# J1.3 ROLE-PLAYING SCENARIO OF A LANDFALLING TROPICAL SYSTEM

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## 1. INTRODUCTION

The NOAA/National Weather Service (NWS) Warning Decision Training Branch (WDTB) has designed and conducted several versions of role-playing scenarios for professional meetings, such as the National Severe Weather Workshop (Morris et al. 2008), the National Hydrologic Warning Council, and the Association for State Floodplain Managers. The scenarios simulated a tornado event, straight-line wind event with an overturned tanker, and tornado and flash flood event with a large event venue. The overall goal of the role-playing scenarios was to improve performance of the Integrated Warning Team (IWT) during actual weather events. The primary learning objectives of the scenarios were to understand and empathize with customer and partner roles and identify ways to improve teamwork within the IWT.

The IWT consists of three independent, yet interdependent, groups: NWS forecasters, broadcast media, and local emergency management (EM) officials; which is similar to the integrated warning system defined by Doswell et al. (1999). The members of the IWT share the goal of protection of life and property and should have a consistent message to promote a favorable public response (Mileti and Sorenson 1990).

At the 2010 National Hurricane Conference, the WDTB and an interdisciplinary team of NWS forecasters, broadcast media, emergency managers, and Sea Grant personnel facilitated a role-playing scenario of a landfalling tropical system in North Carolina. The scenario consisted of three separate and synchronized displaced real-time simulations of operations by an emergency operations center (EOC), a television station, and a NWS weather forecast office (WFO) during the tropical event. Fifty participants played roles outside of their areas of expertise, functioning as members of the IWT, to learn the importance of improved team situation awareness and communications during tropical events. The out-of-role or cross-training approach was based on research indicating that cross-training can increase shared mental models and team situation awareness (Volpe et al. 1996; Bolstad et al. 2005). When communication channels are limited, shared mental models enable IWT members to 1) anticipate actions and information requirements of other team members, 2) increase coordination, and 3) reduce the need for communication among teams (McCann et al. 2000; Converse et al. 1991).

The scenario featured synchronized playback of radar, river forecast, and other relevant weather data along with simulated field reports. While physically separated in different rooms, the simulations were linked such that information was shared among the rooms. A variety of mechanisms facilitated these communications, including NWSChat, creation and dissemination of NWS warning products, and a closed-circuit television broadcast.

## 2. LIVE SCENARIO DESIGN

The live three-role scenario with three interconnected rooms required a total of 10-15 people to

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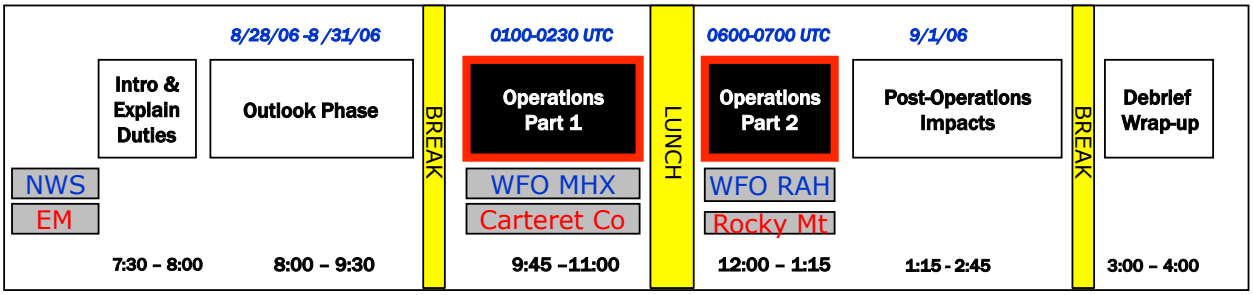


Figure 1. Scenario timeline for the simulation at the National Hurricane Conference. Black boxes with red outlines reflect times when the simulations ran in operational displaced real-time mode.

conduct. The scenario was facilitated by at least two broadcasters, two emergency managers, and four people in the NWS room; a technical support person, and people who roamed between the rooms to ensure the groups were synchronized and did other facilitation tasks. A scenario leader guided each of the three groups with assistance from several subject matter experts. The leader kept the individual simulations on schedule while the subject matter experts operated role-specific software and taught the group while keeping operations as realistic as possible.

