory (NSSL) in Norman, Oklahoma. It was a joint study between the National Weather Service (NWS) Hazard Simplification (HazSimp) project and the Forecasting a Continuum of Environmental Threats (FACETs) project, which creates and displays probabilistic hazard information (PHI) for tornadoes, severe threats (wind and hail), and lightning.

Eastern Research Group, Inc., (ERG) developed this report under NOAA Contract BPA #EA-133C-14-BA-004. Our scope of work covered only the HazSimp portion of the HWT. Other researchers conducted additional analyses under separate initiatives.

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Executive Summary

The National Weather Service (NWS) has embarked on an effort to evaluate its current watch, warning, and advisory (WWA) system through the Hazard Simplification (HazSimp) project. As part of this work, the NWS held a workshop in Kansas City in 2015, to design prototypes for potential new language to replace or enhance the existing WWA terms. Workshop attendees suggested that the NWS use pilot websites and testbeds to assess any significant modifications to the present system.

Building on this suggestion, the NWS contracted with Eastern Research Group, Inc. (ERG), to research the effectiveness of some of the HazSimp prototypes from the workshop with NWS forecasters, emergency managers (EMs), and broadcast meteorologists as part of the 2016 Hazardous Weather Testbed (HWT) at NOAA's National Severe Storms Laboratory (NSSL) in Norman, Oklahoma. The testbed environment provided an opportunity to integrate the HazSimp prototypes and messaging into the NSSL's Forecasting a Continuum of Environmental Threats (FACETs) project, which creates and displays probabilistic hazard information (PHI) through graphical threat grids.

During each week of the three-week study, a research team assembled NWS forecasters, broadcast meteorologists, and EMs to simulate an integrated warning team (see Figure ES- 1) to test both past-event and real-time case studies of severe weather, including tornadoes, severe wind and hail, and lightning. Forecasters conducted ongoing operations, including issuing and updating forecasts. EMs logged actions they would take in response to the case study forecasts, such as sending emails and sounding sirens. Broadcast meteorologists generated news segments that were shared with the other participants.

Figure ES- 1 The testbed process simulates an integrated warning team with NWS forecasters, EMs, and a broadcast meteorologist.

Three HazSimp prototypes were tested (see Table ES- 1). The headline warning was the primary difference among the prototypes tested. The structure and content of the prototype messages were the same.

Key HazSimp Findings

The study revealed that the current WWA system is ingrained in forecasters, and the alert-level language raised many questions. Forecasters had difficulty mapping the Be Aware" or "Take Action" phrases to meteorological criteria and struggled with the implied messaging of the different terms. As a result, they often chose "Take Action" (the equivalent of a warning) for situations that would have warranted an advisory in the current WWA system simply because they wanted to promote more actionable behavior than the "Be Aware' phrase implied. The HazSimp alert-level language also influenced the forecasters' probability choices. Forecasters tended to choose the HazSimp alert level first and then draw the probability. They also tended to increase their probabilities if they chose "Take Action," while they tended to decrease their probabilities if they chose "Be Aware." Another finding was that the forecasters had difficulty distinguishing probability from confidence. While the testbed required forecasters to make separate determinations for probability and confidence, many conflated the concepts, believing that the probability was a measure of their confidence.

From the partner perspective, the study revealed that EMs and broadcast meteorologists used different kinds of NWS information in different ways, but that both groups relied more on graphical than text information. To increase their likelihood of sharing the text, it must be concise and written in complete sentences. Broadcast meteorologists also stressed the importance of "clear guidance" in reference to NWS headlines and products. For example, broadcast meteorologists need to know the criteria, thresholds, or reasons behind "Take Action" versus "Be Aware." In general, the blending of HazSimp and PHI created some messaging inconsistencies that frustrated broadcast meteorologists over the course of the week, demonstrating that clear criteria is required for any potential language change.

Table ES- 1 aggregates the research findings from the EM and broadcast meteorologist rooms from all three weeks of the testbed.

Recommendations and Possible Next Steps

Based on the HWT and participant feedback, ERG offers the following suggestions for NWS consideration:

- **Further refine the prototypes from an operational meteorology perspective.** The most critical issue is determining what meteorological attribute will drive each headline change. Impacts, confidence, or even a matrix system of severity times confidence are all possible.

- **Use the NOAA Testbeds to determine the forecaster training needs relating to any potential changes to the WWA system.** The type of language change (e.g., replacing words or moving toward a matrix system), will impact the amount and length of training required.

- **Research the effects of new alert-level language on forecasters' probability choices, and consider how to blend the concepts of confidence and probability more intuitively.** Knowing how the HazSimp alert-level language and confidence influence forecasters' probability choices is important for future integration of PHI, as well as for future forecaster training.

- **Evaluate how general versus specific action messages impact people's behavioral intent**. Forecasters wanted individuals to take action whether they had a significant weather advisory ("Be Aware") or a warning ("Take Action"). EMs and broadcast meteorologists, however, were concerned that the public will "cry wolf" if all of the messages say to "Take Action" but do not specify what kind of action and why. Some participants acknowledged that simple, actionable language might resonate with the public, but that such phraseology would need to be tested with members of public.

- **Consider maintaining features of the current system, such as the term "warning," to remain responsive to EM and broadcast meteorologist needs.** A number of EMs stated that the current "watch" and "warning" terms work well for them. These terms are also ingrained in their operations, so it would take time to adapt to different language. The broadcast meteorologists also found themselves using the term "warning" out of habit and found the prototype language awkward to use on-air.

- **Conduct further transitional research on the HazSimp prototypes in the HWT.** All three groups of participants agreed that the message structure needs further assessment. Broadcast meteorologists and EMs alike encouraged more dialogue with their broader communities before the NWS makes any significant changes. NWS forecasters wanted to know how any changes would impact the operational environment both in terms of technology and forecaster training.

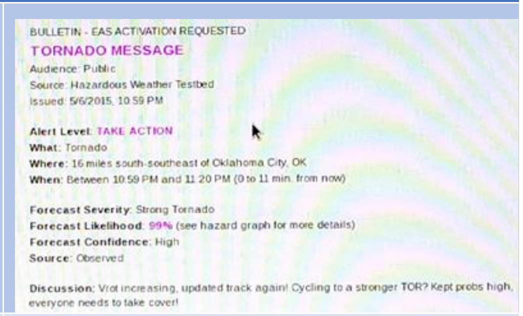
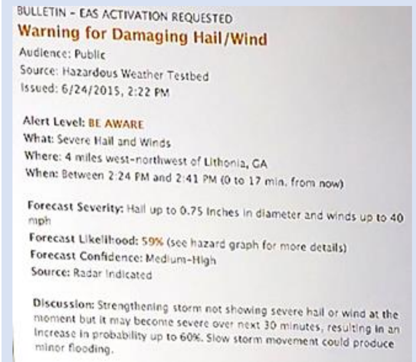
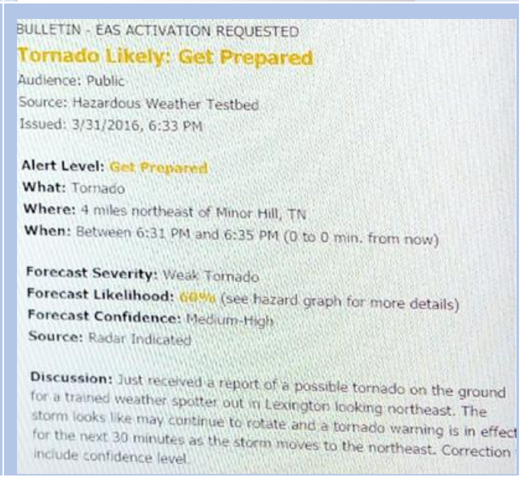
Conclusion

The NWS has invested in important HazSimp research (interviews, focus groups, case studies, and workshops) that has allowed the NWS to narrow options, think about challenges, and produce ideas for improvement. The testbed environment offered a new methodological approach with both strengths and weaknesses. The study had some limitations, including a focus on only one hazard (severe weather), a small sample size (23 participants), and variability in the storm type data used over the course of three weeks making true comparisons somewhat difficult.

At the same time, however, the testbed process enabled the researchers to gather new data in a unique way. Rather than asking participants what they think about the current system or what their ideas are for a future system, participants *used* the system in as close to their own operational environment as possible. One broadcast meteorologist described how adamantly he had supported the use of action language to replace WWA prior to the testbed. After one week in the testbed, however, he realized how awkward it was to express the action language on air and admitted that a buzzword, such as "warning," was missing. This reflection does not discount the possibility that action language may work well for the public, but shows that there is a distinction between collecting ideas versus testing ideas in a real-life environment.

The results gave the research team important insights into science, technology, human behavior, and organizational adaptability. As the HazSimp project moves forward, the NWS should continue to use its partnership with the NSSL's HWT, and other NOAA testbeds, to evaluate how potential operational changes may impact integrated warning teams.

