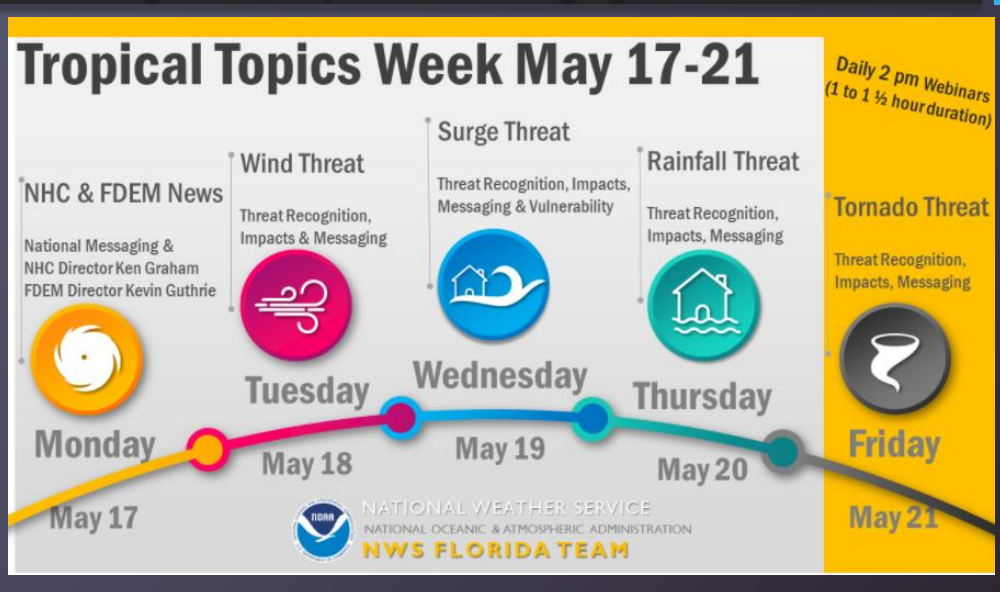
Tornado Recognition, Impacts & Messaging

Scott Spratt; NWS Melbourne | Robert Molleda; NWS Miami

1

TC Tornadoes

Tornado Recognition, Impacts & Messaging



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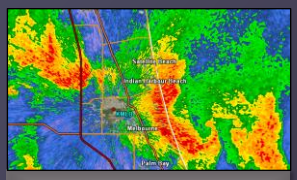
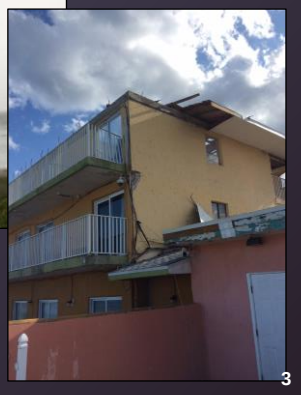
TC Tornadoes

Today's Presentation Topics

- Previous Events
- Climatology/Favorable Patterns
- Worse Case Scenario
- Threat/Impact Messaging
- Future Improvements



Hurricane Irma
September 10, 2017
EF-1 Tornado
1124 am | Indialantic, FL



3

TC Tornadoes

What is the relative threat?

Which tropical cyclone hazard poses the greatest threat?

A. **Wind**

B. **Storm Surge Flooding**

C. **Heavy Rainfall Flooding**

D. **Tornadoes**

E. **It depends - on the particular storm/hurricane; and on where you are located**

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The TC Tornado Hazard can be Significant

A Specific Example – Tropical Storm Gordon (1994)

F2 WATERSPOUT-TORNADO STRUCK THE BAREFOOT BAY AREA OF SOUTHERN BREVARD COUNTY AROUND 653 PM EST ON TUESDAY 11/16. A 74 YEAR OLD MAN WAS KILLED BY TRAUMA TO HIS HEAD. ABOUT 40 PEOPLE WERE INJURED. SIX PEOPLE WERE HOSPITALIZED, TWO WERE SERIOUSLY INJURED. THE WATERSPOUT-TORNADO MADE LANDFALL JUST SOUTH OF THE ENTRANCE TO BAREFOOT BAY ON US HIGHWAY 1. IT MOVED NORTHEAST THROUGH THE SNUG HARBOR/BAREFOOT BAY MOBILE HOME COMMUNITIES. ABOUT 62 MOBILE HOMES WERE DESTROYED, 46 RECEIVED MAJOR DAMAGE AND 181 HAD MINOR DAMAGE. THE TORNADO EXITED THE COMMUNITY AND CONTINUED ON THE GROUND OR IN THE TREETOPS FOR ABOUT A MILE. TOTAL PATH LENGTH WAS ABOUT 2.5 MILES WITH A WIDTH OF 25 TO 50 YARDS. A FUNNEL CLOUD WAS REPORTED BY A TRUCK OPERATOR ON INTERSTATE 95 IN SOUTHERN BREVARD COUNTY. PROPERTY DAMAGE ESTIMATED IN THE VICINITY OF 10 MILLION DOLLARS.

LATEST ESTIMATE IS 498 HOMES DAMAGED IN BAREFOOT BAY AREA... OF THOSE 125 WERE DESTROYED AND 125 SERIOUSLY DAMAGED. PROPERTY DAMAGE ESTIMATED IN THE VICINITY OF 10 MILLION DOLLARS.