The scenario timeline (Fig. 1) was one day in length spread over eight hours. Workshop participants were divided into their assigned roles. The first 30 minutes were devoted to overall scenario objectives and basic training on the duties and responsibilities of the roles before, during, and after a tropical storm impacts the region.

The NWS group reviewed forecaster duties and definitions of various types of watches, warnings, and statements. The media group learned how the management structure of a typical commercial television station supported and affected the decisions about severe weather coverage. The EM group discussed organizational differences between the two simulated EOCs and their respective emergency operations plans.

To support this basic education in job roles and responsibilities, the following 90 minutes were the Outlook Phase with a compressed time format beginning three days prior to landfall of the tropical storm to analyze weather products. The NWS room issued inland tropical storm/hurricane watches and warnings and disseminated them to the broadcast media and EM rooms. The EM group discussed potential evacuation and shelter needs. The media group discussed the appropriate time to begin on-air coverage and content for alerts.

The next 150 minutes were two phases of displaced real-time operations, which included the landfall and inland effects of the tropical storm. Ninety minutes were dedicated to the post-landfall impacts and discussion, 30 of which were devoted to discussion of how participants responded to being in a role they were familiar with during a landfalling tropical storm. The last 60 minutes of the scenario were dedicated to debriefing and wrap-up. The facilitators revealed what actually happened during the landfall of the tropical storm, and each room summarized their wrap-up discussion.

Members of the IWT who had experienced the real event helped create a script that identified key action points. The script specified that certain reports were delivered to specific rooms at appropriate times (Fig. 2). Each group then collectively decided what actions to take based on the new information, including whether to communicate the information to the other rooms. These field reports were mostly based upon reports collected during the actual weather event. However, some reports were modified so that those who remembered the event were not be able to rely on previous knowledge, and additional learning objectives could be included.

The NWS simulation was driven using the Weather Event Simulator (WES). WES consists of the NWS Advanced Weather Interactive Processing System (AWIPS) software fed by other software that allows AWIPS to function in a displaced real-time mode. An AWIPS operator displayed radar products requested by

| Orlando Time | Scenario Time | NWS Room | Media Room | EM Room |
|---|---|---|---|---|
| **10:45 AM** | 9:00 PM EDT 0100 UTC | **Report via microphone:** "You've just seen on one of the national news outlet that DHS officials are saying the Ernesto is expected to be a Cat 2 just as it moves onshore." | **Report via microphone:** "You've just seen on one of the national news outlet that DHS officials are saying the Ernesto is expected to be a Cat 2 just as it moves onshore." | **Report via microphone:** "You've just seen on one of the national news outlet that DHS officials are saying the Ernesto is expected to be a Cat 2 just as it moves onshore." |
| **11:05 AM** | 9:20 PM EDT 0120 UTC | **Report via microphone:** "A trained spotter has reported a tornado just northwest of Sneads Ferry in Onslow County" | | The Moorehead Port Authority has called the County Manager and wants to know if this storm is going to be a rain event as the Governor indicated or if it's going to be a Category 2 hurricane that DHS reported. There are 6 container ships at anchor off shore awaiting docking instructions. |
| **11:30 AM** | 9:45 PM EDT 0145 UTC | **Report via microphone:** "CoCoRAHS heavy rain report received from observer in Holly Ridge, southwest Onslow County, of 1.12 inches of rain in the last hour ending at 9 PM and a storm total thusfar of 4.36 inches. | **Report via microphone:** "An angry viewer is demanding that you stop interrupting the season finale of Big Brother 8 for just a little wind storm." | The Red Cross has called the Carteret EOC and indicated that the local shelters are full and an additional school is needed for another shelter. They also need pet supplies and additional security. |
| **11:40 AM** | 9:55 PM EDT 0155 UTC | | **Report via microphone:** "A viewer in Emerald Isle is reporting rainfall over the last 3 hours of 5 inches." | **Report via microphone:** "A spotter in Moorehead City noticed a damaged roof in downtown Moorehead City. He's not sure when the damage occurred. |
| **11:50 AM** | 10:05 PM EDT 0155 UTC | **Report via microphone:** "A spotter in Sneads Ferry reported a recently measured wind gust to 50 mph. | **Report via microphone:** "A viewer on Roanoke Island, Dare County is wondering why you haven't been talking about all the scary red things on the radar near Wanchese. | |