Table ES- 1. Summary of Feedback on Each HazSimp Prototype

	Prototype Structure	General Feedback	Prototype
Week 1	**Headline**: Severe Message, or Tornado Message, or Lightning Message **Alert Level**: Take Action or Be Aware Colors changed based on forecast likelihood	• Wanted the hazard specified in the headline. • Felt action language too vague. • Needed a buzzword, such as warning, to trigger decisions. • Felt the structure of the message was oversimplified.	 BULLETIN - EAS ACTIVATION REQUESTED TORNADO MESSAGE Audience: Public Source: Hazardous Weather Testbed Issued: 5/6/2015, 10:59 PM **Alert Level**: TAKE ACTION **What**: Tornado **Where**: 16 miles south-southeast of Oklahoma City, OK **When**: Between 10:59 PM and 11:20 PM (0 to 11 min. from now) **Forecast Severity**: Strong Tornado **Forecast Likelihood**: 99% (see hazard graph for more details) **Forecast Confidence**: High **Source**: Observed **Discussion**: Vrot increasing, updated track again! Cycling to a stronger TOR? Kept probs high, everyone needs to take cover!
Week 2	**Headline**: Warning for Damaging Hail/Wind, or Warning for Tornado, or Warning for Lightning **Alert Level**: Take Action or Be Aware Colors changed based on forecast likelihood	• Suggested eliminating the "for"; just say "tornado warning." • Misinterpreted "Damaging Hail/Wind," as damaging hail and some wind, not as damaging hail and damaging wind. • Felt the action language was too vague	 BULLETIN - EAS ACTIVATION REQUESTED Warning for Damaging Hail/Wind Audience: Public Source: Hazardous Weather Testbed Issued: 6/24/2015, 2:22 PM **Alert Level:** BE AWARE **What:** Severe Hail and Winds **Where:** 4 miles west-northwest of Lithonia, GA **When:** Between 2:24 PM and 2:41 PM (0 to 17 min. from now) **Forecast Severity:** Hail up to 0.75 inches in diameter and winds up to 40 mph **Forecast Likelihood:** 59% (see hazard graph for more details) **Forecast Confidence:** Medium-High **Source:** Radar Indicated **Discussion:** Strengthening storm not showing severe hail or wind at the moment but it may become severe over next 30 minutes, resulting in an increase in probability up to 60%. Slow storm movement could produce minor flooding.
Week 3	**Headline**: Damaging Hail/Wind or Tornado or Lightning Emergency: Take Action (purple) Damaging Hail/Wind or Tornado or Lightning Expected: Take Action (red) Damaging Hail/Wind or Tornado or Lightning Likely: Get Prepared (orange) Damaging Hail/Wind or Tornado or Lightning Possible: Be Aware (yellow) **Alert Level**: Take Action, Get Prepared, or Be Aware Headline language and color changed based on forecast likelihood	• Wanted to know the criteria for each level. • Wanted to know why an area is receiving this level; otherwise, the messages are not relevant. • Concerned about false alarm perceptions of the phrases. • Felt the action phrases were too vague. • Felt the phrases were awkward to use on air. • Felt that "tornado possible," "likely," and "expected" all sounded too similar. • Felt that the color meaning needed evaluation.	 BULLETIN - EAS ACTIVATION REQUESTED Tornado Likely: Get Prepared Audience: Public Source: Hazardous Weather Testbed Issued: 3/31/2016, 6:33 PM **Alert Level:** Get Prepared **What:** Tornado **Where:** 4 miles northeast of Minor Hill, TN **When:** Between 6:31 PM and 6:35 PM (0 to 0 min. from now) **Forecast Severity:** Weak Tornado **Forecast Likelihood:** 60% (see hazard graph for more details) **Forecast Confidence:** Medium-High **Source:** Radar Indicated **Discussion:** Just received a report of a possible tornado on the ground for a trained weather spotter out in Lexington looking northeast. The storm looks like may continue to rotate and a tornado warning is in effect for the next 30 minutes as the storm moves to the northeast. Correction include confidence level.

Hazard Simplification Testbed Summary

Introduction

The National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) forecasts hazardous weather situations and issues watches, warnings, advisories (WWAs), and other information products to convey the threats posed by these events. These products are intended to help communities prepare for and respond to hazardous weather to protect people's lives and property. The NWS has embarked on an effort to evaluate the current WWA system through the Hazard Simplification (HazSimp) project.

As part of this evaluation, the NWS held a workshop in October 2015, in Kansas City, Missouri, that brought together more than 100 people representing the NWS (regions, centers, headquarters, and local offices), broadcast meteorologists, weather industry partners, emergency managers (EMs), and social scientists. The goal of the workshop was to design prototypes for potential new language to replace or enhance the existing WWA terms. The workshop resulted in a number of recurring themes and recommendations for evolving the current system, including the use of hierarchical tiers, color-coding, and action terms (such as "Be Aware," "Be Prepared," and "Take Action") to communicate warning information.

The workshop attendees also suggested that the NWS use pilot websites and testbeds (possibly also social media) to assess any significant modifications to the present system. Building on this suggestion, the NWS contracted with Eastern Research Group, Inc. (ERG), to:

- Test some of the HazSimp prototypes from the Kansas City workshop with NWS forecasters, EMs, and broadcast meteorologists as part of the 2016 Hazardous Weather Testbed (HWT) at NOAA's National Severe Storms Laboratory (NSSL) in Norman, Oklahoma.

- Identify key characteristics of the HazSimp prototypes that could help EMs and broadcast meteorologists make decisions relative to ongoing severe weather threats.

The study was a joint effort between the NWS HazSimp project and the NSSL's Forecasting a Continuum of Environmental Threats (FACETs) project, which creates and displays probabilistic hazard information (PHI). (See text box at right for more detail.)

How FACETS Transforms WWA

With the current NWS WWA system, an area is either under a watch, warning, or advisory, or it is not, and the WWAs typically apply to a large area that might be unaffected by the specific weather event. FACETs delivers detailed hazard information through the use of "threat grids" that are monitored and adjusted as new information becomes available, thereby resulting in more precise "warning" areas. FACETs also focuses on the entire warning system and provides a continuous stream of probabilistic hazard information (PHI) extending from days to within minutes of an event.

Methodology and Sample

The research involved assembling a team of researchers with participants, including NWS forecasters, broadcast meteorologists, and EMs to serve as an integrated warning team to test both past-event and real-time case studies of severe weather, including tornadoes, severe wind and hail, and lightning.

The testbed environment allowed researchers to observe how NWS forecasters would work operationally with the HazSimp prototypes, as well as how EMs and broadcast meteorologists would use and communicate them to public audiences.

The team collected data over the course of three weeks: May 9–13, May 23–27, and June 6–10, 2016. Three forecasters, one broadcast meteorologist, and three to four EMs participated in the project each week. The total sample consisted of nine forecasters, three broadcast meteorologists, and 11 EMs.

The overall schedule for each week remained the same (see Table 1). Each Monday, the research team welcomed the week's participants and provided them with training on the software to be used for all case studies. From Tuesday to Thursday, participants assumed the role of their respective profession. On each of these three days, participants examined a case study using one past event and one real-time event based on the day's severe weather forecast (the order of past and real-time cases depended on the timing of the severe weather each day).

Table 1. Overview of Testbed Schedule

Monday	Tuesday	Wednesday	Thursday	Friday
• Welcome presentations • Training • Group debrief	• Weather briefing • Simulated case • Debrief • Weather briefing • Real-time case • Debrief	• Weather briefing • Simulated case • Debrief • Weather briefing • Real-time case • Debrief	• Weather briefing • Simulated case • Debrief • Weather briefing • Real-time case • Debrief	• Sector debriefs • Group debrief

All participants gathered together in one room at the start of each case to watch a weather briefing from one of the researchers. The briefing explained the technical aspects of the forecast setup, followed by the case study. Participants then broke into their respective sector (forecaster, EM, or broadcast meteorologist) in separate rooms to conduct job-related tasks (see Figure 1) in response to the case study. Social and physical science researchers were also in each of the three rooms, working on research issues related to HazSimp, FACETs, or both.

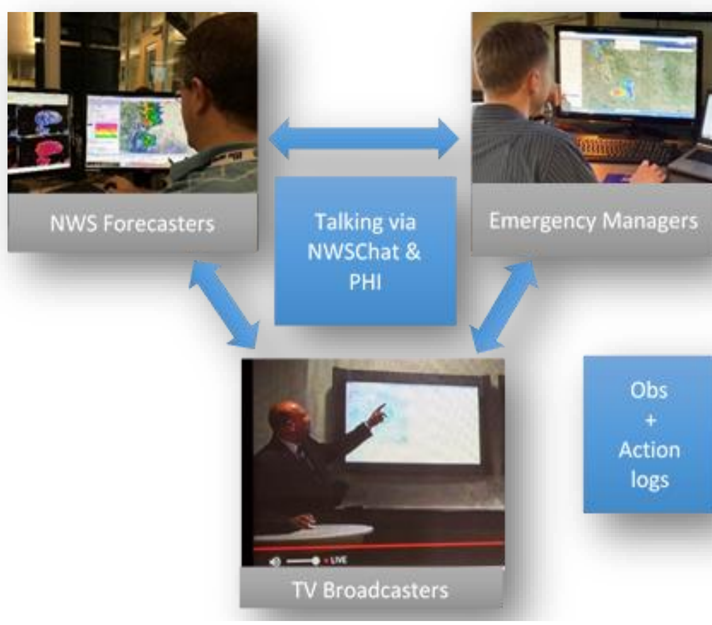


Figure 1. The testbed process simulates an integrated warning team with NWS forecasters, EMs, and a broadcast meteorologist.

The NWS forecasters conducted ongoing operations, including issuing and updating forecasts using the PHI software tool, which fed the data to another software tool, the

[Enhanced Data Display](#) (EDD). The EMs and broadcast meteorologists viewed the forecast information on the EDD.

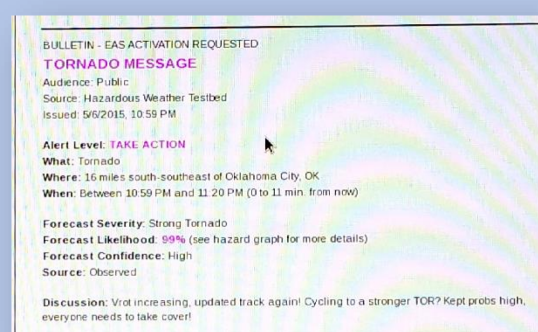
EMs and broadcast meteorologists were assigned a location in the geographic area of the case study. EMs were asked to log any actions they would take in response to the forecasts, such as making phone calls, sending emails, posting on social media, sounding sirens, sending out text alerts, issuing reverse 911 calls, etc. Broadcast meteorologists also generated news segments that were shared through a private YouTube channel and shown on a large screen as a “situational awareness” wall in the forecaster and EM rooms. The researchers in the broadcast meteorologist room logged when and why a broadcast meteorologist decided to cut in, go wall-to-wall, or send out social media postings. Participants were all connected through a private NWSChat log. Both NWSChat and the YouTube channel linked each sector together, creating an integrated warning team.

After completing a case, all researchers and participants gathered for a large group debrief to discuss the case details and findings. In general, Tuesday debriefs focused primarily on software learning challenges, Wednesday debriefs focused on the use and communication of probabilities, and Thursday debriefs focused on HazSimp messaging. On Friday, the debriefs focused on holistic issues, impressions, and lasting thoughts about the entire experience.

HazSimp Prototypes

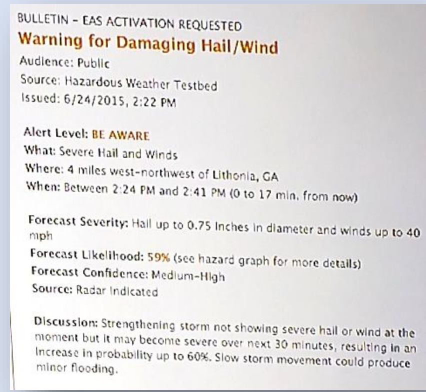
Three HazSimp prototypes were tested during the HWT. For ease of programming, one prototype was shown each week. Table 2 describes each prototype. Visual examples of each set of prototypes can be found in Appendix A.

