



When TORFF met WDTD: An R2O Story

By Katy Christian, CIWRO/WDTD Research Associate



Preface: Who is WDTD?

- The Warning Decision Training Division (WDTD) develops and delivers training on the integrated elements of the warning process
 - Primarily serve NWS Forecast offices



RAC Distance Learning: Online and instructor-led training



RAC Workshop: In-residence week of weather simulations



WOCs: Further enhance warning operation skills

Chapter 1: How it all started...

- Tasked in 2020 with developing training over TORFF that encapsulated the severe, flash flood, and human factors interactions

Jill Hardy



Barb Mayes Boustead




Justin Gibbs



...with a supportive team!

Chapter 2: What's out there?

- Conducted literature review of all TORFF-related publications, news articles, etc.
 - Few articles existed and most documented meteorological side except for one...
- Looked for:
 - Geographic areas common to TORFFs -> WFOs to contact?
 - Future areas of research -> SMEs to contact?
 - Local best practices -> national best practice?
 - Messaging dilemmas -> how to address operationally?
 - Common themes/topics -> outline for TORFF training?

<p>416 WEATHER AND FORECASTING VOLUME 15</p> <p>Multiscale Overview of a Violent Tornado Outbreak with Attendant Flash Flooding</p> <p>JOSEPH A. ROGASH <i>NOAA/NWS/Storm Prediction Center, Norman, Oklahoma</i></p> <p>RICHARD D. SMITH <i>National Weather Service, Tulsa, Oklahoma</i></p> <p>(Manuscript received 8 January 1999, in final form 7 January 2000)</p>	<p>SEVERE WEATHER</p> <p>What to Do When Tornado and Flash Flood Warnings Are Issued Simultaneously</p> <p>By Jonathan Belles - April 09, 2020</p>  <p>5 Ways to Stay Safe in a Tornado Here's a quick look at five ways to stay safe in a tornado.</p> <p>5 WAYS TO STAY SAFE IN A TORNADO</p> <p>Follow @jonathandbells</p> <p>Facing a tornado and flash flooding can be terrifying, and when you put the two potentially deadly threats together, it can be paralyzing. Where do you go? Do you climb to your roof or into the basement, and which threat takes priority? This is an increasingly problematic and common scenario in some parts of the country, and the answer is not easy.</p>	<p>DECEMBER 2015 NIELSEN ET AL. 1673</p> <p>Double Impact: When Both Tornadoes and Flash Floods Threaten the Same Place at the Same Time</p> <p>ERIK R. NIELSEN, GREGORY R. HERMAN, ROBERT C. TOURNAY, JOHN M. PETERS, AND RUSS S. SCHUMACHER <i>Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado</i></p> <p>(Manuscript received 6 July 2015, in final form 1 September 2015)</p> <p>ABSTRACT</p> <p>While both tornadoes and flash floods individually present public hazards, when the two threats are both concurrent and collocated (referred to here as TORFF events), unique concerns arise. This study aims to evaluate the climatological and meteorological characteristics associated with TORFF events over the continental United States. Two separate datasets, one based on overlapping tornado and flash flood warnings and the other based on observations, were used to arrive at estimations of the instances when a TORFF event was deemed imminent and verified to have occurred, respectively. These datasets were then used to discern the geographical and meteorological characteristics of recent TORFF events. During 2008–14, TORFF events were found to be publicly communicated via overlapping warnings an average of 400 times per year, with a maximum frequency occurring in the lower Mississippi River valley. Additionally, 68 verified TORFF events between 2008 and 2013 were identified and subsequently classified based on synoptic characteristics and radar observations. In general, synoptic conditions associated with TORFF events were found to exhibit similar characteristics of typical tornadic environments, but the TORFF environment tended to be moister and have stronger synoptic-scale forcing for ascent. These results indicate that TORFF events occur with appreciable frequency and in complex meteorological scenarios. Furthermore, despite these identified differences, TORFF scenarios are not easily distinguishable from tornadic events that fail to produce collocated flash flooding, and present difficult challenges both from the perspective of forecasting and public communication.</p>	<p>AUGUST 2020 HENDERSON ET AL. 1459</p> <p>A Hazard Multiple: Overlapping Tornado and Flash Flood Warnings in a National Weather Service Forecast Office in the Southeastern United States</p> <p>JEN HENDERSON <i>Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, and NOAA/AR/ESRL/Global Systems Laboratory, Boulder, Colorado</i></p> <p>ERIK R. NIELSEN, GREGORY R. HERMAN,¹ AND RUSS S. SCHUMACHER <i>Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado</i></p> <p>(Manuscript received 18 October 2019, in final form 6 May 2020)</p> <p>ABSTRACT</p> <p>The U.S. weather warning system is designed to help operational forecasters identify hazards and issue alerts to assist people in taking life-saving actions. Assessing risks for separate hazards, such as flash flooding, can be challenging for individuals, depending on their contexts, resources, and abilities. When two or more hazards co-occur in time and space, such as tornadoes and flash floods, which we call TORFFs, risk assessment and available actions people can take to stay safe become increasingly complex and potentially dangerous. TORFF advice can suggest contradictory action—that people get low for a tornado and seek higher ground for a flash flood. The origin of risk information about such threats is the National Weather Service (NWS) Weather Forecast Office. This article contributes to an understanding of the warning and forecast system through a naturalistic study of the NWS during a TORFF event in the southeastern United States. Drawing on literature for the Social Amplification of Risk Framework, this article argues that during TORFFs, elements of the NWS warning operations can unintentionally amplify or attenuate one threat over the other. Our results reveal three ways this amplification or attenuation might occur: 1) underlying assumptions that forecasters understandably make about the danger of different threats; 2) threat terminology and coordination with national offices that shape the communication of risks during a multihazard event; and 3) organizational arrangements of space and forecaster expertise during operations. We conclude with suggestions for rethinking sites of amplification and attenuation and additional areas of future study.</p>
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Chapter 3: Getting real-life perspective