Figure 2. Segment of the scenario script for the displaced real-time warning operations of the simulation at the National Hurricane Conference.

the participants. The operator also used the AWIPS WarnGen software to create warning products and follow-up statements according to the group consensus, which were disseminated from the NWS room to a web server that fed displays in the other two rooms.

The media simulation was based on FasTrac® software (Baron Services 2011) and GR2Analyst (Gibson Ridge Software 2011) that facilitated playback of Level II radar data and generated familiar broadcast-quality radar displays. Complete with interactive scrolling and zooming capabilities, this software also provided algorithm output. This display was visualized on a projection screen. Volunteers took turns at playing the role of an on-camera meteorologist in front of the radar display; a closed-circuit television feed ("WRAL-TV") was broadcast to the NWS and EM rooms. NWS products were available in the media room using a connection to the web server.

Weather data for the EM room were fed directly from the web server. Radar data and surface maps were visualized using a mockup of the NC-First Weather Portal (Proud and Galluppi 2008). In addition, the EM room had various decision assist tools, such as Hurricane Evacuation (HURREVAC) and Sea, Lake, and Overland Surges from Hurricanes (SLOSH).

During the simulations, each room had NWSChat, a telephone, and data displays unique to each role, all in time-sync showing displaced real-time weather data.

## 3. LEARNING OBJECTIVES

The role-playing scenario was designed to be an interactive learning experience, thus the simulations were constructed with several objectives in mind. The scenario planners drafted specific objectives for each role that could be covered either in the pre-briefing or during the scenario. The objectives for each role are listed below.

### 3.1. NWS Weather Forecast Office

- Demonstrate forecast challenges regarding quantitative precipitation forecasts, official and contingency river forecasts, wind forecasts, and multiple simultaneous hazards
- Demonstrate the challenging nature of providing lead time for topical cyclone tornadoes due to their quick development
- Highlight the value of providing a continuous flow of information in various forms (instant messaging, graphics, and Warning Decision Updates)
- Demonstrate the importance of using all available data to make a forecast and warning decision [observed data (rain gauges, stream gauges, satellite, radar, surface weather observations), spotter reports, and media reports]
- Demonstrate challenges of forecasting and warning along CWA boundaries
- Highlight graphical forecast products (river forecasts, inundation mapping, and National Digital Forecast Database)

### 3.2. Broadcast Media

- Understand the challenge of maintaining continuous coverage, forecasting analysis and preparation, forecast graphics generation, cut-ins, crawls, one-on-one consultations with reporters in the field, Internet products, radio communications, and keeping management updated
- Understand how factors affect coverage decisions (regular programming; need for advertising revenue; competition; image-building; nature, severity, location, timing, and duration of threat; number of people affected; unexpected impacts; and resources available for coverage)
- Understand the need for effective communication with the News Department to ensure adequate preparations for coverage; adequate command, control, and safety of field crews; and accuracy of information rolled into news elements
- Understand the impacts of public phone calls during events (complaints about too much coverage, coverage not specific to their immediate needs, unconfirmed viewer reports)
- Understand the need for current information and timely forecasts (impacts type and quantity of coverage)