Table 2. HazSimp Prototypes Tested Each Week

HazSimp Prototype Structure		Example
Week 1	**Headline**: Severe Message, or Tornado Message, or Lightning Message **Alert Level**: Take Action or Be Aware Colors changed based on forecast likelihood	 BULLETIN - EAS ACTIVATION REQUESTED TORNADO MESSAGE Audience: Public Source: Hazardous Weather Testbed Issued: 5/6/2015, 10:59 PM **Alert Level**: TAKE ACTION **What**: Tornado **Where**: 16 miles south-southeast of Oklahoma City, OK **When**: Between 10:59 PM and 11:20 PM (0 to 11 min. from now) **Forecast Severity**: Strong Tornado **Forecast Likelihood**: 99% (see hazard graph for more details) **Forecast Confidence**: High **Source**: Observed **Discussion**: Vrot increasing, updated track again! Cycling to a stronger TOR? Kept probs high, everyone needs to take cover!

<table>
<tr>
<td>Week 2</td>
<td>Headline:
Warning for Damaging Hail/Wind, or
Warning for Tornado, or
Warning for Lightning

Alert Level: Take Action or Be Aware

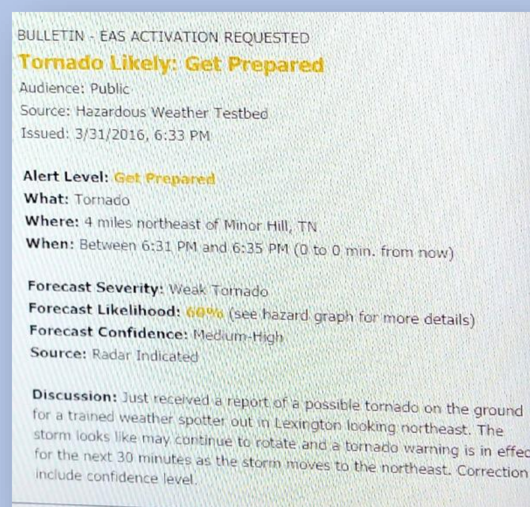
Colors changed based on forecast likelihood</td>
<td>
BULLETIN – EAS ACTIVATION REQUESTED
Warning for Damaging Hail/Wind
Audience: Public
Source: Hazardous Weather Testbed
Issued: 6/24/2015, 2:22 PM

Alert Level: BE AWARE
What: Severe Hail and Winds
Where: 4 miles west-northwest of Lithonia, GA
When: Between 2:24 PM and 2:41 PM (0 to 17 min. from now)

Forecast Severity: Hail up to 0.75 inches in diameter and winds up to 40 mph
Forecast Likelihood: 59% (see hazard graph for more details)
Forecast Confidence: Medium-High
Source: Radar Indicated

Discussion: Strengthening storm not showing severe hail or wind at the moment but it may become severe over next 30 minutes, resulting in an increase in probability up to 60%. Slow storm movement could produce minor flooding.</td>
</tr>
<tr>
<td>Week 3</td>
<td>Headline:
Damaging Hail/Wind or Tornado or Lightning Emergency: Take Action (purple)
Damaging Hail/Wind or Tornado or Lightning Expected: Take Action (red)
Damaging Hail/Wind or Tornado or Lightning Likely: Get Prepared (orange)
Damaging Hail/Wind or Tornado or Lightning Possible: Be Aware (yellow)

Alert Level: Take Action, Get Prepared, or Be Aware

Headline language and color changed based on forecast likelihood</td>
<td>
BULLETIN - EAS ACTIVATION REQUESTED
Tornado Likely: Get Prepared
Audience: Public
Source: Hazardous Weather Testbed
Issued: 3/31/2016, 6:33 PM

Alert Level: Get Prepared
What: Tornado
Where: 4 miles northeast of Minor Hill, TN
When: Between 6:31 PM and 6:35 PM (0 to 0 min. from now)

Forecast Severity: Weak Tornado
Forecast Likelihood: 60% (see hazard graph for more details)
Forecast Confidence: Medium-High
Source: Radar Indicated

Discussion: Just received a report of a possible tornado on the ground for a trained weather spotter out in Lexington looking northeast. The storm looks like may continue to rotate and a tornado warning is in effect for the next 30 minutes as the storm moves to the northeast. Correction include confidence level.</td>
</tr>
</table>

The primary difference among the three prototypes was the headline wording. The structure and content of the prototype messages were the same, and each message had the following components:

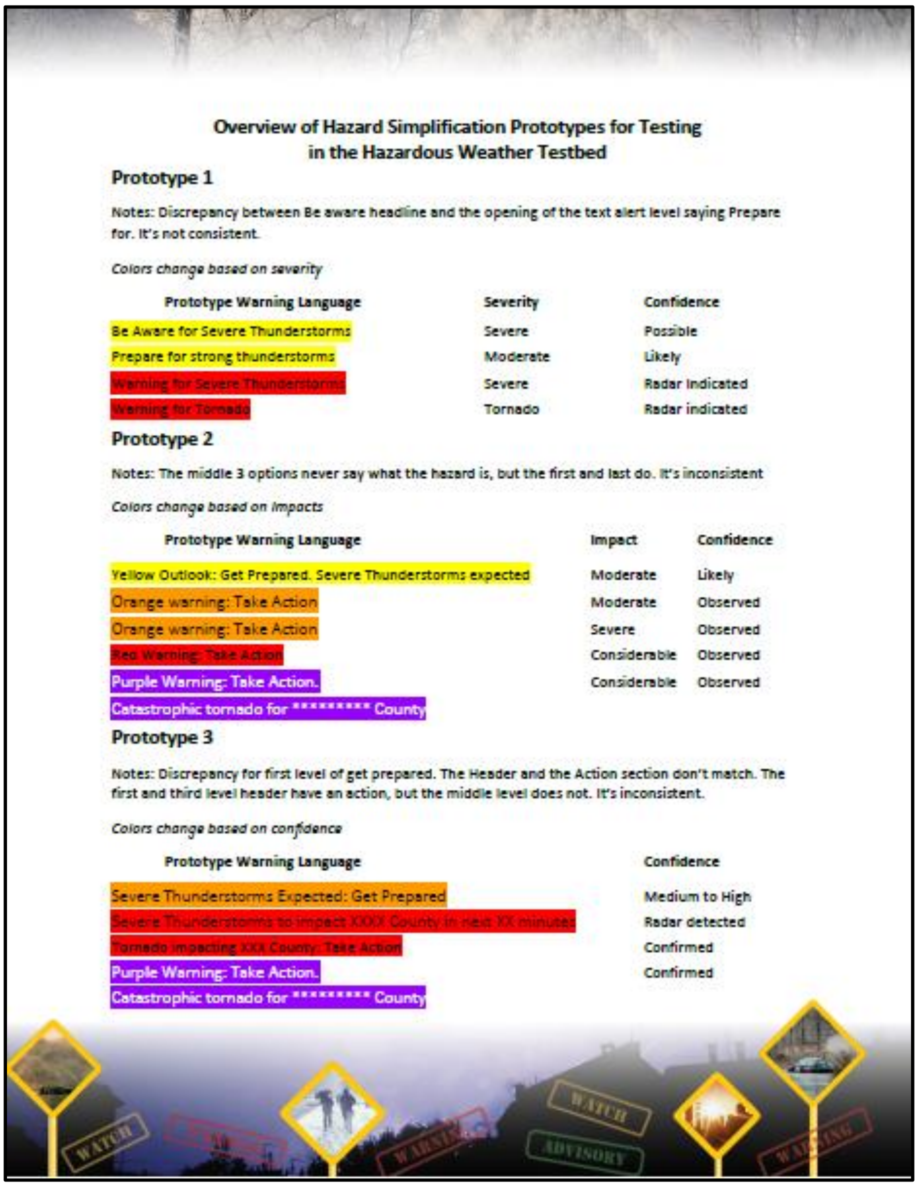
- Alert level
- What
- Where
- When
- Forecast severity
- Forecast likelihood
- Forecast confidence
- Source
- Discussion

In addition to each HazSimp prototype, the participants also saw the corresponding WWA legacy product (e.g., tornado warning, severe storm warning, or a significant weather advisory) for comparison.

Prototype Integration

Integrating the nascent HazSimp prototypes from the Kansas City workshop into the FACETs PHI testbed environment presented programming challenges both before and during the experiment.

The researchers first needed to program the prototypes into both the EDD and PHI software. To do this, they had to know the underlying attribute driving the language system in the prototypes. Figure 2 shows the meteorological attribute (severity, confidence, impact, etc.) behind each *original* HazSimp prototype.



Overview of Hazard Simplification Prototypes for Testing in the Hazardous Weather Testbed

Prototype 1

Notes: Discrepancy between Be aware headline and the opening of the text alert level saying Prepare for. It's not consistent.

Colors change based on severity

Prototype Warning Language	Severity	Confidence
Be Aware for Severe Thunderstorms	Severe	Possible
Prepare for strong thunderstorms	Moderate	Likely
Warning for Severe Thunderstorms	Severe	Radar Indicated
Warning for Tornado	Tornado	Radar indicated

Prototype 2

Notes: The middle 3 options never say what the hazard is, but the first and last do. It's inconsistent

Colors change based on impacts

Prototype Warning Language	Impact	Confidence
Yellow Outlook: Get Prepared. Severe Thunderstorms expected	Moderate	Likely
Orange warning: Take Action	Moderate	Observed
Orange warning: Take Action	Severe	Observed
Red Warning: Take Action	Considerable	Observed
Purple Warning: Take Action.	Considerable	Observed
Catastrophic tornado for ********* County		

Prototype 3

Notes: Discrepancy for first level of get prepared. The Header and the Action section don't match. The first and third level header have an action, but the middle level does not. It's inconsistent.

Colors change based on confidence

Prototype Warning Language	Confidence
Severe Thunderstorms Expected: Get Prepared	Medium to High
Severe Thunderstorms to impact XXXX County in next XX minutes	Radar detected
Tornado impacting XXX County: Take Action	Confirmed
Purple Warning: Take Action.	Confirmed
Catastrophic tornado for ********* County	

Figure 2.Original HazSimp prototypes.

The research team realized, however, that the prototypes were not easily transferrable to the software. The team therefore made two decisions to better integrate the PHI and HazSimp projects for the testbed and address the software challenges.

The first decision focused on adapting the prototype warning levels to the PHI environment. The PHI probabilities are presented through a moving probability plume (see rainbow-colored feature in Figure 3). Prior PHI research has not included warnings, but rather conveyed the percent chance that a storm or location was severe or could produce a tornado. Thus, integrating warnings was a challenge by itself, in addition to factoring in specific HazSimp prototypes.

