AWR-326
Tornado Awareness

Participant Handouts

Version 2.0

FEMA

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AWR-326 Tornado Awareness

Module 1: Welcome, Introduction, and Administration

Version 2.0

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Enabling Learning Objectives

#	Objective
1-1	State the course agenda
1-2	State the course goal
1-3	Explain how performance will be evaluated

Welcome

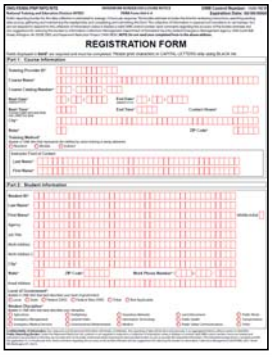
- Instructor introduction
- Class structure and housekeeping:
  - Breaks
  - Restrooms
  - Emergency exits
  - Cell phones
- IACET CEUs and Other Professional CECs available

Introductions

- Name
- Agency or Organization
- Title

Continuing Education

- International Association for Continuing Education and Training (IACET)
  - Participants who successfully complete this course will receive 0.1 CEUs for every eligible course contact hour
- This course may also be eligible to provide the other professional continuing education credits


REGISTRATION FORM

Course Registration

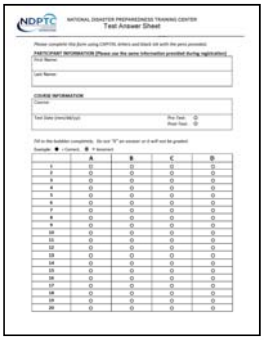
✓ UPPERCASE letters
No abbreviations

Evaluation Strategy

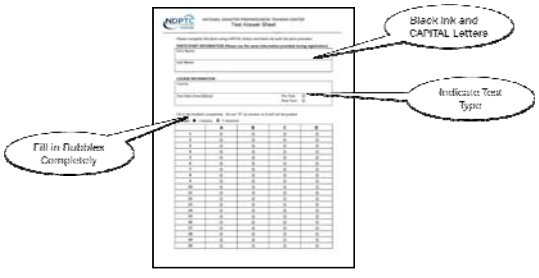
- Pre-test to assess current knowledge of course content
- Post-test administered at conclusion of course
- Pre- and post-test scores compared to measure performance
- Need a score of 70% or better on the post-test to successfully complete the course

Pre-test

- Self-evaluation tool to assess your current knowledge
- Answer to the best of your ability



Test Answer Sheet



Pre-test Answers

1.	2.	3.
4.	5.	6.
7.	8.	9.
10.	11.	12.
13.	14.	15.

Course Goal

This course will prepare participants to understand the basics of tornado science, forecasting, warning, and preparedness.

Learning Objectives

Upon successful completion of this course, participants will be able to:

1. Describe the current state of tornado science;
2. Describe the weather forecast process and appreciate its complexities while making decisions in the face of tornado hazards;

Learning Objectives (cont.)

3. State the tornado warning process and associated definitions; and
4. Review procedures to maximize the safety of self, family, and organizations during a tornado.

Alignment with FEMA Strategic Plan 2018-2022

Each NDPTC course aligns with one or more of the FEMA Strategic Plan Goals and Objectives:

1. **Build a Culture of Preparedness**
2. **Ready the Nation for Catastrophic Disasters**
3. **Reduce the Complexity of FEMA**

More information can be found at:
https://www.fema.gov/strategic-plan

Specific Objectives

- AWR-326 Tornado Awareness is specifically aligned to Goal #1, Objectives:
  - **1.3** Help People Prepare for Disasters

AWR-326 Tornado Awareness

Course Agenda

Module	Title	Time
1	Welcome, Introduction, and Administration	50 minutes
2	The Science of Tornadoes	75 minutes
3	Weather Forecast Process	50 minutes
4	Tornado Warning Process	55 minutes
5	Tornado Safety	120 minutes
6	Course Summary and Administration	40 minutes

(10-minute breaks will take place during or between modules as needed with a 1-hour break for lunch)

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AWR-326 Tornado Awareness

Weather Fatalities

(Source: NOAA, 2018)

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Summary

- Stated course agenda
- Stated course goals
- Explained how performance will be evaluated

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AWR-326 Tornado Awareness

Module 2: Science of Tornadoes

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Enabling Learning Objectives

#	Objective
2-1	Describe the characteristics of tornadoes
2-2	State why the U.S. is unique in its observed tornado frequency
2-3	State the necessary conditions for severe thunderstorms and tornadoes
2-4	Discuss weather observational platforms and detection methods that are available to tornado forecasters

What is a Tornado?

- Violently-rotating vortex, often associated with a thunderstorm
- The strongest ones contain the highest winds on earth
- Has no fixed shape, duration, or size
- Can develop with little advanced warning

Official Tornado Definitions

"A violently rotating column of air, usually pendant to a cumulonimbus, with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. On a local scale, it is the most destructive of all atmospheric phenomena."

(National Weather Service Glossary, 2013)

"A rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often visible as a funnel cloud and/or circulating debris/dust at the ground."

(American Meteorological Society Glossary, 2013)

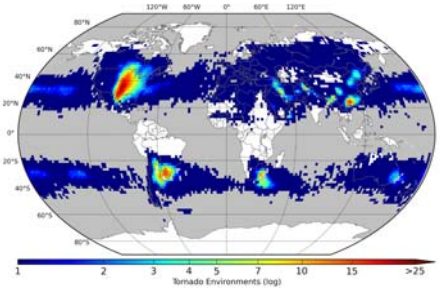
Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Inferred Wind Speed (mph)	% of Tornadoes per NOAA (1991-2010)
5	200+	0.04%
4	166 – 200	0.58%
3	136 – 165	2.6%
2	111-136	8.0%
1	86-110	26.5%
0	65-85	62.2%

(Source: NOAA, 2013)

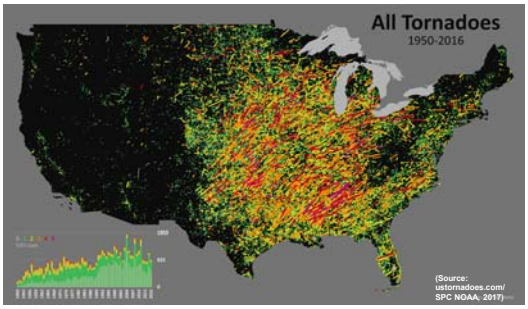
(Source: FEMA, 2013)

Global Tornado Environments



(Source: Gensini and Brooks, 2014)

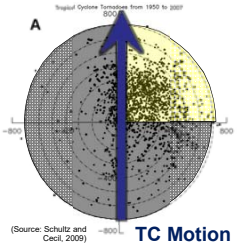
Tornado Tracks (1950-2016)



Tropical Cyclone Tornadoes

- Usually occur in **outer rainbands** of the **right-front quadrant** (relative to the storm motion)
- ~90% of TC tornadoes are weak (EF0 or EF1) but can be moderate to even strong
- Almost all landfalling hurricanes will spawn a tornado!