HQ Perspective:

- Greg Schoor* (Severe Weather Program Lead)
- Kate Abshire (National Flash Flood Services Lead)

Comms/IDSS Perspective:

- Doug Streu (NWSTC)

WFO Perspective:

- Norman, OK (OUN)
- Houston, TX(HGX)
- Shreveport, LA (SHV)
- Jackson, MS (JAN)
- Columbia, SC (CAE)

Research Perspective:

- Dr. Jen Henderson (Texas Tech)
- Dr. Erik Nielsen (Texas A&M)

Interview Questions:

- Does your office have any operational best practices for TORFF events?
- Does your office discuss the potential for TORFF events leading up to an event?
- How is the office configured during TORFF events to facilitate communication between forecasters issuing FF and TOR warnings?
- How does your office handle overlapping TOR and FF warnings, as well as conflicting CTAs?
- Is your CWA more sensitive to TOR or FF threats? Or both equally?
- Do you communicate the threat of dual-hazards differently between Emergency Managers, Broadcast Meteorologists, and the public?

Chapter 4: Putting the puzzle pieces together

- Combed through scientific literature, articles, interview notes, and e-mail threads to see emerging **themes** and **best practices**
- Final module reviewed by internal and external collaborators

What it felt like...



What it looked like...

A screenshot of a course interface. The title is "Warning for Dual Hazard Events: Tornado and Flash Flood (TORFF)". In the top right corner, there are links for "Resources" and "Exit". On the left side, there is a profile for Katy Christian, Research Associate at NOAA, with her email katy.christian@noaa.gov. Below the profile is a "Menu" and "Notes" section. The menu items are: Introduction, Course Completion Info, Learning Objectives, TORFF: Overview, TORFF Challenges: Hierarchy of H..., Best Practices: BEFORE a TORFF E..., Best Practices: DURING a TORFF ..., Summary, Lesson Quiz, and Contact Information. The main content area features a red background with the text "Warning for Dual Hazard Events: Tornado and Flash Flood (TORFF)". There are three logos: "Warning Operations Course Severe", "Warning Operations Course Flash Flood", and "Warning Operations Course Human Factors". On the right, there is a large image of a computer monitor displaying a weather map. At the bottom, there is a video player control bar with a play button, a progress bar, a refresh button, a volume icon, and "PREV" and "NEXT" buttons.