At the outset of the testbed, the HazSimp prototypes functioned in parallel to the WWA system. That is, a "Be Aware" level corresponded to a hazardous weather outlook, "Be Prepared" corresponded to a watch, and "Take Action" corresponded to a warning. Under the PHI environment, however, NWS forecast participants do *not* issue watches, as the watch component is assumed. The PHI environment only tests the short-term operational environment of warnings, not a full day of forecasting, which may include an outlook, watch, and warning. To blend the HazSimp prototype language with the PHI warning environment, the team adapted the HazSimp prototypes to use "Be Aware" as the equivalent of a significant weather advisory and "Take Action" as the equivalent of a warning.

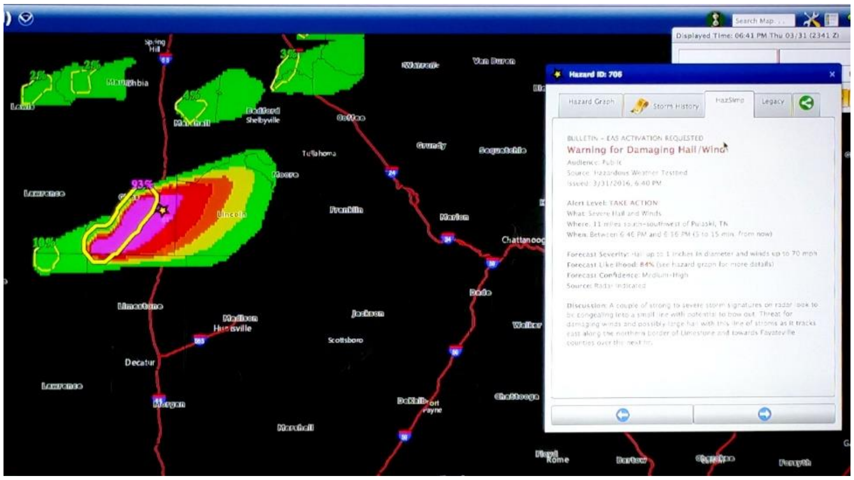


Figure 3. An example of a PHI plume in the EDD.

The second decision focused on visualizing the PHI probabilities in the HazSimp prototype messaging. Figure 4 shows an example of how the colors change based on the forecaster's forecast trend of subjective probability of a tornado occurring. The colors are as follows:

- Green = 0 to 20 percent
- Yellow = 21 to 40 percent
- Orange = 41 to 60 percent
- Red = 61 to 80 percent
- Purple = 81 to 100 percent

Figure 4. Colors associated with forecaster's chosen probability levels. Each black dot is a forecast point.

Based on the probability level, the associated color linked to the HazSimp prototype headline. For example, if the probability was 50 percent, then the headline showed an orange, "Warning for Tornado," during week 2. The probabilities were also shown numerically (e.g., 80%) in the "Forecast Likelihood" section of the HazSimp message.

The blending of HazSimp and PHI led to the *final* prototypes, which are shown in Table 2 and in Appendix A.

Additional programming changes were also required *during* the experiment. For example, because the yellow text was very difficult to read, programmers edited the software to place a black outline around the yellow text to make it legible. Another change included the addition of a polygon to demarcate the "Take Action" area.

NWS Forecaster Perspective

The testbed forecaster room was set up to mimic a typical weather forecast office, except each desk was organized by hazard (tornado, severe [hail and wind], and lightning). Each forecaster participating in the testbed spent one day at a different desk. In this way, they got an in-depth look at the new PHI software (see Figure 5) for forecasting each hazard. Each desk was also assigned a researcher with expertise in the particular hazard area. These same researchers were available to assist the forecast participants with the software.

The testbed experiment began with the creation of a forecast. As in the traditional operational environment, forecasters used various tools and models to gather available meteorological data and then synthesized this information into a forecast.

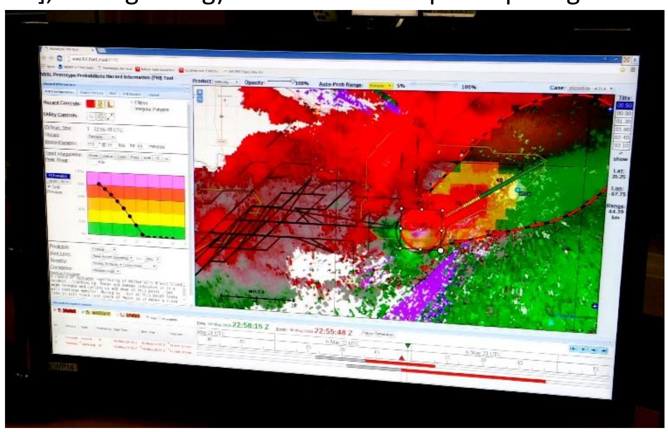


Figure 5. Forecasters used drop-down menus in the software to choose probability levels and other forecast components. The software automatically populated the HazSimp prototype message based on these selections.

Using this information, the forecasters then populated the HazSimp prototype by following this general process:

- Choose the alert-level language: “Be Aware” or “Take Action.”
- Choose a probability threshold corresponding to a warning. For example, a 30-percent threshold drew a warning polygon around the PHI probabilities equal to or above that amount.

The PHI probabilities then drive the HazSimp colors: 0–20 (green), 21–40 (yellow), 41–60 (orange), 61–80 (red), 81–100 (pink/purple).

To generate the rest of the HazSimp prototype content, forecasters chose from a series of drop-down menus in the PHI software (see Figure 6). The menu options changed depending on the hazard (tornadoes, severe [wind and hail], and lightning). Forecasters had to:

- Choose the alert-level language: “Be Aware” or “Take Action.”
- Choose a severity level (e.g., “Strong Tornado”) and information source (e.g., “Radar Indicated”), if applicable.
- Choose a confidence level:
    - Low
    - Low-Medium
    - Medium
    - Medium-High
    - High
- Create a forecast discussion:
    - This was an optional feature, but most forecasters chose to use it.

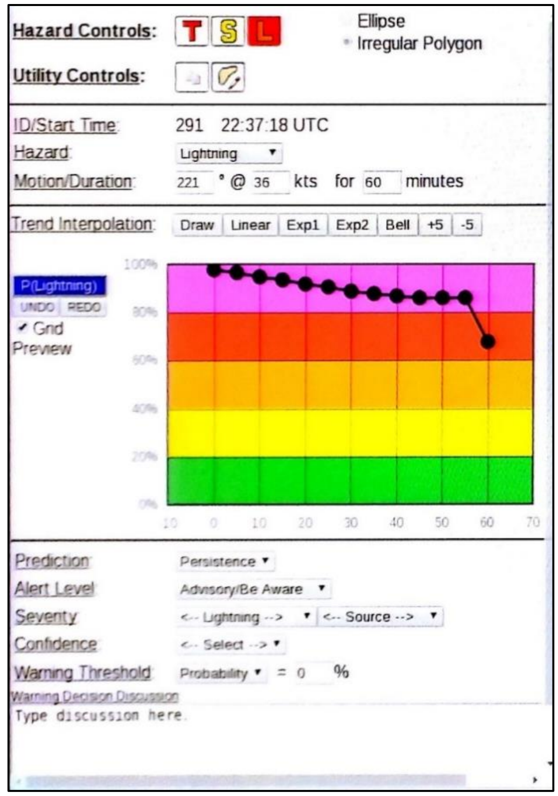


Figure 6. Drop-down menu options for HazSimp message generation.

Key HazSimp Findings

Over the course of the three-week testbed, researchers observed the following:

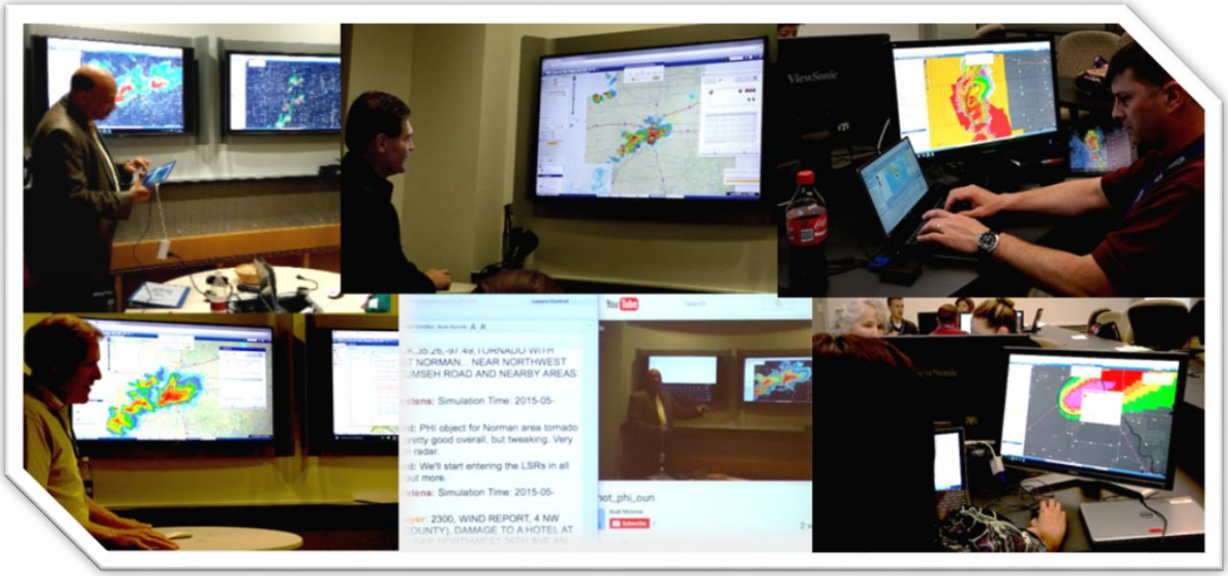
- **The current WWA system is ingrained in forecasters, and the alert-level language raised many questions to them**. During week 1, the research team observed that the alert-level language (“Be Aware” or “Take Action”) confused the forecasters who were trying to understand how the phrases mapped to meteorological criteria. Forecasters also spent time considering whether they wanted the public to just stay aware or whether they wanted to promote more action. In addition, they considered what language they thought the EMs and broadcast meteorologists would like to see.

  In response to these considerations, forecasters often chose “Take Action” (the equivalent of a warning) for situations that would have warranted an advisory in the current WWA system. To reduce confusion, programmers edited the software drop-down choices to “Be Aware/Advisory” and “Take Action/Warning.” Researchers also informed the forecasters to map their current meteorological criteria for warnings and advisories to the corresponding alert-level language in the prototype. Although the research team shared this new approach with the forecasters in weeks 2 and 3, the confusion persisted.