Relative TC Tornado Positions 1950-2007



Conditions for Tornado Formation

Favorable conditions for tornadoes, often found along and ahead of cold fronts and drylines, include:

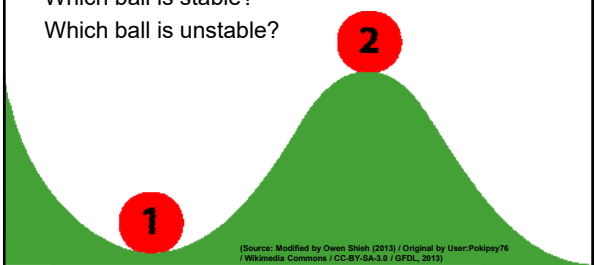
- Unstable atmosphere (including lift)
- Sufficient vertical wind shear
- Sufficient moisture

Life Cycle of a Tornado

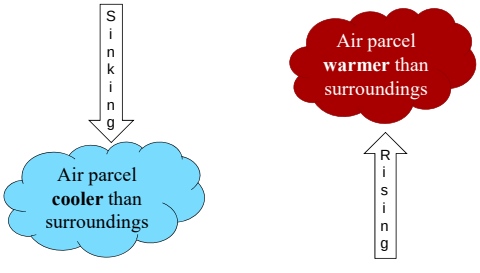
1. Beginning Stage
   - Wall clouds with the formation of a funnel
2. Early Stage
   - Funnel develops and extends to ground
3. Mature Stage
   - Funnel reaches maximum width, then shows signs of weakening
4. Decay or Dissipation
   - Funnel shrinks and may become rope-like in appearance

Concept of Stability

Which ball is stable?
Which ball is unstable?



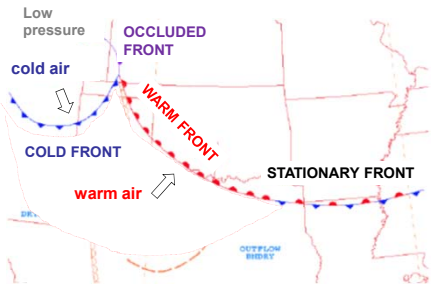
Atmospheric Instability



Stable

Unstable

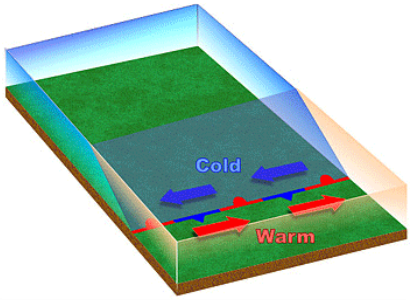
Mid-Latitude Cyclones and Fronts



(Source: NOAA, 2013, Annotated by B. Brown)

2-13

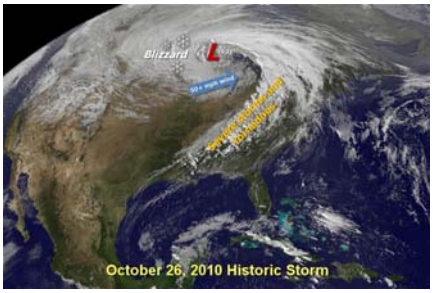
3-D Evolution of Fronts



(Source: NOAA, 2014)

2-14

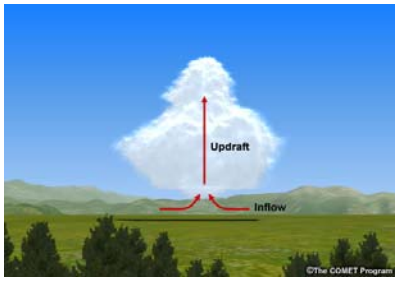
Mid-Latitude Cyclone Warm Sector



(Source: NOAA, 2013)

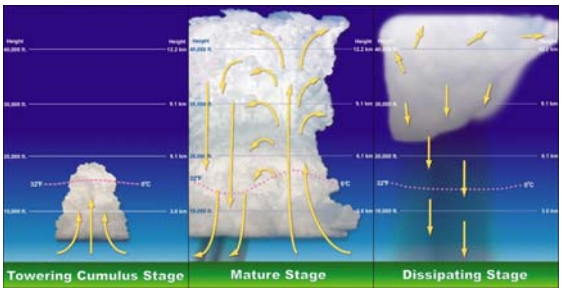
2-15

Thunderstorm Initiation



(Source: UCAR/COMET Program, 2013)

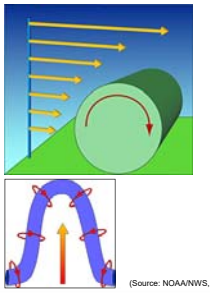
Thunderstorm Life Cycle



(Source: NOAA, 2013)

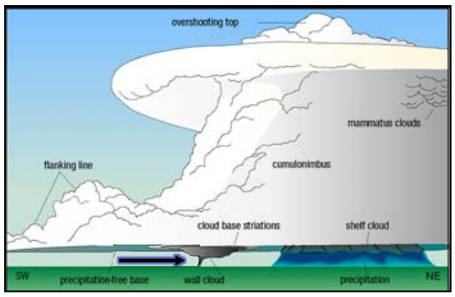
Vertical Wind Shear

- Changes in *wind speed* or *wind direction* with height
- Source of rotation
- Rising updraft changes orientation of rotation



(Source: NOAA/NWS, 2017)

Supercell Thunderstorm



(Source: NOAA/NSSL, 2017)