Chapter 5: What it looks like

- TORFF: Overview
 - **Climatological Characteristics**
- TORFF Challenges: Hierarchy of Hazards
 - Messaging Dilemma
- Best Practices: BEFORE a TORFF Event
 - Gain Situational Awareness
 - Message BOTH Threats
 - Designate Hydro Warning Forecaster or Event Coordinator Roles
- Best Practices: DURING a TORFF Event
 - Minimize Overlapping Warnings
 - Be Aware of Conflicting Call-To-Action (CTA) Statements
 - Practice Dual Messaging to Partners

TORFF: Climatological Characteristics

Yearly Frequency

- 400 TORFF events per year

Seasonal Preference

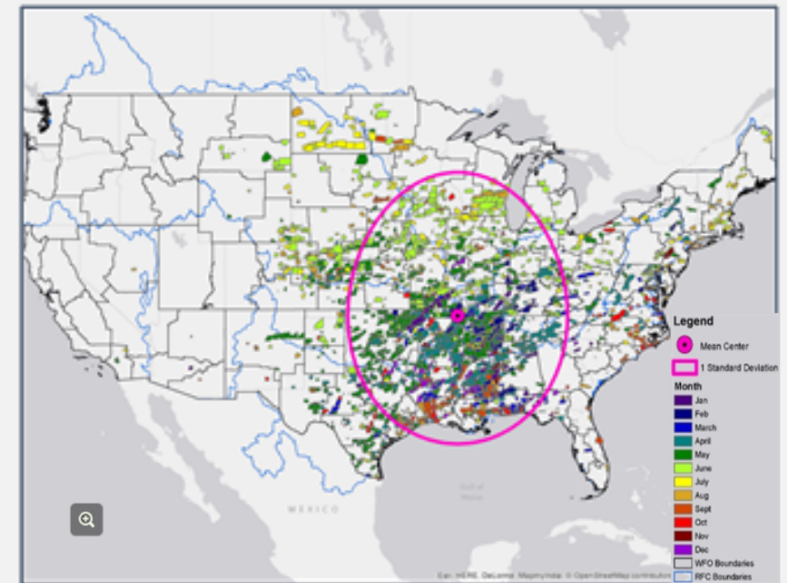
- Southern states: March – May
- Northern states: May - July

Diurnal Preference

- 2 PM to 7 PM local time

Common Mechanisms

- Typical tornado environments*
- Hurricanes/tropical storms
- Training or slow-moving supercells