- **The HazSimp alert-level language also influenced the forecasters’ probability choices**. There are two approaches for forecasters to choose their respective probability. The forecaster either 1) draws his or her probability first, and then chooses the HazSimp alert level, or 2) chooses the HazSimp alert level first, and then draws the probability. More often than not, the research team observed forecasters choosing the HazSimp alert level first. Forecasters tended to increase their probabilities if they chose “Take Action,” while they tended to decrease it if they chose “Be Aware.” The forecasters were unconsciously assigning probability ranges to the language.

- **The forecasters could not separate probability from confidence.** Under the PHI paradigm, confidence and probability coexist, but are two distinct concepts. For example, a forecaster may have high confidence that an 80-percent chance of a tornado threat exists, but they may also have high confidence that a 20-percent chance of a tornado threat exists. In the testbed, the software for generating the prototype required forecasters to make separate determinations for probability and confidence. Many forecasters, however, saw the concepts as the same and were unable to distinguish how they were different**.** As such, forecasters conflated the concepts, believing that the probability was a measure of their confidence.

The Partner Perspective



The EM and broadcast meteorologist rooms were set up for “business as usual,” as they conducted their testbed operations to mimic their normal job responsibilities. For example, broadcast meteorologists followed their respective station’s guidelines on how and when to conduct a cut-in or go wall-to-wall. EMs followed their jurisdiction’s siren policies and documented their communication to colleagues or other first responders. EMs also operated from their respective level of responsibility (e.g., county, state, or regional) and coordinated with one another where applicable. For example, two county EMs coordinated their sirens to create a consistent message during one week of the testbed.

Much like the traditional operational environment, EMs and broadcast meteorologists synthesized a variety of meteorological information. During the past-event case studies, they primarily used the EDD software and NWSChat. EMs also played the broadcast meteorologists’ live TV footage (nicknamed “KPHI TV”) on their situational awareness wall. During the live events, EMs used real-time social media information, storm chaser footage, and real-time radar and warning information from RadarScope, which they said was part of their normal weather monitoring routine. When information, such as a storm report, was unavailable, both the EMs and broadcast meteorologists used creativity and imagination. For example, one EM reported that an outdoor circus was postponed due to the severe weather. KPHI TV then covered this impromptu story.

The EDD software displayed HazSimp information in two ways. EMs and broadcast meteorologists could mouse over a storm displayed on the map, which would make a popup box appear with the HazSimp headline information, or they could right-click on a location in the storm, prompting a popup box with multiple tabs to appear containing location-derived information (see Figure 7 and examples in Appendix A).

The most relevant tabs to HazSimp included:

- The "HazSimp" tab, which included the new prototype information.
- The "Legacy" tab, which included the current advisory or warning language and messaging.
- The share tab (designated with a symbol), which created graphics for social media (see Figure 8).

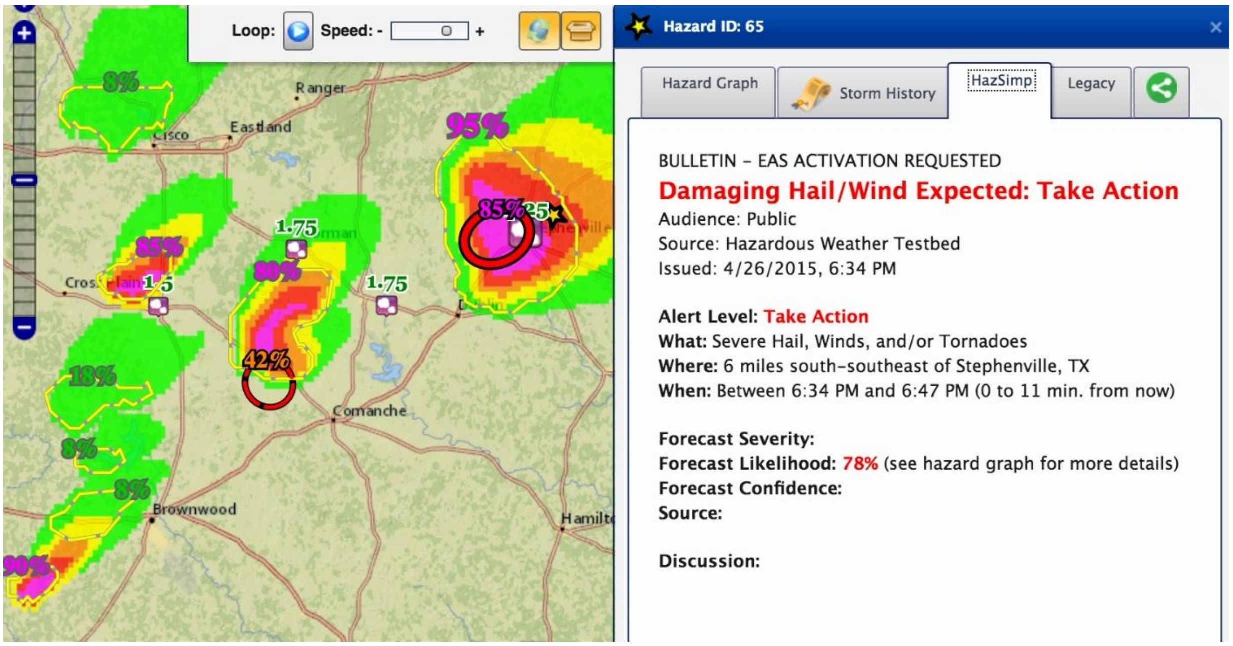


Figure 7. Example of popup box with the following tabs: "Hazard Graphic," "Storm History," "HazSimp," "Legacy," and a tab for sharing to social media (designated by symbol).

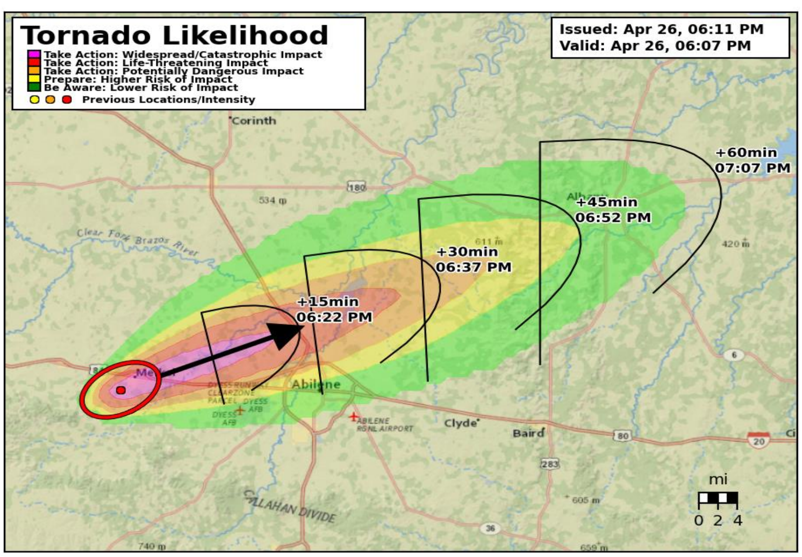


Figure 8. Example of a tornado social media graphic.

Key HazSimp Findings

The testbed revealed that EMs and broadcast meteorologists used different kinds of NWS information in different ways:

- **Partners used NWS information, including both the new HazSimp messages and the current WWA system, but relied less on the official text products.** For example, one EM explained that he did not rely on the warning text product (prototype or current text), as he is “using radar, TV, and PHI. We don’t need the text product. We’re looking at graphics.” Another EM added that the product (WWA or prototype) verifies EM confidence and looked to see if “it was matching everything else I was seeing.” In reference to tornadoes, EMs remarked that they want sophisticated meteorological background to help them understand why an event is or is not happening; for example, “There is mid-level rotation, but no low-level rotation.” EMs described how they triangulate meteorological data, both text and visuals. Any information the forecaster provides is important and influences their confidence during the decision-making process.

- **Broadcast meteorologists and EMs agreed that NWS information is important, but emphasized their reliance on graphical information.** Overall, participants agreed that the text products are useful, especially prior to the start of an event. But, once an event begins there is not always time to read them. For this reason, the visuals play a more important role in garnering attention and situational awareness. They described visuals as “easy to process” and the “right now stuff,” as opposed to text, which may already be minutes out of date. The visuals, however, may drive the participants to read the text when they need supporting evidence or validation of what they are seeing. To increase their likelihood of sharing the text, it must be concise and written in complete sentences. Some participants urged the NWS to provide more information, but to allow users to toggle features on and off, letting them decide when and what information to use for different types of events.

- **Broadcast meteorologists stressed the importance of “clear guidance” in reference to NWS headlines and products.** For example, broadcast meteorologists need to know the criteria, thresholds, or reasons behind “Take Action” versus “Be Aware.” In general, the blending of HazSimp and PHI created some messaging inconsistencies that frustrated broadcast meteorologists over the course of the week, demonstrating that clear criteria is required for any potential language change.

HazSimp Messaging Feedback

Table 3 aggregates the research findings from the EM and broadcast meteorologist rooms from all three weeks of the testbed. Table 4 provides an overview of feedback on each individual prototype’s headline.

Table 3. Overview of Broadcast Meteorologist and EM Feedback on HazSimp Headlines and Message Structure

Overview of Hazard Simplification Findings		
	Broadcast Meteorologists	**EMs**
Language: Take Action and Be Aware	• Felt the phrases were too vague and the actions lacked specificity. • Were unsure of how to use phrases on air. • Felt awkward using the phrase on air.	• Felt the phrases were too vague and the actions lacked specificity. • Wanted language that can be easily shared or forwarded. • Needed an authoritative voice (like an NWS warning) to forward messages.

Decisions Based on Language	• Did not use for decisions.
	  o Used local storm reports for cut-ins.
	  o Used confirmation for wall-to-wall.
		• Found it hard to make decisions without the official use of the word “warning” simply due to habit.
		• Became more comfortable using the HazSimp/PHI terminology over time.
		• Said that standard operating procedures rely on the word “warning.”
		• Said that HazSimp language did not change their decisions (PHI might have).