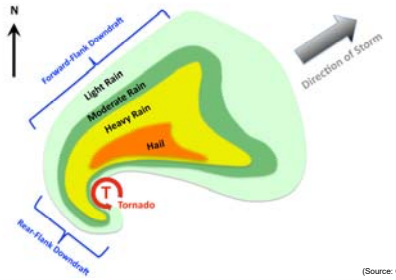
2-19

Supercell Thunderstorm Timelapse

(Source: Mike Olbinsky, 2014)

2-20

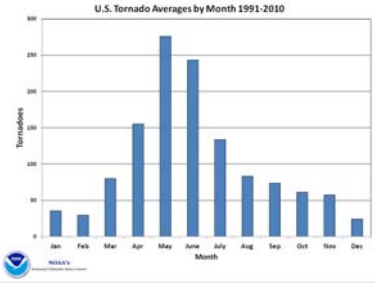
Supercell Thunderstorm Schematic



(Source: Owen Shieh, 2013)

2-21

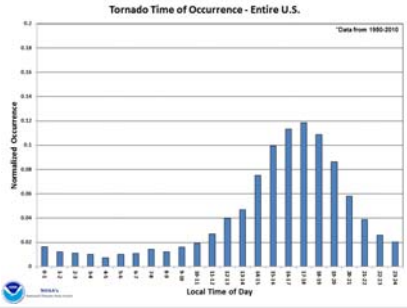
U.S. Tornado Averages by Month (1991 – 2010)



(Source: NOAA, 2013)

2-22

Tornado Time of Occurrence – Entire U.S.



(Source: NOAA, 2013)

2-23

Tools

Some weather observation tools that are available to tornado forecasters include:

- ASOS (Automated Surface Observing System)
- Upper Air Observations
- Surface and Upper Air Analysis
- Remote Sensing

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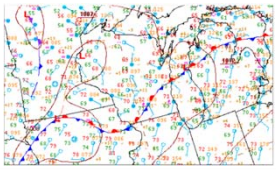
Observations

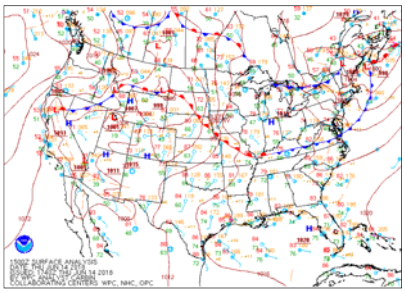
- ASOS (Automated Surface Observing System)
  - Primary Federal weather platform
- Upper air
  - instrument packages on weather balloons

(Source: NOAA, 2017)



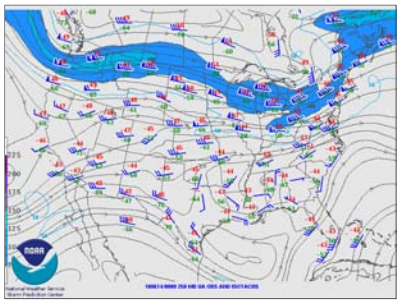
(Source: COMET, 2017)

Surface Analysis



(Source: NOAA, 2018)

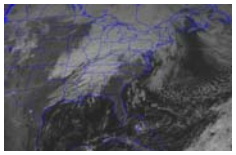
Upper-Air Analysis



(Source: NOAA, 2018)

Remote Sensing

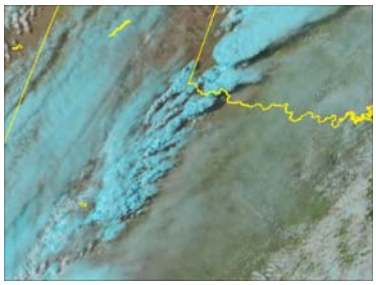
Satellite
- Space based
- Visible, infrared (heat), water vapor
- Can show cloud tops, moisture content



Radar
- Ground based NEXRAD
- Base reflectivity (rain rate)
- Storm total precipitation
- Type of precipitation

(Source (both): NOAA, 2017)

Geostationary Satellite Animation



(Source: NASA/NOAA, 2018)

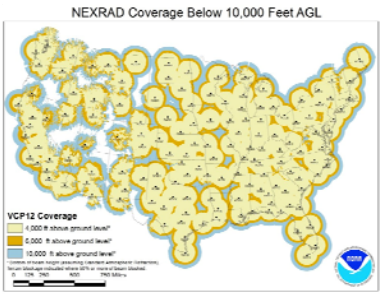
Doppler Radar

Car Horn Example of Doppler Effect:

(Source: NOAA, 2013)

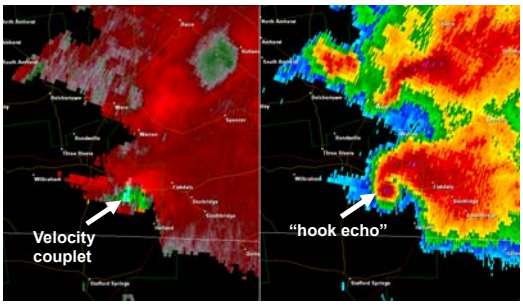
(Source: User: Magickalfeliz/ Wikipedia, 2014)

NEXRAD Doppler Radar Network



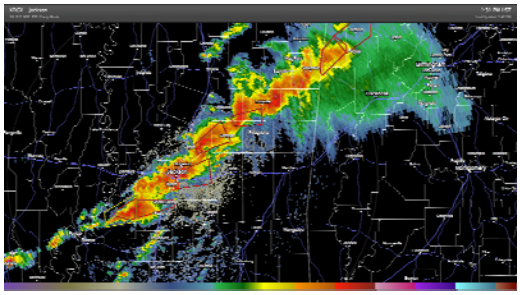
(Source: NOAA, 2013)

Radial Velocity and Reflectivity



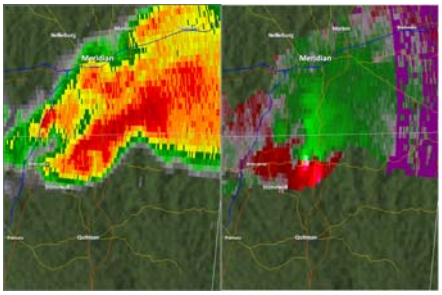
(Source: NOAA, 2011)

Supercells Within a Line



(Source: NOAA (radar data), RadarScope (visualization), 2014)

Supercell with Embedded Tornado



(Source: NOAA, 2014)

Summary

- Described the characteristics of tornadoes
- Stated why the U.S. is unique in its observed tornado frequency
- Stated the necessary conditions for severe thunderstorms and tornadoes
- Discussed weather observation tools that are available to tornado forecasters