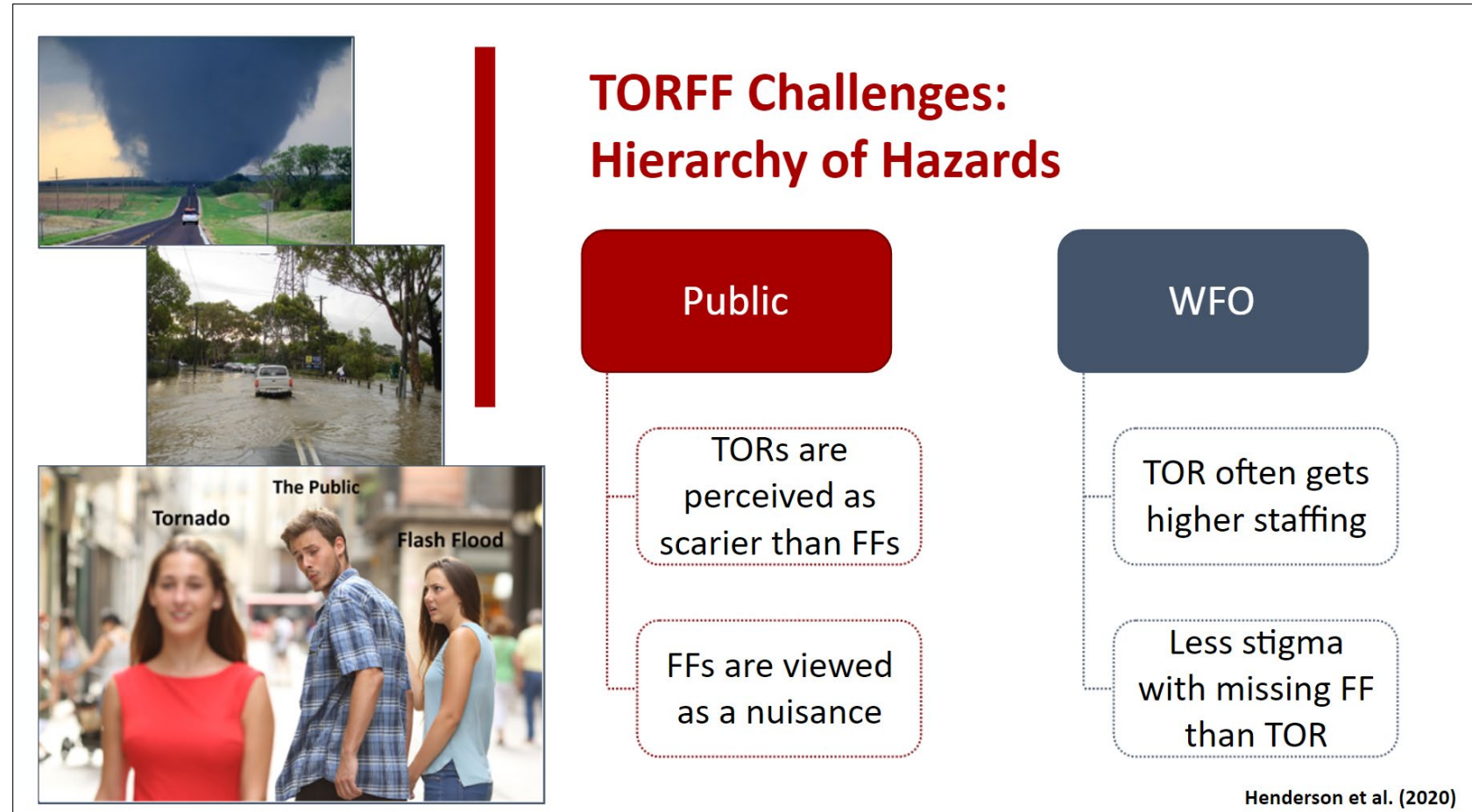


↑ Click to zoom
Geospatial Climatology of TORFF Events in the U.S.
(Image Credit: Erik Nielsen)

* More info in "Resources"

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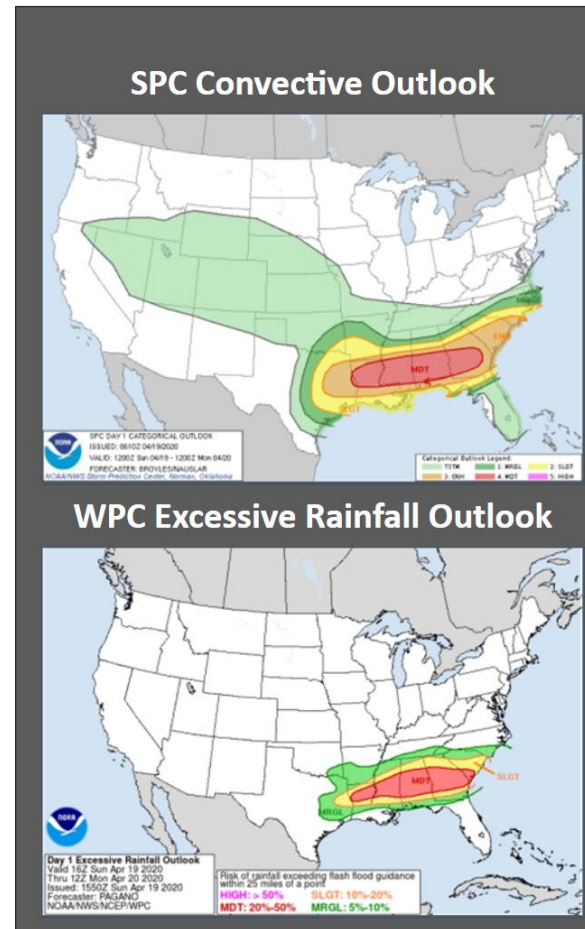
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“The image of the guy and girl where the guy swung his head at another girl was SUCH a great metaphor for the TOR vs FF. Very creative and spot on.” – WFO Meteorologist

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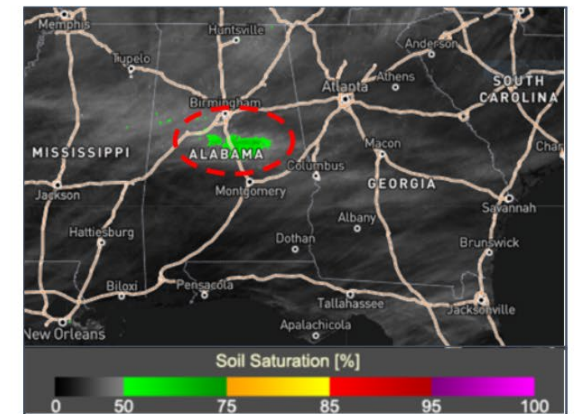
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Best Practices: BEFORE a TORFF Event