### 3.3. Emergency Management

- Foster partnerships among IWT members to improve political support and public awareness
- Understand non-uniformity and limited staffing and resources of EM operations
- Understand importance of NWS and EM coordination and understanding of how forecasts influence evacuation and sheltering decisions
- Understand citizen reaction to media broadcasts and the associated impacts on EM and other emergency services operations
- Understand the impacts of lack of correlation of forecasts and reports of media broadcasts and NWS
- Improve EM feedback to media and NWS
- Improve communication between media spotters/chasers and local officials
- Understand weather impacts on non-weather related incidents and coordination with NWS
- Understand importance of communication with local media during complex and high-impact incidents
- Understand the use of HURREVAC software in the response to a landfalling tropical system

## 4. CASE SELECTION

A tropical event was chosen for the role-playing scenario for several reasons. Because tropical systems

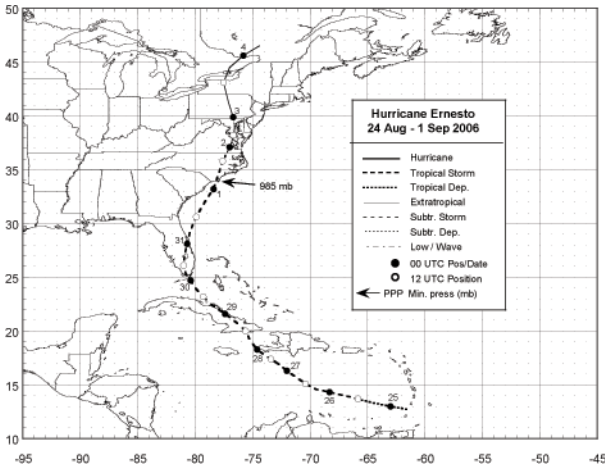


Figure 3. Best track positions for Hurricane Ernesto, 24 Aug - 1 Sep 2006 (Knabb and Mainelli 2006).

impact large areas, this type of event provided the opportunity to address the complications of having multiple NWS offices and different EM jurisdictions involved in a single event. The choice of a tropical event and a coastal location also provided opportunity to incorporate some core NWS partners that may have less experience, including Sea Grant Extension Agents. Hydrologists were incorporated because they have a critical and integrated role during tropical events. The tropical event was particularly significant for emergency managers and broadcasters due to changes in the forecasted track and intensity of the tropical system.

The scenario simulated Hurricane Ernesto (2006), which was briefly a category 1 hurricane over the central Caribbean Sea. Ernesto moved across eastern Florida as a weak tropical storm. After turning to the northeast, it intensified and made landfall on 31 Aug on the North Carolina coast just below hurricane status (Fig. 3). The center came ashore at 0340 UTC 1 Sep on Oak Island, North Carolina, a few kilometers south-southwest of Wilmington. At the time of final landfall, Ernesto was very near the threshold between tropical storm and hurricane status, with an intensity of 31 m $s^{-1}$ and a minimum pressure of 985 hPa (Knabb and Mainelli 2006). Thereafter, Ernesto weakened as it moved across eastern North Carolina where it became a tropical depression by 1200 UTC 1 Sep.

Torrential rainfall and floods in portions of eastern North Carolina resulted in the flooding of several homes. For days following landfall, rain-induced river floods inundated several homes. Storm surge caused minor coastal flooding and beach erosion along the immediate Atlantic coastline. The surge along bays and rivers flooded several homes and businesses. Minor property damages were caused by the three tornadoes in eastern North Carolina. Strong winds downed trees and power lines in coastal areas of North Carolina.