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Module 3: Weather Forecast Process

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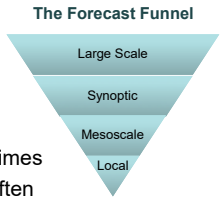
Enabling Learning Objectives

#	Objective
3-1	Discuss the forecast process and cycle
3-2	Explain the principle of numerical modeling and how it is used
3-3	Describe the challenges of tornado forecasting and the uncertainty associated with tornado predictions

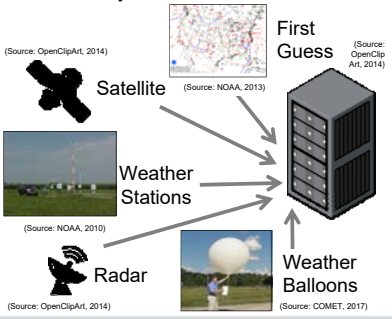
The Forecast Process

- View current satellite, radar, surface, and upper-air observations
- Follow "forecast funnel"
- Evaluate numerical model output
- Make decisions based on available data
- Issue routine products at fixed times
- Issue warnings as necessary, often under time pressure



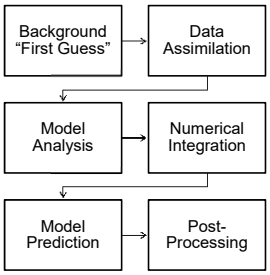
What is a Computer Model?

Complex computer program ingests data and solves mathematics that describe the atmosphere to determine the forecast

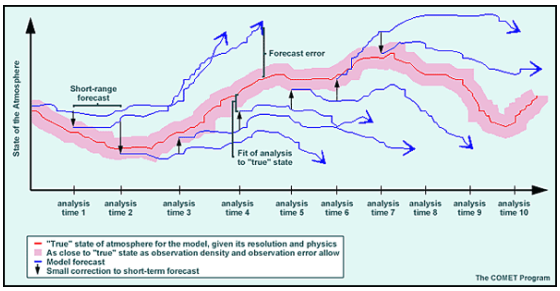


Numerical Forecast Cycle

- Each process listed in the boxes is handled slightly differently by different models
  - Different models output different, but equally valid, predictions



Progression of Forecast Cycles



(Source: UCAR/COMET Program, 2013)

Types of Numerical Models

- *Global*: covers the whole planet but has less detail
- *Regional*: only covers a limited area but has more detail
- *Ensemble:* range of possible scenarios

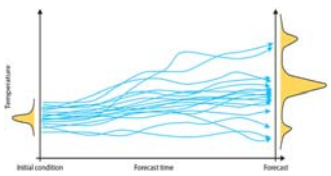
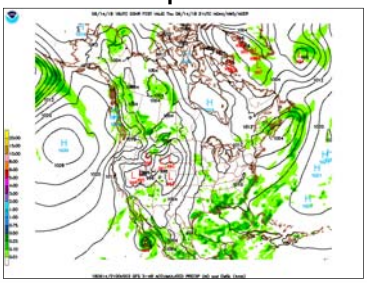


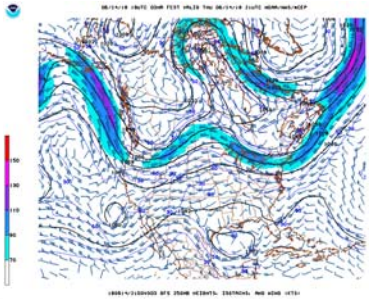
Illustration of ensemble of forecasts
(Source: European Centre for Medium-Range Weather Forecasts, 2017)

GFS Surface Pressure and Precipitation



(Source: NOAA, 2018)

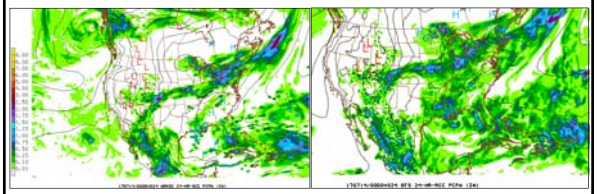
GFS Upper-Level Winds



(Source: NOAA, 2018)

Computer Models – Differing Predictions

North American Model (NAM) Global Forecast Model (GFS)



(Source: NOAA, 2017)

Forecast Uncertainty

- Tornadoes themselves are too small to be explicitly forecast in weather models
- Forecasters must use all of the tools available to them to predict when and where ***conditions will be most favorable*** for tornadoes to form
- In spite of all the conditions being right, sometimes tornadoes do not form, ***OR*** sometimes the environment changes rapidly from unfavorable to conducive and tornadoes form where they were not predicted

Forecast Uncertainty (cont.)

- Forecasting or issuing a watch or warning for tornadoes when none occur is a **"false alarm"**
- Not having issued a watch or warning when tornadoes do form is a **"miss"**
- Forecasters often discuss the forecast uncertainty and give probabilities in discussions, but this can be hard to communicate
- It is better not to miss a tornado, but we also worry about public complacency if there are too many false alarms

Forecasting Activity

(25 minutes)

- Break into groups of 5-6 people
- Analyze maps in handout
- Determine tornado threat
  - **What?** Describe necessary conditions for tornadoes
  - **Where?** Determine the region of greatest threat
  - **Why?** Explain the challenges of tornado forecasting

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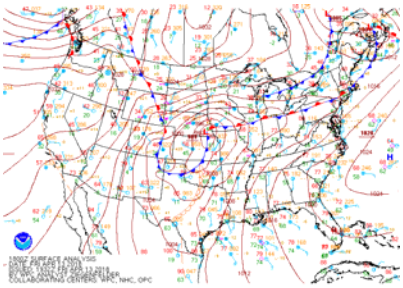
Figure #1: Surface Analysis



(Source: NOAA, 2018)

3-14

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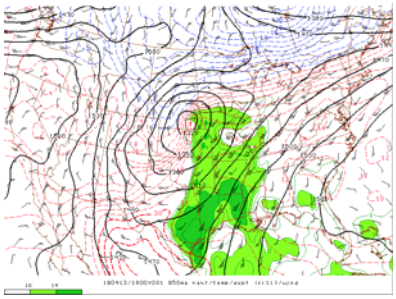
Figure #2: Low-Level Moisture



(Source: NOAA, 2018)