Colors	• Felt that news directors may not allow the use of NWS colors because of marketing implications. • Wanted the colors, if used, to convey actions.	• Preferred gradual increase of color gradient to rainbow colors. • Did not want lightning to have five color levels (maybe three). • Suggested eliminating the use of green. • Slightly preferred to keep purple for an emergency-level weather event. • Needed color consistency: too many different colors used on popups, objects, warning text, etc.
Content Structure	• Were unable to use the language in its current form for a crawl. • Expressed mixed sentiments on what content to crawl (some said do not include confidence or the discussion in the crawl; do crawl hazard, alert level, impact, where, when, and what). • Expressed mixed sentiments between needing complete sentences versus using bullets. • Suggested deleting the top few lines (Bulletin-EAS, audience, source).	• Liked the discussion box best of all because it synthesized all the information, gave it a human component, and clarified the automated forecast text. • Did not find the HazSimp features clear by themselves. • Felt the information was oversimplified; needed more context. • Felt the pieces of information overlapped; confidence and probability too similar; impact and severity too similar. • Did not want the NWS deciding impacts; EMs should decide impacts. • Wanted the meteorological information and severity.
Use of “Warning”	• Used by some out of habit. • Tried not to for the sake of the project.	• Standard operating procedures rely on the word “warning,” which will take

		time to change and adapt to in an operational environment.
HazSimp and PHI Combined	• Confused between forecaster confidence and probability. o Probabilities were not calibrated with the warnings. o Probabilities were not calibrated with the HazSimp action language.	• The PHI information provided more flexibility to make decisions earlier. • Concerned about how a traditional polygon would work with all of the action messages ("Be Aware," "Be Prepared," "Take Action," etc.) with PHI. • Asked if everyone in the polygon receives the same message.
Overall	• Rarely used the HazSimp prototype tab, as it did not add any value to their coverage; instead, they gained information needed by analyzing radar. • Wanted conversational sentences in text for reading on air (especially for radio broadcasters).	• The action messages do not work for EMs; they want hazard information, but posed that the action language may work for the public. • Felt that "watch" and "warning" still work for them, but that the public requires constant education (which they believe will be true for any system).

Table 4. Feedback on Each HazSimp Prototype Headline

	Prototype Structure	General Feedback
Week 1	**Headline**: Severe Message, or Tornado Message, or Lightning Message **Alert Level**: Take Action or Be Aware Colors changed based on forecast likelihood	• Wanted the hazard specified in the headline.
Week 2	**Headline**: Warning for Damaging Hail/Wind, or Warning for Tornado, or Warning for Lightning **Alert Level**: Take Action or Be Aware Colors changed based on forecast likelihood	• Suggested eliminating the "for"; just say "tornado warning." • Misinterpreted "Damaging Hail/Wind," as damaging hail and some wind, not as damaging hail and damaging wind.
Week 3	**Headline**: Damaging Hail/Wind or Tornado or Lightning Emergency: Take Action (purple) Damaging Hail/Wind or Tornado or Lightning Expected: Take Action (red) Damaging Hail/Wind or Tornado or Lightning Likely: Get Prepared (orange) Damaging Hail/Wind or Tornado or Lightning Possible: Be Aware (yellow) **Alert Level**: Take Action, Get Prepared, or Be Aware Headline language and color changed based on forecast likelihood	• Wanted to know the criteria for each level. • Wanted to know why an area is receiving this level; otherwise, the messages are not relevant. • Concerned about false alarm perceptions of the phrases. • Felt that "tornado possible," "likely," and "expected" all sounded too similar.

Partner Suggestions for HazSimp Messaging

The EMs and broadcast meteorologists offered several suggestions for the NWS to consider related to the HazSimp messaging.

Keep the discussion box. The discussion box was the most liked and used feature of the HazSimp messaging by both EMs and broadcast meteorologists. The box tied all of the HazSimp content together, as well as provided a desired human connection with the forecaster, which increased partner trust in the forecast. For EMs in particular, the automated information produced from the forecasters' drop-down menus (confidence, severity, etc.) were not as useful without the discussion.

Participants suggested the following improvements to the discussion box:

- List the discussions in reverse chronological order, with the most recent discussion at the top.
- Time stamp all of the discussion points.
- Move the discussion box to the top of the warning text.
- Add the forecaster name to the box.

Re-evaluate the alert-level language. EMs and broadcast meteorologists wanted the headline to state the hazard explicitly, not the desired action. They also said they needed a buzzword such as "warning"; the action phrases were too vague to act as buzzwords. In addition, they wanted to understand how and why the colors change. They were also concerned about some of the language (such as "Be Aware of Tornado") contributing to false alarm perceptions.

Participants suggested the following improvements:

- Provide clarity for why colors change.
- Provide set criteria for the alert-level language.
- Consider other "buzzword" language or maintain warning.

> "*When we ring the bell, they [the public] go to shelter*." – EM
>
> EMs need to "ring" a buzzword to spur people to take specific actions.

If action language is used, EMs and broadcast meteorologists suggested the following:

- Change "Take Action" and "Get Prepared," which are passive, to active voice, such as "Act Now" and "Get Ready."
- Make the language more specific. State what action a person should take.[1]
- Provide different actions for different levels of "warnings" if the system has multiple levels.
- Specify "action-to-threat" or "preparedness-to-hazard" information (see Figure 9).

[1] Although EMs and broadcast meteorologists want hazard-specific actions, they also cringed at the idea of doing this for every hazard in every product. The action language met a lot of pushback.

Edit the structure of the HazSimp text. EMs and broadcast meteorologists appreciated the concise structure of the new HazSimp layout and found it easier to identify information than in the current system. They did, however, have the following suggestions to further improve it:

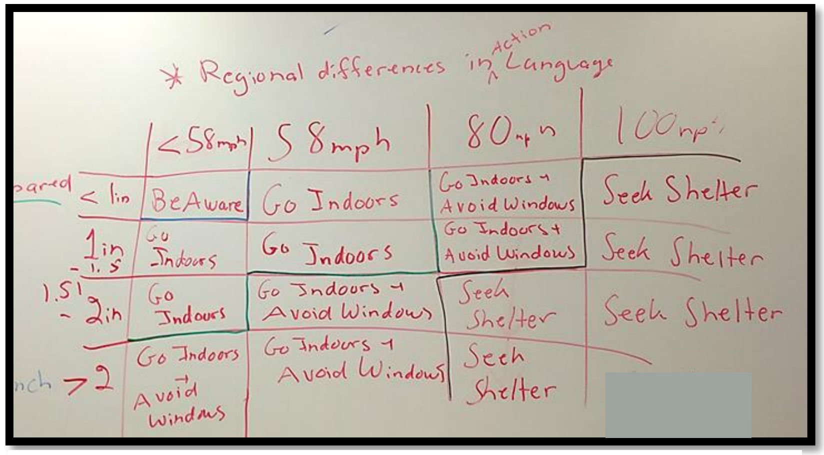


Figure 9. Suggested threat-specific action language for wind and hail combinations (see footnote 1).

- Change "what" to the actual hazard.
- Change "where" to the actual location.
- Change "when" to the actual timing.
- Add the storm's forward speed (e.g., "Moving east at 35 mph").
- Always use complete sentences.
- Add the call-to-action statements.
- Add impact statements (this was only suggested by forecasters; EMs and broadcast meteorologists expressed mixed views on the use of impact statements).
- Add the forecast pathcasts with location and timing information.

Add a social media graphic. EMs noted how quickly they could share the graphic via email to local officials or on social media, for example. The prototype graphic (see Figure 8) was user-friendly and easy to read, but they struggled with the action language. Collective suggestions included the following:

- Use "catastrophic" sparingly and clarify its definition.
- Potentially remove the term "emergency." EMs disagreed on whether to use this word as it has a specific meaning in their profession.
- Make an animated GIF of the graphic that shows the movement of the storm.

Re-evaluate the use of colors. EMs and broadcast meteorologists were not opposed to using color with language, but they wanted each color to be associated with a clear meaning (see Table 5 for some of their suggestions). Broadcast meteorologists emphasized that their TV stations will still push for their own color palettes, however, since color is often a marketing and branding tool. Participants offered the following suggestions:

- Do not use green, unless it is for conveying an "all-clear/safe" message.
- Define what the colors mean.
- Make sure the yellow text is readable (See Figure 10).
- Consider colorblind individuals. If only the color changes in a message (e.g., a green "Take Action" versus red "Take Action"), then a colorblind person may not see the difference.
- Make sure there is a visual hierarchy if colors are used.
- Do not combine a colored system with icons. It will require too much time and effort to find what they need (EMs only).

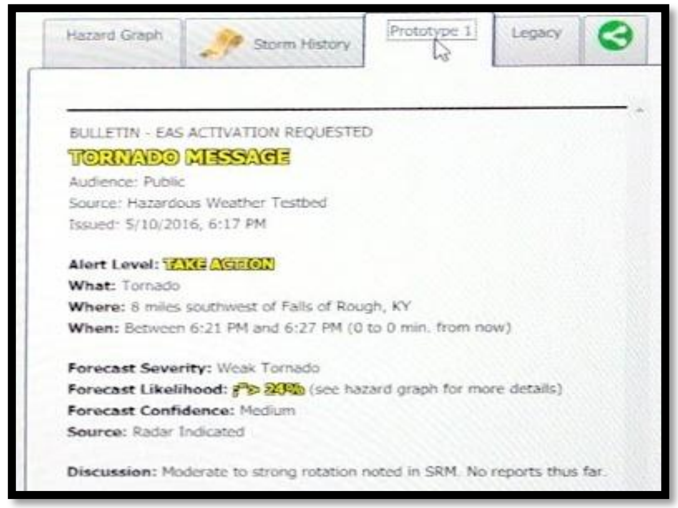


Figure 10. Example of yellow HazSimp text as edited by programmers to make it more readable.

Table 5. Possible Color and Meaning Associations

Purple	Red	Orange	Yellow	Green
• Tornado emergency • Seek shelter immediately	• Shelter • High danger • High risk • Imminent threat	• Heightened • Threat • Take shelter for special needs • Increasing risk/threat • Prepare to take shelter	• Should be lowest threshold • Caution • Awareness • Stay weather-aware	• Not much • Go • Safe

Additional Suggestions for the NWS

The partners also provided several suggestions for the NWS to consider beyond hazard messaging as it considers potential changes to the WWA system.