The NWS group played two roles in sequence: the Newport/Morehead City, North Carolina (MHX) WFO and the Raleigh, North Carolina (RAH) WFO. The MHX

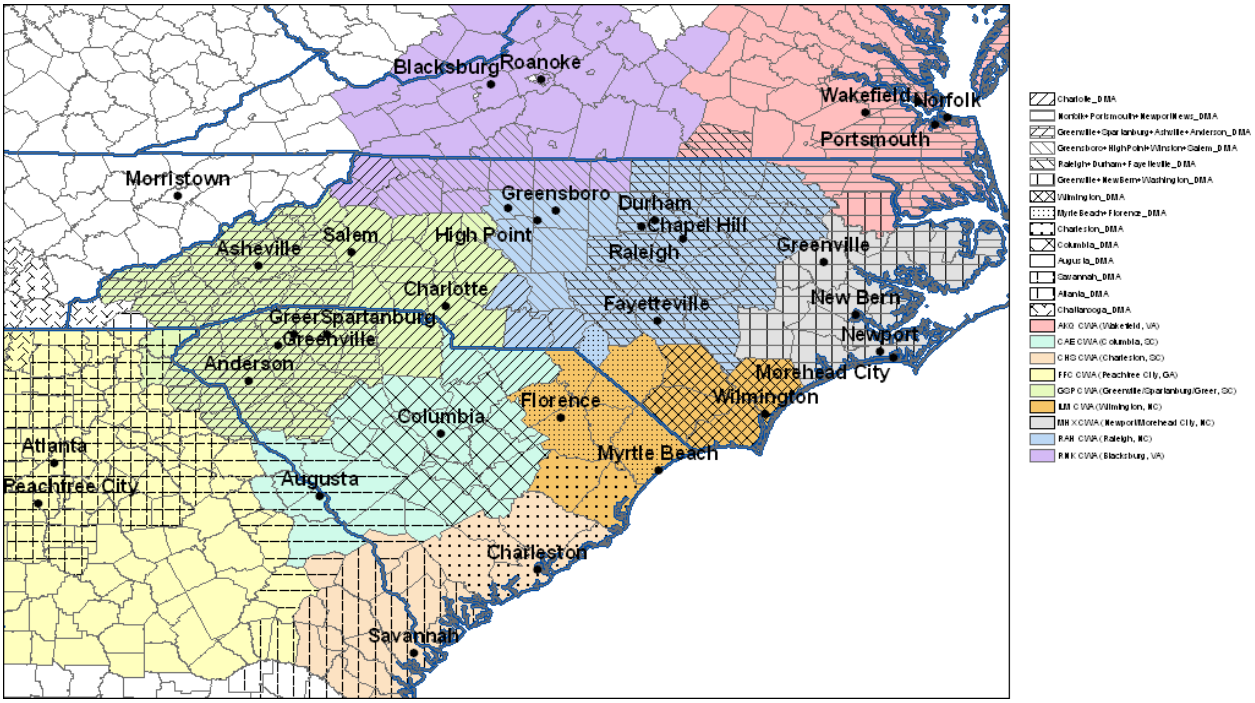


Figure 4. Configuration of NWS county warning areas (solid colors) and Neilsen Designated Market Areas (stippled) for the domain of the 2010 scenario. The scenario used the Newport/Morehead City CWA (gray), Raleigh CWA (blue), and Raleigh+Durham+Fayetteville DMA.

a) b)