3-15

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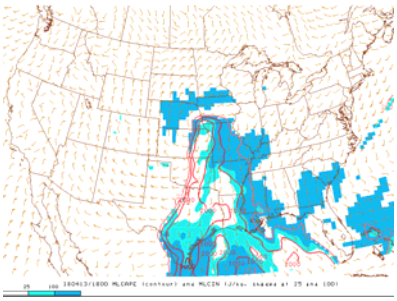
Figure #3: Atmospheric Instability



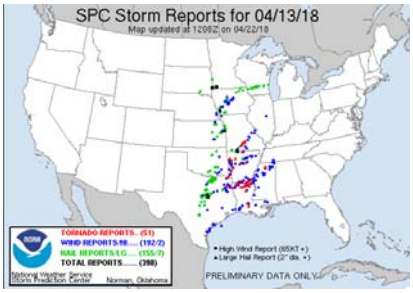
(Source: NOAA, 2018)

3-16

Figure #4: Vertical Wind Shear

(Source: NOAA, 2018)

Actual Storm Reports



(Source: NOAA, 2018)

Summary

- Reviewed forecast process and cycle
- Explained principle of numerical modeling and how it is used
- Described the challenge of uncertainty that forecasters face

AWR-326 Tornado Awareness

Module 4: Tornado Warning Process

Version 2.0

FEMA

Enabling Learning Objectives

#	Objective
4-1	State the organizational hierarchy of the National Weather Service and its tornado forecast process
4-2	Define severe thunderstorm watches and warnings and tornado watches and warnings
4-3	Describe several ways in which tornado warnings are disseminated

National Weather Service

122 local Weather Forecast Offices

9 national centers

- Environmental Modeling Center
- Weather Prediction Center
- Storm Prediction Center
- National Hurricane Center
- Ocean Prediction Center
- Climate Prediction Center
- Space Weather Prediction Center
- Aviation Weather Center
- NCEP Central Operations

NWS Storm Prediction Center

- Located in Norman, Oklahoma
- Responsible for severe (thunderstorm) and fire weather forecasts for the contiguous United States
- Issues convective outlooks and severe thunderstorm and tornado watches
- www.spc.noaa.gov

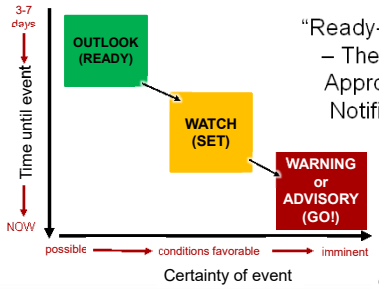
(Source: NOAA, 2014)

(Source: Tyler Arbogast / Wikimedia Commons / CC-BY-2.5, 2013)

NWS Weather Forecast Offices

(Source: NOAA, 2018)

Outlook/ Watch/ Warning/ Advisory

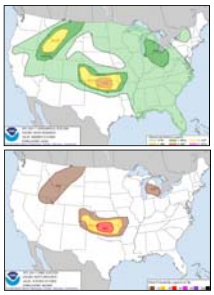


"Ready-Set-Go!" – The Tiered Approach to Notification

(Based on NOAA graphic, 2017)

Convective Outlooks

- Severe weather probability forecasts routinely issued by the SPC
- Can provide lead times of 1, 2, 3, and 4-8 days in advance
- Quantifies the risk of occurrence within 25 miles of a given point
- Day-1 Outlooks provide probabilities for tornado, hail, or severe wind



(Source: NOAA, 2018)

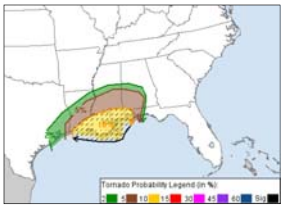
SPC Severe Thunderstorm Risk Categories

Thunderstorms (no label)	1-MARGINAL (MRGL)	2-SLIGHT (SLGT)	3-ENHANCED (ENH)	4-MODERATE (MDT)	5-HIGH (HIGH)
No severe thunder-storms expected	**Isolated severe thunder-storms possible**	**Scattered severe thunder-storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/ flooding threats exist with all thunderstorms	*Limited in duration and/or coverage and/or intensity*	*Short-lived and/or not widespread, isolated intense storms possible*	*More persistent and/or widespread, a few intense*	*Long-lived, widespread and intense*	*Long-lived, very widespread and particularly intense*

* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

Probabilistic Outlooks

Black hatching and outline indicates "significant severe" risk



(Source: SPC/NOAA, 2017)

Day 1 Outlook Probability	TORN	WIND	HAIL
2%	MRGL	Not Used	Not Used
5%	SLGT	MRGL	MRGL
10%	ENH	Not Used	Not Used
10% with Significant Severe	ENH	Not Used	Not Used
15%	ENH	SLGT	SLGT
15% with Significant Severe	MDT	SLGT	SLGT
30%	MDT	ENH	ENH
30% with Significant Severe	HIGH	ENH	ENH
45%	HIGH	ENH	ENH
45% with Significant Severe	HIGH	MDT	MDT
60%	HIGH	MDT	MDT
60% with Significant Severe	HIGH	HIGH	MDT

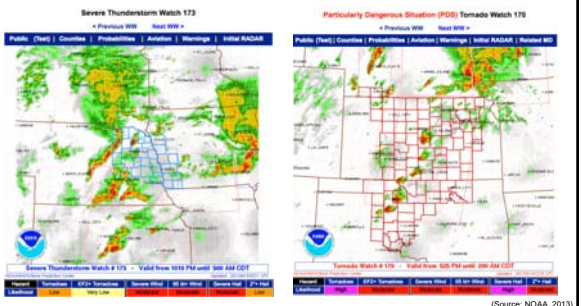
Probabilistic Outlooks – Day 2 and 3

Day 2 Outlook Probability	Combined TOR, WIND, HAIL
5%	MRGL
15%	SLGT
15% with Significant Severe	SLGT
30%	ENH
30% with Significant Severe	ENH
45%	ENH
45% with Significant Severe	MDT
60%	MDT
60% with Significant Severe	HIGH

Day 3 Outlook Probability	Combined TOR, WIND, HAIL
5%	MRGL
15%	SLGT
15% with Significant Severe	SLGT
30%	ENH
30% with Significant Severe	ENH
45%	ENH
45% with Significant Severe	MDT