Further develop the concept of a "continuous flow of information." PHI emphasizes a continuous flow of information, a key aspect of the FACETs paradigm. Although PHI is not yet ready for operational implementation, the participants provided several ideas to implement a continuous flow of *current* NWS information already used in operations. For example, participants wanted to see how confidence, severity, and storm reports changed over time (attributes included in the HazSimp messages). EMs and broadcast meteorologists wanted to know if

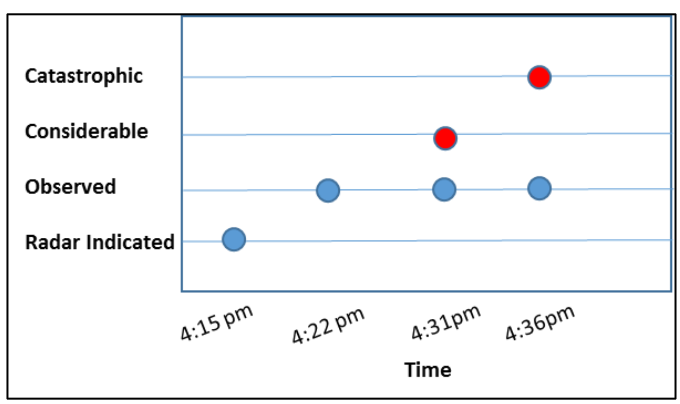


Figure 11. Example of a continuous flow of Impact-Based Warning information.

severity was increasing, decreasing, or remaining the same, or if storm reports were coming in at a faster rate than 20 minutes ago. They said these kinds of changes over time provide additional cues that aid in situational awareness. Currently, the NWS conveys levels of severity through its Impact-Based Warning (IBW) program using language such as “radar indicated,” “observed,” “considerable,” and “catastrophic.” Applying the continuous flow idea, rather than seeing one snapshot in a single text product, a trend graphic could show the IBW language over time during an event (see Figure 11). Partners suggested “unlocking” the text packaged in individual NWS products by showing specific components visually in a graph, for example.

Consider having both a simple and a complex view of NWS information. EMs and broadcast meteorologists pushed back against using action language to replace the current system, stating that they rely on meteorology and trigger words, not action words. At the same time, however, they acknowledged that action language may work well for public audiences. Because the NWS has different audiences with different needs, participants suggested that the NWS consider a way to provide both a simple and a complex view of NWS information (though both would remain publicly available). Ideas included posting a simple view at “weather.gov” and a more complex view at “em.weather.gov,” or a clickable header with a simple view visible when a user enters the site, but a detailed view available when double-clicked (see Table 6 for an example). It is important to emphasize that these are partner suggestions, and they may not be operationally viable.

Table 6. Example of Simple and Complex Views

Simple	Complex
• Hazard with specifics (e.g., Up to 1’’ Hail, 60 mph Wind) • National Weather Service • Issued: Date, Time • Where: • When:	• Header = Hazard only • Discussion (without the word) • Issued: Date/Time by NOAA’s NWS • Where: • When: • Forecast Severity: • Forecast Likelihood: • Forecast Confidence: • Source:

Recommendations and Possible Next Steps

Based on the HWT and participant feedback, ERG offers the following suggestions for NWS consideration:

- **Further refine the prototypes from an operational meteorology perspective.** All participants from all sectors stated that they need to know how the system functions, especially as it relates to what the NWS is communicating. Partners emphasized that communication using color and words cannot change arbitrarily; instead, the system must have criteria or definitions relating it to an underlying meteorological attribute. The most critical issue is determining what meteorological attribute will drive each headline change. Impacts, confidence, or even a matrix system of severity times confidence are all possible.

- **Use the NOAA Testbeds to determine the forecaster training needs relating to any potential changes to the WWA system.** Although connecting the HazSimp alert levels (“Be Aware” and

"Take Action") to the current paradigm (advisory and warning) helped minimize forecaster confusion, it is clear that any future change in NWS warning language will require training and time for forecasters to adapt. The type of language change (e.g., replacing words or moving toward a matrix system), will impact the amount and length of training required.

- **Research the effects of new alert-level language on forecasters' probability choices, and consider how to blend the concepts of confidence and probability more intuitively.** Including both the HazSimp alert-level language and confidence impacted the forecasters' probability choices in ways the research team had not anticipated. Knowing how the HazSimp alert-level language and confidence influence forecasters' probability choices is important for future integration of PHI, as well as for future forecaster training.

- **Evaluate how general versus specific action messages impact people's behavioral intent.** Participants had mixed reactions to the action language. Although they appreciated the appearance of simplicity, the language did not meet their needs. From the forecaster perspective, an individual should take action whether it is a significant weather advisory ("Be Aware") or a warning ("Take Action"); thus, the action language initially prompted operational confusion. Forecasters also were concerned that if the system provides a "red" level for multiple messages, for example, then the NWS may lose its ability to distinguish severity through its communication. EMs and broadcast meteorologists were concerned that the public will "cry wolf" if all of the messages indicate to "Take Action" but do not specify what kind of action and why. Even with these reservations, however, some participants acknowledged that simple, actionable language might resonate with the public, but that such phraseology would need to be tested with members of public.

- **Consider maintaining features of the current system, such as the term "warning," to remain responsive to EM and broadcast meteorologist needs.** A number of EMs stated that the current "watch" and "warning" terms work well for them. These terms are also ingrained in their operations, so it would take time to adapt to different language. The broadcast meteorologists also found themselves using the term "warning" out of habit and found the prototype language awkward to use on-air.

- **Conduct further transitional research on the HazSimp prototypes in the HWT.** All three groups of participants agreed that the message structure needs further assessment. Broadcast meteorologists encouraged more dialogue with the entire broadcast community before any structural changes are made to the warning content. Message style and content impacts their communication and technology, such as TV crawl software. EMs urged the NWS to conduct focus groups and surveys with the larger EM community to find out what information they need in a warning message and how they want it structured *before* the NWS makes any significant changes. NWS forecasters described openness to any change that will benefit their partners, but recommended that the NWS research how the change will impact the operational environment both in terms of technology and forecaster training. Transitional research provides an opportunity to test operational ideas, such as message structure, in a contained environment, allowing the NWS to vet ideas without causing real-time operational disruption. The testbed process allows the NWS and NSSL to identify areas worthy of more research, areas that may require training, and areas that may require more operational consideration.

Conclusion

Before the 2016 HWT, the NWS invested in HazSimp research that included interviews, focus groups, case studies, and workshops. All of these research efforts have allowed the NWS to narrow options, think about challenges, and produce ideas for improvement. The testbed environment offered a new methodological approach with both limitations and challenges. First, this research focused on only one hazard: severe weather. Second, the sample size (nine forecasters, three broadcast meteorologists, and 11 EMs) was quite small. Lastly, given that the testbed environment used real-time severe weather for half the cases, the events each week varied, which makes a true comparison from week to week more challenging. For these reasons, care must be taken to not overgeneralize the results from this research.

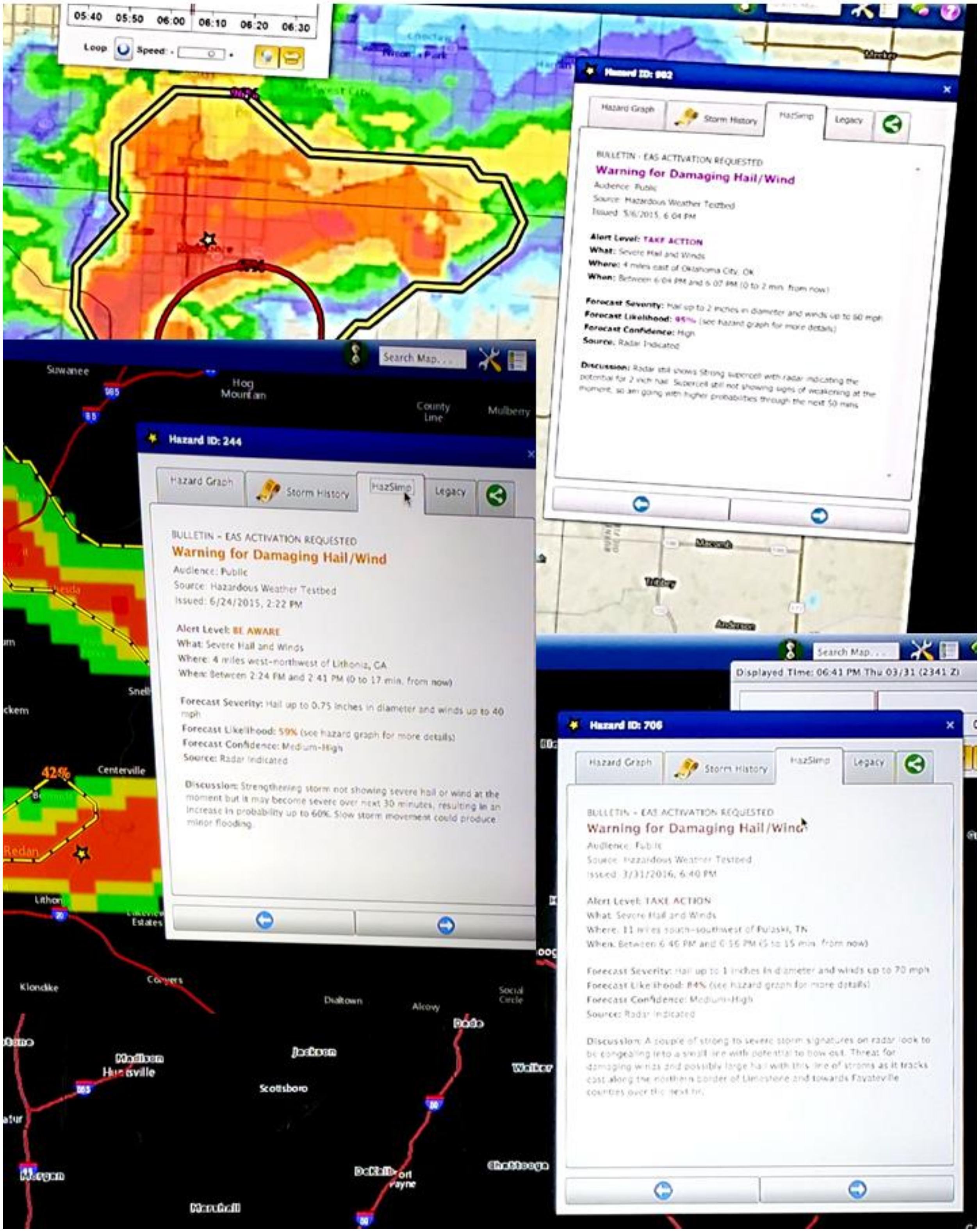
At the same time, however, the testbed process enabled the researchers to gather new data in a unique way compared to other HazSimp research efforts. Rather than asking participants what they think about the current system or what their ideas are for a future system, participants *used* the system in as close to their own operational environment as possible. This process allowed the research team to discover findings such as the EMs' reliance on visual information as opposed to language, broadcast meteorologists' difficulties in trying to use the action-oriented language on air, and the forecasters' struggles with the passivity of the "Be Aware" alert-level language. One broadcast meteorologist described how adamantly he had supported the use of action language to replace WWA prior to the testbed. After one week in the testbed, however, he realized how awkward it was to express the action language on air and admitted that a buzzword, such as "warning," was missing. This reflection does not discount the possibility that action language may work well for the public, but shows that there is a distinction between collecting ideas versus testing ideas in a real-life environment. Therefore, although the sample size is small, the findings are significant.