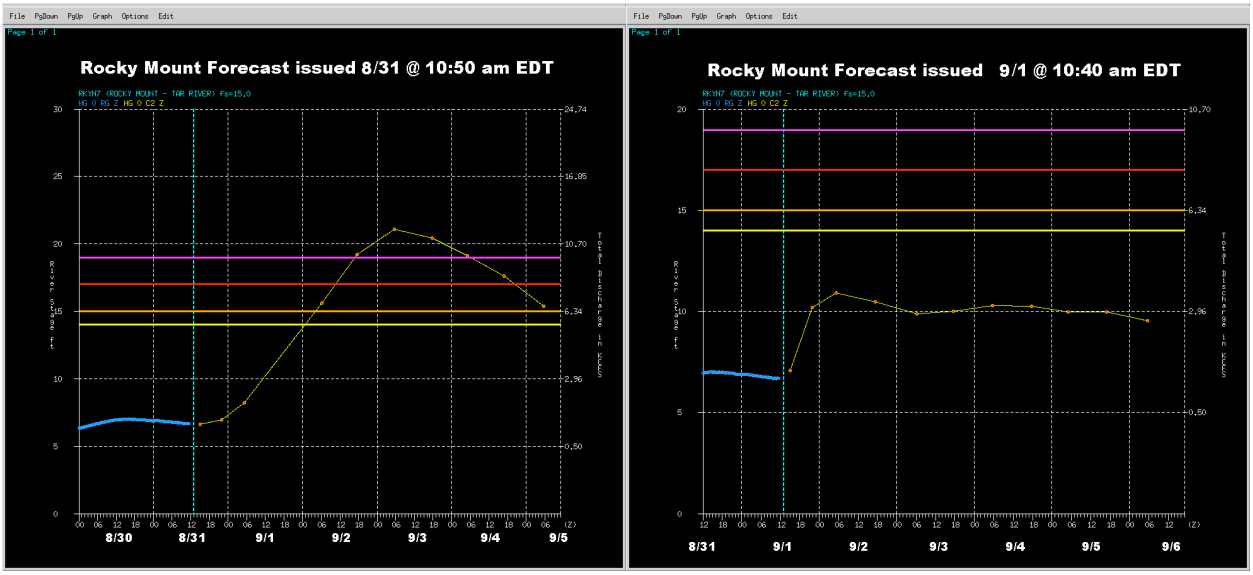


Figure 5. Forecast of river stage (ft) and total discharge (kcfs) at Rocky Mount Tar River (RKYN7) valid for a) 10:50 AM EDT on 31 Aug 2006 and b) 10:40 AM EDT on 1 Sep 2006.

WFO was concerned with storm surge and tropical cyclone tornados. The RAH WFO was concerned with heavy rainfall and river flooding.

The Nielsen Designated Market Area® (DMA) chosen was Raleigh+Durham+Fayetteville. By choosing only one television DMA, the scenario oversimplified the real-world situation because CWAs and DMA boundaries do not align exactly (Fig. 4). For example, in real life, the RAH WFO must deal with four media markets (Charlotte, Greensboro+High Point+Winston +Salem, Myrtle Beach+Florence, Raleigh+Durham +Fayetteville). Conversely, broadcast meteorologists in the Raleigh+Durham+Fayetteville DMA must deal with two WFOs (RAH and Wakefield, VA), while those in the Greenville+New Bern+Washington DMA must deal with the MHX and Wakefield, VA WFOs.

To demonstrate the jurisdictional nature of EM operations, two EOCs were simulated. A coastal, county-level EOC was located in Carteret County, North Carolina. An inland, municipal-level EOC was located in Rocky Mount, North Carolina. The Carteret County EOC had to consider whether evacuations to inland counties were necessary given the forecast track of the tropical system. They also had to deal with a few instances of erroneous information in addition to normal duties. The Rocky Mount EOC had to consider both direct and indirect impacts of weather. Hurricane Ernesto did not require large scale coastal evacuations and had limited shelter openings.

Hurricane Ernesto was a particularly challenging case for the NWS group due to significant changes in forecasts of storm track and precipitation. Thirty-six hours prior to the predicted peak flooding, the area of maximum rainfall was forecast for west of Rocky Mount, NC in the headwaters of the Tar and Neuse Rivers. Hydrologic forecasts predicted major flooding for Rocky Mount (Fig. 5a). Typically, Rocky Mount, NC would be an appropriate inland location for the EM group to stage state resources. Precipitation and hydrologic forecasts forced alternate locations to be used for staging resources. The forecast continued to shift the area of maximum rainfall to the east through landfall.

## 5. PARTICIPANT FEEDBACK

Scenario participants were given three separate opportunities to provide feedback on the role-playing scenario. The final 30 minutes of the workshop were spent in a debriefing session. After experiencing someone else's role, scenario facilitators documented participant discussion regarding things they learned about the role that they did not previously know, the top three problems that arose for the role (as well as why the problem arose and ideas to alleviate the problem), and things they will do differently to help those in that role.