(Source: SPC/NOAA, 2017)

SPC Weather Watches



(Source: NOAA, 2013)

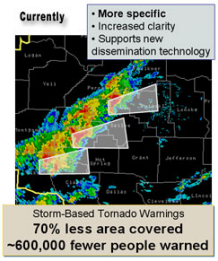
NWS WFO Weather Warnings

Severe Thunderstorm Warning

- Issued by local WFO
- Radar-indicated or spotter-confirmed 1”+ diameter hail and/or winds of ≥ 58 mph

Tornado Warning

- Issued by local WFO
- Radar-indicated or spotter-confirmed tornado is imminent



(Source: NOAA, 2013)

Impact-Based Warnings

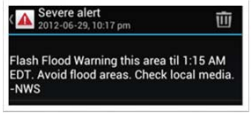
TORNADO TAG	
TORNADO…RADAR INDICATED	Evidence on radar and near storm environment is supportive, but no confirmation
TORNADO…OBSERVED	Tornado is confirmed by spotters, law enforcement, etc.

TORNADO DAMAGE TAG	
NO TAG	Used most of the time, when tornado damage is possible within the warning polygon. Tornado duration generally expected to be short lived.
TORNADO DAMAGE THREAT…CONSIDERABLE	Used rarely, when there is credible evidence that a tornado, capable of producing considerable damage, is imminent or ongoing. Tornado duration generally expected to be long lived.
TORNADO DAMAGE THREAT…CATASTROPHIC	Used exceedingly rarely, when a severe threat to human life and catastrophic damage from a tornado is occurring, and will only be used when reliable sources confirm a violent tornado. Tornado duration generally expected to be long lived.

(Source: NOAA, 2014)

Cellular Phone Alerts

- Wireless Emergency Alerts (WEA)
  - Most smartphones
  - Not an app
  - Can be disabled
  - Opt-out rather than opt-in
- Phone Apps
  - FEMA, Red Cross, radar, TV stations
- Interactive NWS (iNWS)



(Source: NOAA, 2017)

NOAA All Hazards Radio

- Typically called a “Weather Radio”
- Can be set to alert based on event type and location
- Important to have if broadcast or cell services go offline

(Source: NOAA, 2017)

Television Broadcasts

- Public “face” of meteorologists during hazardous weather
- Multiple national and local TV news stations
- Relays and interprets advisories, watches, and warnings from the NWS and other government officials

(Source: David Yeomans / KXAN Austin, TX, 2013)

Outdoor Warning Devices

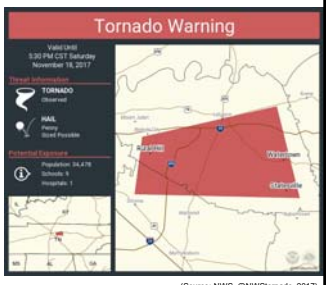
- WWII and Cold War air raid sirens adapted for emergencies
- Only intended to be heard when outdoors
- Operated by local emergency management agencies, while warnings originated from NWS
- **Should not be only source of information**

(Source: Robert Lawton / Wikimedia Commons / CC-BY-SA-2.5, 2013)

(Source: Ben Franske / Wikimedia Commons / CC-BY-SA-3.0 / GFDL, 2013)

Social Media

- Social media provide flexible, highly responsive communication
- @NWStornado distributes tornado warning graphic with geographic area, population, hospitals, schools covered by warning, and the hazards



(Source: NWS, @NWStornado, 2017)

Warning Coordination Meteorologists

- Coordinates NWS decision support services for severe weather and floods with EOCs and EOPs
- Partners with IPAWS, EAS, and WEA
- Provides data to support process of Presidential Disaster Declarations
- Community Preparedness
  - StormReady Program
  - Monthly awareness/preparedness campaigns

Emergency Response Meteorologists (ERMETs)

- NWS Meteorologists receive extra training to become part of the program
- Augment Weather Forecast Office (WFO) staff and concentrate on communicating the forecast and emergency response
- Play a critical role in Information Decision Support Services to the local emergency management and first-responder communities

SKYWARN Spotter Program

- National network of 290,000 volunteer storm spotters who report severe weather to NWS
- Include public safety personnel, emergency managers, amateur radio operators, and weather enthusiasts
- Administered by WCM
- Local training hosted by WFO
- Important for real-time weather info

(Source: NOAA, 2013)

Storm-Ready Communities

- StormReady uses a grassroots approach to help communities develop plans to handle all types of severe weather
- Administered through your local WFO
- www.weather.gov/stormready

(Source: NOAA, 2014)

Summary

- The organizational hierarchy of the National Weather Service and its tornado forecast process was stated
- Severe thunderstorm watches and warnings and tornado watches and warnings were defined
- Ways in which tornado warnings are disseminated were described

AWR-326 Tornado Awareness

Module 5: Tornado Safety

Version 2.0

FEMA

Enabling Learning Objectives

#	Objective
5-1	State tornado preparedness and safety tips for each alert level
5-2	Discuss different scenarios and strategies of sheltering during a tornado
5-3	Complete a practical tornado exercise

Preparing Communities for Tornadoes

- Community education on individual preparedness, including:
  - Emergency kits
  - Family and organization communication plans
  - Understanding and heeding hazardous weather watches and warnings
  - Identifying storm shelters, cellars, and safe rooms
- EOC hardening, power and communication backup
- Large-scale exercises/drills

(Source: Wisconsin Sea Grant, 2014)

Actions During Tornado Watch

- The public should:
  - Keep up with latest weather updates via TV, Internet, and radio
  - Place NOAA Weather Radio on "alert" if not already done
  - Review family emergency plan
- Everyone should be alert for rapidly changing weather conditions
- Close communication with NWS
- Be ready for **immediate action** if tornado warning is issued

(Source: NOAA, 2018)

Actions During Tornado Warning

- 13 minute average lead time from warning issuance to tornado
- The public should:
  - Seek shelter in storm cellar, safe room, or interior room on lowest floor of sturdy building; if absolutely necessary, drive to nearest shelter
  - If outside, seek shelter in nearest sturdy building
  - If in vehicle, cover head below window level or leave vehicle and get below road level
  - Assume tornado safety position and cover head with pillows and blankets if available

(Source: NOAA, 2013)