1. Gain Situational Awareness

- ❖ Look for overlapping SPC and WPC threat areas
- ❖ Identify your urban hotspots and know your antecedent soil conditions
- ❖ Know what types of events and environments result in TORFFs*



FLASH Max Soil Saturation

* Training supercells, TCs/Hurricanes, or transition from discrete storms to MCSs

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Best Practices: BEFORE a TORFF Event

2. Message BOTH Threats

- ❖ Start dual messaging before the event
- ❖ Give equal attention to both threats during daily or weekly briefings
- ❖ Be intentional about hazard order, text color, and wording in graphics
- ❖ Counter your public's hazard bias with intentional messaging

Henderson et al. (2020)

Severe Weather Expected Late Tonight

- **Significant Threat:** Severe storms expected with tornadoes, damaging wind gusts and small hail. A **Strong tornado** is possible.
- **Elevated Threat:** Severe storms expected with damaging wind gusts, small hail. Some tornadoes possible.
- **Limited Threat:** Severe storms possible with damaging wind gusts. A few tornadoes possible.

Legend: Limited (Yellow), Elevated (Orange), Significant (Red), Extreme (Purple)

Heavy Rain Tonight Through Thursday Night

Threat:

- Multiple rounds of **heavy rainfall** are expected
- Widespread 3 to 5 inches are likely, with locally higher amounts possible

Impacts:

- For **SIGNIFICANT** THREAT - Flooding may threaten homes and close roads later tonight!
- Otherwise, river flooding & flooding of streets and low lying areas likely.

Overview

- Enhanced Risk of severe weather tomorrow for much of the Four State Region
 - Timing: Mainly midday through late in the evening
 - Threats:
 - Hail: Entire timing window
 - Wind/Tornado: Mid-afternoon through late in the evening
 - Highest tornado threats confined to East/Deep East TX
- Flash Flooding threat
 - Mainly in Deep East TX and along and south of I-20 in LA
 - Timing: Mid afternoon and well into the night
 - Flash Flood Watch is in effect
- More thunderstorm chances in the forecast:
 - Mainly northern zones on Friday/Friday Night
 - All areas Tuesday/Wednesday of next week

Tuesday, April 21, 2020 NWSDrepsport <http://www.weather.gov/hh>

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Best Practices: BEFORE a TORFF Event

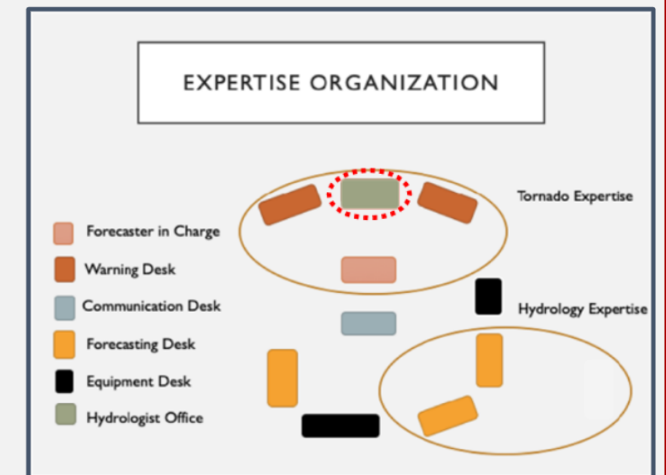
3. Designate Hydro Warning Forecaster or Event Coordinator Roles

Hydro Desk

- ❖ Focuses **ONLY** on hydro threat
 - Does **NOT** work any other hazards
- ❖ Communicates FFWs to team members

Event Coordinator

- ❖ Maintains situational awareness
 - Prevents tunnel-vision and “Oopsie FFWs”
- ❖ Relays which threat is greater at the moment
- ❖ Keeps track of overlapping warnings



Recommended WFO Configuration
(Image Credit: Henderson et al. 2020)