Prior to the scenario, the participants in the NWS group were unaware of the volume and complexity of data NWS forecasters analyzed during a limited period of time. As a result, participants were overwhelmed by incoming data. The NWS group said that better data integration, forecaster training, and forecaster experience would make them more comfortable with the role. The NWS group also stated the number of inaccurate reports from IWT partners was problematic, but the number could be reduced by educating IWT partners on critical data needs during a weather event. To help their NWS partners in the future, participants planned to start using NWS Chat, provide timely reports

that are relevant to NWS products, and continue dialog with IWT members outside of the hurricane season.

Participants in the media group were surprised by the level of real-time communication between the media and other IWT members. Due to their limited awareness of NWS Chat, participants planned to begin using NWS Chat to help their media partners in the future. The media group also learned about the chaotic nature of broadcasting during a major weather event and will be more understanding of the demands of their media partners.

The EM group participants learned the importance of verifying reports before they are released to the IWT partners and the general public. Misinformation due to rumors was a problem identified by the EM group during the scenario due to the free flow of information on the Internet. Thus, participants planned to feed more accurate information on a timely basis to the IWT members and the public using more than one method during future weather events (e.g., television, social networks).

At the start (conclusion) of the 2010 Atlantic hurricane season, voluntary and anonymous online surveys were distributed to the participants. These surveys were attempts by the scenario planners to gain some general feedback and to qualitatively learn whether perceptions of participants about the warning process and other IWT members had been affected by the scenario. The online surveys assessed what participants learned, strengths and weaknesses of the workshop, what changes they will make (made) in their real-life roles to benefit those in the role they played, as well as which elements from the workshop are most important to include in a distance learning version of the scenario. In addition, the surveys assessed what changes participants intended to make in their real-life roles but were unable to, and why.

## 6. LESSONS LEARNED

After conducting the scenario at the National Hurricane Conference, the facilitators discussed aspects of the scenario that could be improved. Facilitators agreed that future scenarios of tropical systems should simulate conference calls between NWS WFOs and EMs at the beginning of each displaced real-time session to resynchronize everyone after breaks. In addition, five-minute status updates could be provided by the EM room prior to any evening or late night news segments. Finally, storm reports received by the EM room should be more actionable by the NWS room.

## 7. DISTANCE LEARNING MODULES

To increase the audience able to participate in the role-playing scenario, the WDTB is developing online versions of the simulations that can be used locally by groups or individuals. Each module begins with introductory material to pre-train or orient participants to the role. Participants will learn terminology and characteristics of their role, such as organizational structures, duties, and responsibilities. Then the module continues to a mix of compressed and real-time simulations. The simulations will be guided by a virtual leader, who explains what is happening and helps participants understand when decisions must be made. A virtual subject matter expert will be available at several points in the simulation to explain background material that may or may not have been learned at the outset of the module.

The first module focuses on playing the EM's role. Since this is an out-of-role scenario, the target audience for this module will be NWS and media meteorologists. The EM module will be completed in the third quarter of the 2011 fiscal year and released shortly thereafter. Following scenario modules, subject to funding availability, should be released every 6-9 months.

## 8. ACKNOWLEDGEMENTS

The authors would like to thank the following individuals who contributed their assistance and expertise. The scenario would not have occurred without their support: Bob Bacon, Rich Bandy, Brandon Bolinski, Brian Brantley, John Cole, Josh Creighton, Roger Dail, Somer Erickson, Darin Figurskey, James Franklin, Doug Haas, Todd Hamill, Keith Harris, Rebecca Jennings, Nate Johnson, Jessica Losego, Mike Moneypenny, Jeff Orrock, Greg Padgett, Kim Robertson, Sandy Sanderson, John Schmidt, Jack Thigpen, Ron Wall, and Mark Willis.

A portion of the funding for this work was provided by NWS WDTB, NOAA National Sea Grant Office, NOAA/Office of Oceanic and Atmospheric Research under NOAA/University of Oklahoma Cooperative Agreement #NA08OAR4320904.

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