Keeping the Public Safe

- Busting myths about tornado safety:
  - It is ***not safe*** to shelter from a tornado under a bridge or overpass
  - Mobile home or trailers ***do not*** attract tornadoes, but they are more vulnerable to damage and destruction
  - Traffic and the unpredictable nature of tornado movement make it ***extremely dangerous*** to try to escape a tornado in a vehicle; sheltering in place is much safer
  - **Do not open** windows in house before a tornado

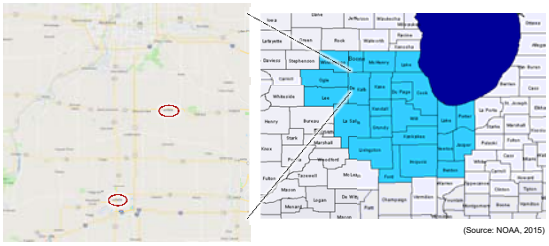
Tornado Activity

(90 minutes)

- Break into 6 groups
- Divide into groups of professions
  - County Emergency Manager in Emergency Operations Center/Elected Officials
  - Restaurant Manager
  - Town Manager/Mayor
  - First Responder (Police/Fire)
  - Health (Public Health, Hospitals, Care Facilities, etc)
  - Schools
- Instructor to play role of National Weather Service
- Discussions will revolve around handouts

Handout #1

Maps of Storm Area and NWS Chicago CWA



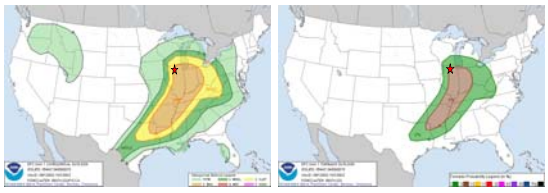
(Source: NOAA, 2015)

Class Discussion: Handout #1

- Given what you know about the weather in that part of Illinois, what are the biggest threats? What season is the greatest risk?
- Think about the professional role you represent. What are your primary concerns if a tornado threatens your area of responsibility?

Handout #2

SPC Convective Outlook (1300Z / 8:00 am CDT)

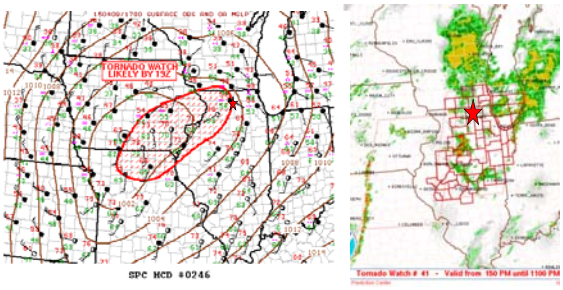


(Source: NOAA, 2015)

Class Discussion: Handout #2

- Evaluate the severe weather threat. Based on the latest SPC Convective Outlook, what is the risk of tornadoes in your area?
- What actions should take place at this point?
- There are no storms this morning, it is chilly and drizzly, and people are wondering why you are preparing for severe weather later. How do you respond?

Handout #3



(Source: NOAA, 2015)

Class Discussion: Handout #3 (1 of 2)

- Where is your area in relation to the potential Tornado Watch?
- Based on knowledge of weather radar obtained from this course, can you tell whether thunderstorms have formed within the watch area when this bulletin was issued? Are storms already widespread?

Class Discussion: Handout #3 (2 of 2)

- What preparations does your profession need to make?
- What is the next type of NWS alert that you should expect if the tornado risk becomes imminent?

Class Discussion: Handout #4

NWS Chicago Tornado Warning #30

Radar Reflectivity

(Source: NOAA/The Vane, 2015)

6:09 pm CDT (2309Z)

- NWS Chicago issues Tornado Warning #30 for De Kalb, Boone, Ogle, and Winnebago Counties, activating Emergency Alert Systems (EAS)
- At 6:08 pm CDT, a severe thunderstorm capable of producing a tornado was located over Byron, or 8 miles NE of Oregon, moving NE at 40 mph

Class Discussion: Handout #4

- Now that a tornado warning is issued, it is critical to identify threats to your specific location. Where are you in relation to the tornado warning polygon?
- What is the tell-tale sign in this radar reflectivity pattern that indicates the potential for a tornadic supercell thunderstorm?
- Based on this tornado warning, where do you expect the tornado to move? Will you be affected in your area?
- Based on all available data, alerts, and reports, what decisions will you make for your profession?

Handout #5

(2335Z / 6:35 pm CDT)

Radar Reflectivity

(Source: NOAA/The Vane, 2015)

6:35 pm CDT (2359Z)

- At 6:35 pm CDT, NWS Chicago issued a tornado warning for Ogle County and Lee County, activating Emergency Alert Systems
- At 6:35 pm CDT, a severe thunderstorm capable of producing a tornado was located over Franklin Grove, or 9 miles E of Dixon, moving NE at 45 mph

Tornado Near I-39

(Source: Walker Ashley/NOAA, 2015)

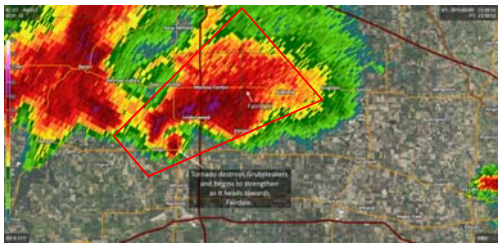
6:58 pm CDT (2358Z)

- Tornado destroys Grubsteakers Restaurant near Rochelle
- All building occupants survive uninjured after sheltering in basement

Handout #5

(2359Z / 6:59 pm CDT)

Radar Reflectivity



(Source: NOAA/The Vane, 2015)

6:58 pm CDT (2358Z)

- At 6:58 pm CDT, NWS Chicago issued a tornado warning for De Kalb, Boone, Ogle, and Winnebago Counties, activating Emergency Alert Systems
- At 6:57 pm CDT, a confirmed large and extremely dangerous tornado was located near Hillcrest, or just NW of Rochelle and moving NE at 45 mph

7:10 pm CDT (0010Z)

- NWS Update. A tornado warning remains in effect until 7:45 pm CDT for De Kalb, Boone, Ogle, and, Winnebago Counties.
- At 7:09 pm CDT, a confirmed large and extremely dangerous tornado was located just W of Kirkland, or 11 miles SE of Rockford airport, moving NE at 45 mph. A second tornado could form just east of the current tornado and come very close to the town of Kirkland.
- This is a particularly dangerous situation.