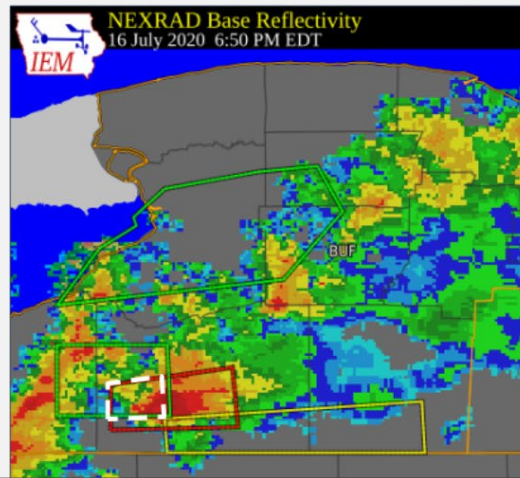
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Best Practices: DURING a TORFF Event

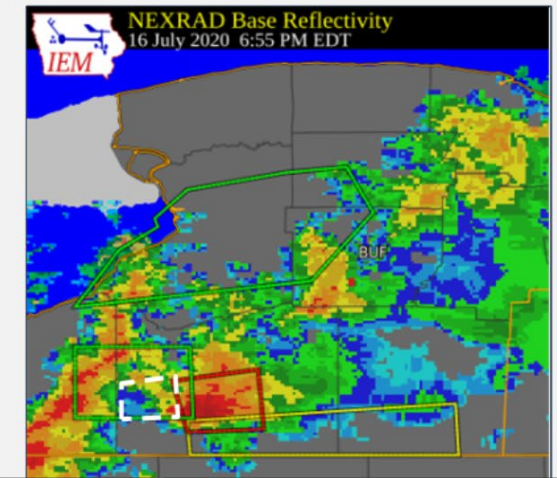
1. Minimize Overlapping Warnings

- ❖ Be targeted with TOR warnings
 - Draw TOR around tornado - not entire storm!
- ❖ Trim and update TORs frequently to eliminate overlapping areas
- ❖ Consider confidence, magnitude, and distance from radar of TOR before issuing on top of ongoing catastrophic flash flooding



5 minutes later

Goal: Get public out of overlapping warnings ASAP!





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Best Practices: DURING a TORFF Event

2. Be Aware of Conflicting Call-To-Action (CTA) Statements

		
FFW	“Move to higher ground!”	“Turn around, don’t drown!”
TOR	“Move to a basement or an interior room on the lowest floor of a sturdy building.”	“Torrential rainfall is occurring with this storm, and may lead to flash flooding. Do not drive your vehicle through flooded roadways.”

**** SPECIAL CASE CALLS TO ACTION ****

- Squall line tornadoes
- Over water - boaters seek shelter
- Torrential rainfall

* Tornado Warning for...
Northeastern Chambers County in southeastern Texas...

* Until 715 AM CDT.

* At 639 AM CDT, a severe thunderstorm capable of producing a tornado was located near Winnie, or 9 miles west of Hamshire, moving northeast at 15 mph. The main threat remains flash flooding, as this area is in a flash flood emergency.

HAZARD...Tornado.

SOURCE...Radar indicated rotation.

IMPACT...Flying debris will be dangerous to those caught without shelter. Mobile homes will be damaged or destroyed. Damage to roofs, windows, and vehicles will occur. Tree damage is likely.

* This dangerous storm will be near...
Winnie around 655 AM CDT.
Stowell around 700 AM CDT.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TAKE COVER NOW! If you are outdoors, in a mobile home, or in a vehicle, move to the closest substantial shelter and protect yourself from flying debris.

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Best Practices: DURING a TORFF Event

3. Practice Dual Messaging to Partners

- ❖ Message both threats equally on social media
- ❖ Use graphics that address recommended actions during TORFF events
- ❖ Use NWSChat to communicate hazard prioritization to emergency managers and media partners

Warning
Operations
Course
Severe

TORNADO AND FLOOD THREAT Here's What You Should Do

Find your safe place that protects you from extreme winds AND flash flooding.

- Move to a designated storm shelter or interior room on the lowest floor - safe from flooding.
- Minimize travel. Stay away from flooded roads.
- Culverts/roadside ditches are not safe places during heavy rainfall.