The testbed environment represents some of the most intricate research one can undertake. As such, the 2016 HWT required a fine balance between structure and flexible creativity. Studying specific research questions and ideas on the brink of operational implementation, such as PHI, as well as operations in need of research improvement, such as HazSimp, provided the structure; meanwhile, simulating an integrated warning team with multifaceted human needs required flexible creativity. The results gave the research team important insights into science, technology, human behavior, and organizational adaptability. As the HazSimp project moves forward, the NWS should continue to use its partnership with the NSSL's HWT, and other NOAA testbeds, to evaluate how potential operational changes may impact the integrated warning team.

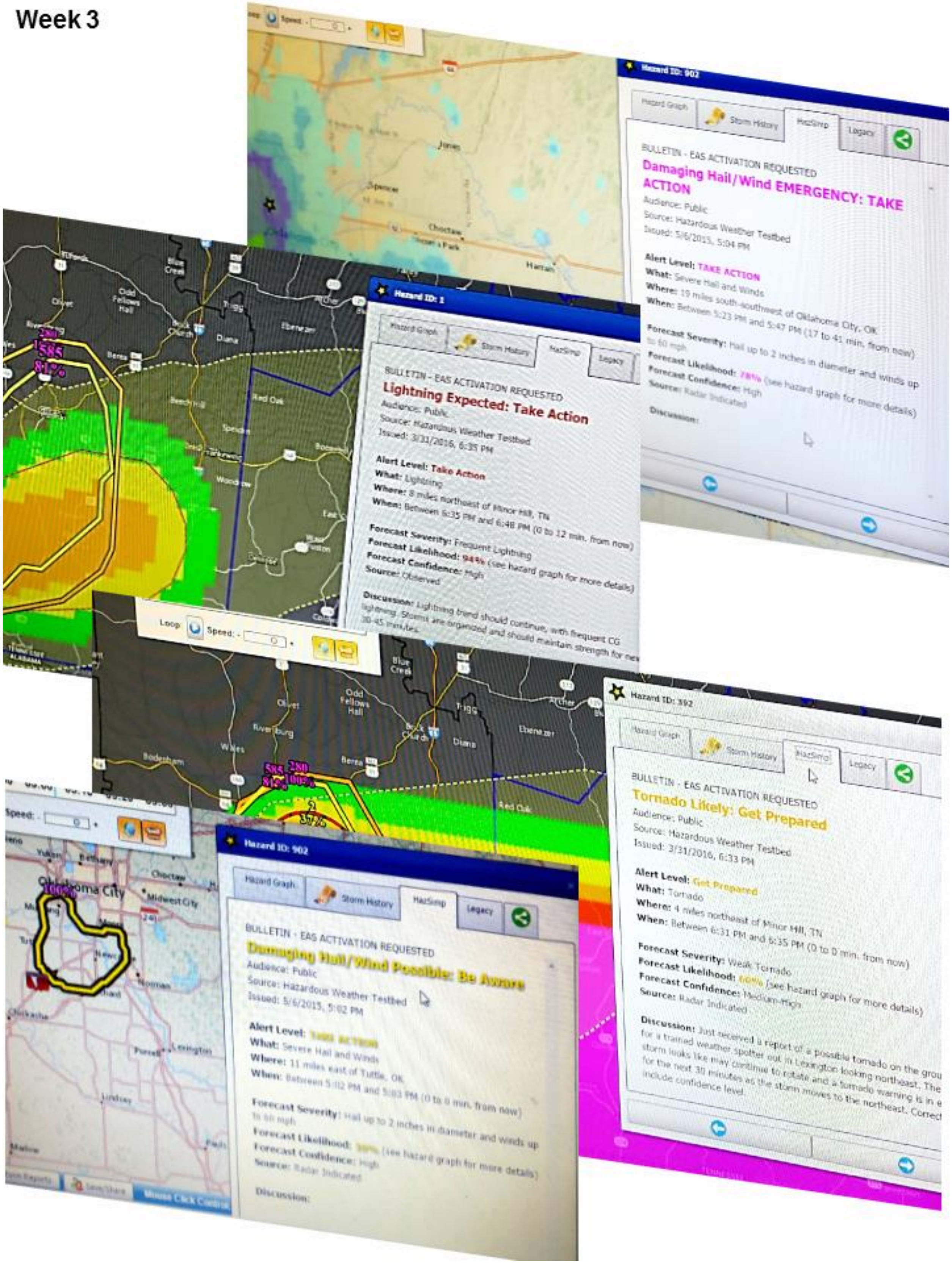
Appendix A

Week 1

Week 2


Hazard ID: 962
Hazard Graph
Storm History
HazSimp
Legacy
BULLETIN - EAS ACTIVATION REQUESTED
Warning for Damaging Hail/Wind
Audience: Public
Source: Hazardous Weather Testbed
Issued: 5/6/2015, 6:04 PM
Alert Level: TAKE ACTION
What: Severe Hail and Winds
Where: 4 miles east of Oklahoma City, OK
When: Between 6:04 PM and 6:07 PM (0 to 2 min. from now)
Forecast Severity: Hail up to 2 inches in diameter and winds up to 60 mph
Forecast Likelihood: 95% (see hazard graph for more details)
Forecast Confidence: High
Source: Radar Indicated
Discussion: Radar still shows Strong supercell with radar indicating the potential for 2 inch hail. Supercell still not showing signs of weakening at the moment, so am going with higher probabilities through the next 50 mins
Hazard ID: 244
Hazard Graph
Storm History
HazSimp
Legacy
BULLETIN - EAS ACTIVATION REQUESTED
Warning for Damaging Hail/Wind
Audience: Public
Source: Hazardous Weather Testbed
Issued: 6/24/2015, 2:22 PM
Alert Level: BE AWARE
What: Severe Hail and Winds
Where: 4 miles west-northwest of Lithonia, GA
When: Between 2:24 PM and 2:41 PM (0 to 17 min. from now)
Forecast Severity: Hail up to 0.75 inches in diameter and winds up to 40 mph
Forecast Likelihood: 59% (see hazard graph for more details)
Forecast Confidence: Medium-High
Source: Radar Indicated
Discussion: Strengthening storm not showing severe hail or wind at the moment but it may become severe over next 30 minutes, resulting in an increase in probability up to 60%. Slow storm movement could produce minor flooding.
Search Map...
Displayed Time: 06:41 PM Thu 03/31 (2341 Z)
Hazard ID: 706
Hazard Graph
Storm History
HazSimp
Legacy
BULLETIN - EAS ACTIVATION REQUESTED
Warning for Damaging Hail/Wind
Audience: Public
Source: Hazardous Weather Testbed
Issued: 3/31/2016, 6:40 PM
Alert Level: TAKE ACTION
What: Severe Hail and Winds
Where: 11 miles south-southwest of Pulaski, TN
When: Between 6:40 PM and 6:56 PM (5 to 15 min. from now)
Forecast Severity: Hail up to 1 inches in diameter and winds up to 70 mph
Forecast Likelihood: 84% (see hazard graph for more details)
Forecast Confidence: Medium-High
Source: Radar Indicated
Discussion: A couple of strong to severe storm signatures on radar look to be congealing into a small line with potential to bow out. Threat for damaging winds and possibly large hail with this line of storms as it tracks east along the northern border of Limestone and towards Fayateville counties over the next hr.
05:40 05:50 06:00 06:10 06:20 06:30
Loop
Speed:
Suwanee
Hog Mountain
County Line
Mulberry
Centerville
Klondike
Conyers
Dialtown
Alcovy
Social Circle
Scottsboro
Huntsville
Jackson
Walker
Dade
Madison
Marshall
42%

Week 3



Hazard ID: 902
Hazard Graph
Storm History
HazSimp
Legacy
BULLETIN - EAS ACTIVATION REQUESTED
Damaging Hail/Wind EMERGENCY: TAKE ACTION
Audience: Public
Source: Hazardous Weather Testbed
Issued: 5/6/2015, 5:04 PM
Alert Level: TAKE ACTION
What: Severe Hail and Winds
Where: 19 miles south-southwest of Oklahoma City, OK
When: Between 5:23 PM and 5:47 PM (17 to 41 min. from now)
Forecast Severity: Hail up to 2 inches in diameter and winds up to 60 mph
Forecast Likelihood: 78% (see hazard graph for more details)
Forecast Confidence: High
Source: Radar Indicated
Discussion:
Hazard ID: 1
BULLETIN - EAS ACTIVATION REQUESTED
Lightning Expected: Take Action
Audience: Public
Source: Hazardous Weather Testbed
Issued: 3/31/2016, 6:35 PM
Alert Level: Take Action
What: Lightning
Where: 8 miles northeast of Minor Hill, TN
When: Between 6:35 PM and 6:48 PM (0 to 12 min. from now)
Forecast Severity: Frequent Lightning
Forecast Likelihood: 94% (see hazard graph for more details)
Forecast Confidence: High
Source: Observed
Discussion: Lightning trend should continue, with frequent CG lightning. Storms are organized and should maintain strength for
30-45 minutes.
Hazard ID: 392
BULLETIN - EAS ACTIVATION REQUESTED
Tornado Likely: Get Prepared
Audience: Public
Source: Hazardous Weather Testbed
Issued: 3/31/2016, 6:33 PM
Alert Level: Get Prepared
What: Tornado
Where: 4 miles northeast of Minor Hill, TN
When: Between 6:31 PM and 6:35 PM (0 to 0 min. from now)
Forecast Severity: Weak Tornado
Forecast Likelihood: 60% (see hazard graph for more details)
Forecast Confidence: Medium-High
Source: Radar Indicated
Discussion: Just received a report of a possible tornado on the
for a trained weather spotter out in Lexington looking northeast. The
storm looks like may continue to rotate and a tornado warning is in
for the next 30 minutes as the storm moves to the northeast.
include confidence level.
Hazard ID: 902
BULLETIN - EAS ACTIVATION REQUESTED
Damaging Hail/Wind Possible: Be Aware
Audience: Public
Source: Hazardous Weather Testbed
Issued: 5/6/2015, 5:02 PM
Alert Level:
What: Severe Hail and Winds
Where: 11 miles east of Tuttle, OK
When: Between 5:02 PM and 5:03 PM (0 to 0 min. from now)
Forecast Severity: Hail up to 2 inches in diameter and winds up
Forecast Likelihood:
Forecast Confidence: High
Source: Radar Indicated
Discussion:
Loop
Speed:
Oklahoma City
Blue Creek
Odd Fellows Hall
Trigg
Archer
Ebenezer
Diana
Berea
Red Oak
Olivet
Riverburg
Wales