7:12 pm CDT (0012Z)

- Tornado hits Fairdale
- EF-4 damage begins in Fairdale

Class Discussion: Handout #5

- What points of confusion do you anticipate among your constituents and the general public in your area, given how this situation is evolving?

Handout #6

Radar Reflectivity

Storm-Relative Velocity

(Source: NOAA/The Vane, 2015)

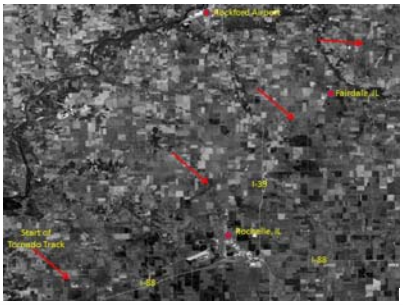
Class Discussion: Handout #6

- What is the defining characteristic of the radar representation of this supercell thunderstorm?
- How do you know it is an extremely strong, tornadic storm?

The Aftermath

- 200+ mph winds; 700-yard wide vortex; ~30.2 mile long track
- 2 fatalities (Fairdale), 22 injuries
- Strongest tornado on record in Ogle and DeKalb Counties

The Aftermath (cont.)



(Source: NASA, 2015)

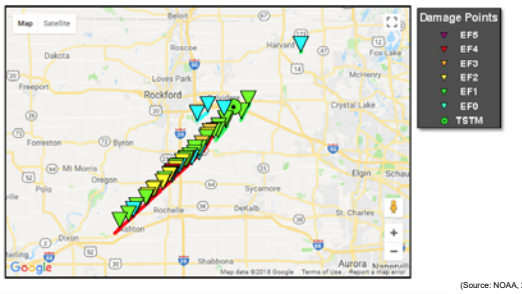
Fairdale

(Source: NOAA, 2015)

The Damage

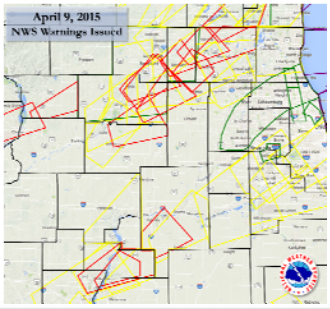
- Trees were debarked
- Grass/pavement scoured
- Every home in Fairdale damaged or destroyed
- Buildings swept off foundations
- Vehicles tossed

Damage Path



(Source: NOAA, 2015)

Progression of Tornado Warnings



(Source: NOAA, 2015)

Lessons Learned

- Severe weather is often “messy,” not always following textbook scenarios
- Destructive tornadoes can occur even in “slight” risk areas
- Frequent “false alarms” can influence human decisions
- Supercell thunderstorms can be “cyclic,” resulting in new tornado development and subsequent tornado warnings to the southwest

More Lessons Learned

- Radar data is easily accessible and a general understanding of radar helps decision making
- Remember to always follow recommended actions from officials
- Activity focused on warning and preparedness, but response and recovery requires a longer-term approach across the whole community

Further Reading

- NWS Chicago Event Summary: www.weather.gov/lot/15apr09
- Local News Article about NWS actions: www.wrex.com/story/all-hands-on-deck-the-national-weather-service-reveals-how-they-prepared-for-april-9

Summary

- Stated tornado preparedness and safety tips for each alert level
- Discussed different scenarios and strategies of sheltering during a tornado
- Participated in a guided tornado exercise

AWR-326 Tornado Awareness

Module 6: Evaluation and Conclusion

Version 2.0

FEMA

Enabling Learning Objectives

#	Objectives
6-1	Share “lessons learned” gathered from the course
6-2	Identify additional resources and training opportunities
6-3	Provide feedback on a course evaluation form
6-4	Complete a post-test

Course Summary

This course prepared participants to understand the basics of tornado science, forecasting, warning, and preparedness.

Additional Resources

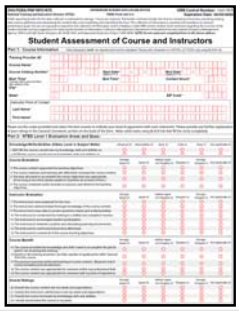
- Storm Prediction Center FAQ
  www.spc.noaa.gov/faq
- FEMA Tornado Page
  www.ready.gov/tornadoes
- SKYWARN Training
  www.skywarn.org
- COMET Program
  www.comet.ucar.edu
- FEMA Daily Operations Briefing
  www.fema.gov/email

Discussion

Questions? Comments? Thoughts?

AWR-326 Tornado Awareness

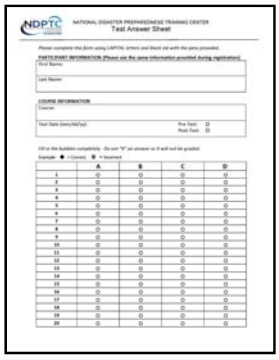
Course Evaluation


Student Assessment of Course and Instructors

6-6

AWR-326 Tornado Awareness

Post-test


Test Answer Sheet

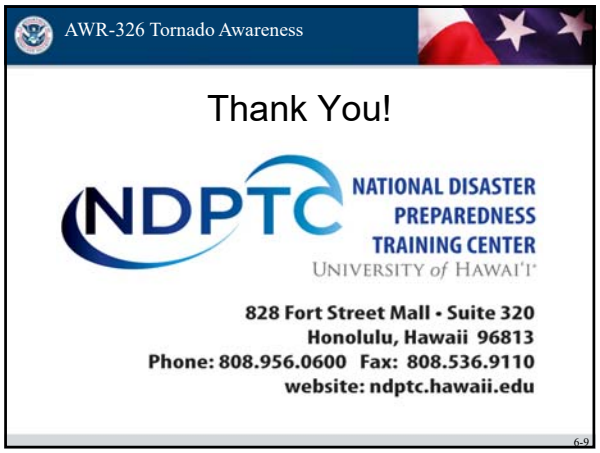
6-7

AWR-326 Tornado Awareness

National Domestic Preparedness Consortium

www.ndpc.us

6-8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Thank You!
NDPTC
NATIONAL DISASTER
PREPAREDNESS
TRAINING CENTER
UNIVERSITY of HAWAI'I
828 Fort Street Mall • Suite 320
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Phone: 808.956.0600 Fax: 808.536.9110
website: ndptc.hawaii.edu
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