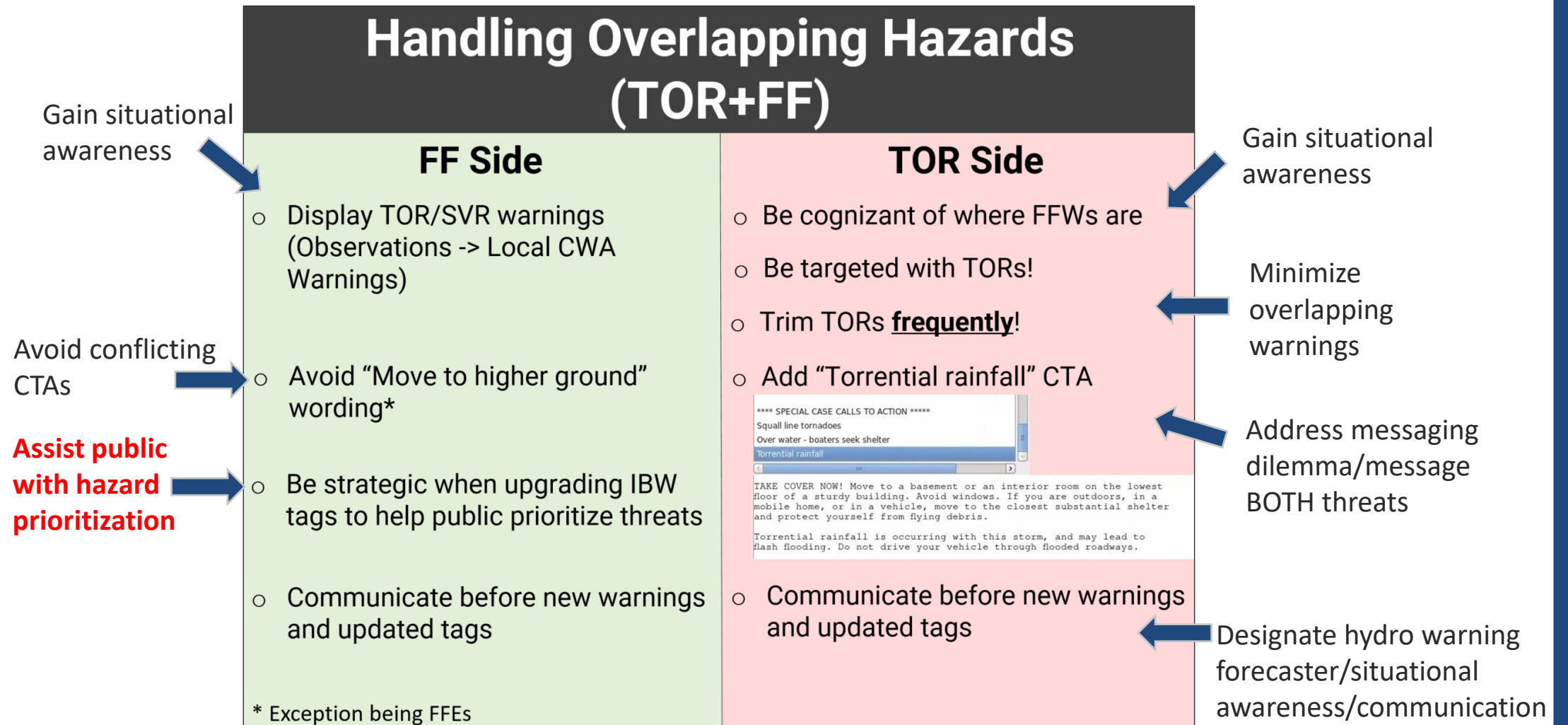


Chapter 6: Downscaling concepts further

- How can we further downscale concepts from the TORFF training to be applicable to our workshop simulations?
 - Last day of workshop: **Ideal TORFF simulation**
 - Overlapping FF and TOR warnings with FFE criteria met



Chapter 6: Downscaling concepts further



Chapter 7: Practice makes progress

Before TORFF Discussion

- Hydro warning forecaster is VERY often siloed from 2 SVR warning forecasters throughout the simulation
- Little attention given to overlapping hazards and messaging dilemma until in the moment OR after it's over

After TORFF Discussion

- Both Severe and Hydro Warning Forecasters are MUCH more proactive to:
 - Anticipate the TORFF threat
 - Message appropriately in CTAs
 - Mitigate overlapping hazards
 - Communicate with each other!

Epilogue: Where do we go from here?

- Developing TORFF training specific to Tropical Cyclone situations
- Understanding how NWS warnings are used and disseminated by our partners (e.g. Is attention to CTAs in TORFF scenarios making a difference?)



Thank you for your time!

Contact Info: katy.christian@noaa.gov