Barefoot Bay, FL
November 16, 1994

Nearly 500 MH damaged
Including 62 destroyed
1 Fatality; 40 injuries

F Scale	Character	Estimated winds
Zero (F0)	Weak	40-72 mph
One (F1)	Weak	73-112 mph
Two (F2)	Strong	113-157 mph
Three (F3)	Strong	158-206 mph
Four (F4)	Violent	207-260 mph
Five (F5)	Violent	260-318 mph

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TC Tornadoes

Threat Recognition, Impacts & Messaging

The primary Tropical Cyclone (TC) tornado challenges are. . .

1) **Predicting tornadoes outside the area where people are prepared for hurricane force winds; or prior to the damaging hurricane wind onset.**

2) **Predicting tornadoes from weaker systems where tornadoes may pose the greatest threat.**

3) **Minimizing the amount of over-warning.**

4) **Successfully Messaging #1-3**

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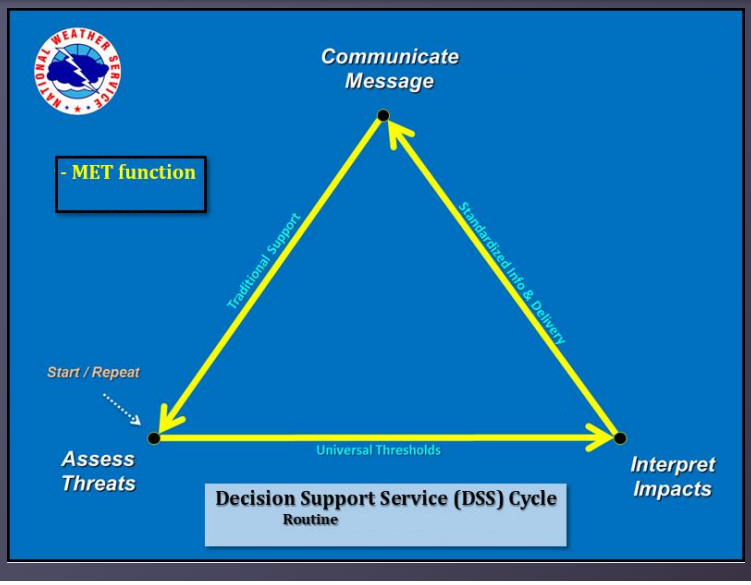
TC Tornadoes

Addressing the primary challenges



- Threat Assessment
- Impact Recognition
- Effective Messaging

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TC Tornado Development

Diagnosing the local tornado hazard

- Certain weather factors enhance the tornado potential of landfalling or paralleling systems:
  - ✓ Strong low-level wind shear (maximized in right-front quadrant).
  - ✓ Pockets of dry air (enhance instability; isolated cells).
  - ✓ Interaction with other weather features (early/late season fronts, wind-shift boundaries, troughs, etc.).
- Threat can begin one-two days before landfall/approach and/or linger one-two days after landfall.
  - ✓ Multiple 12-hour Tornado Watches possible, especially for slow-moving systems.

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TC Tornadoes
Favored Locations

Majority of tornadoes occur within the right-front quadrant, relative to motion.

Northward moving system

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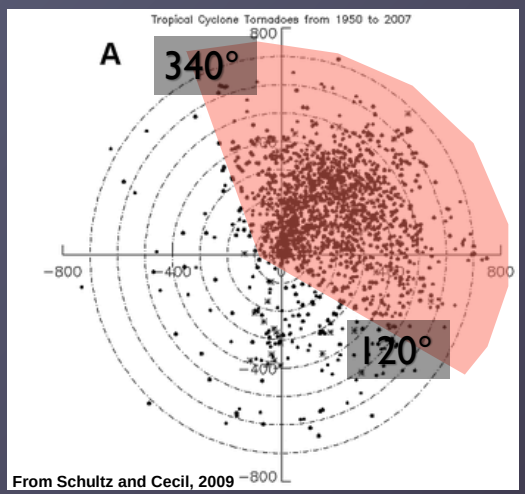
TC Tornadoes
Favored Locations - Climatology



From Schultz and Cecil, 2009

Majority of tornadoes occur within the right-front quadrant, relative to motion.

90% of tornadoes occur within 340˚to 120˚ relative to the storms motion (right-front region), sometimes far from the TC center.

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TC Tornadoes

Favored Locations

Majority of tornadoes occur within the right-front quadrant, relative to motion.

Westward moving system

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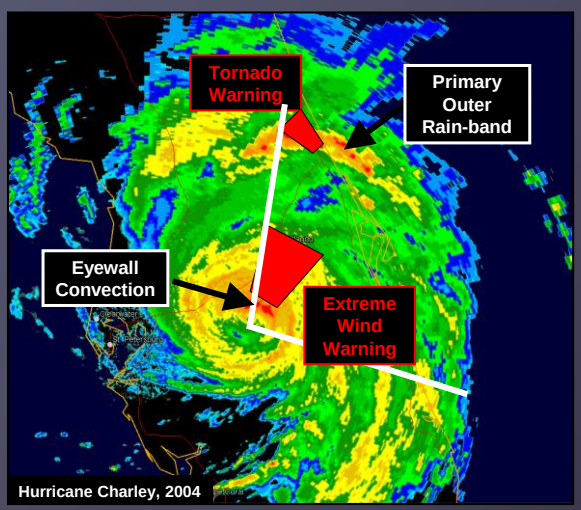
Tornado dangers

Wind-related deaths occur within two well-defined areas



1) The strongest and most damaging winds occur in the eyewall, associated with the innermost rain-band. **Extreme Wind Warnings** are issued for the imminent onset of 115+ mph (Category 3) sustained winds.

2) Tornadoes often develop within one or more primary outer rain-bands, several hundred miles from the center, within the right-front quadrant. **Tornado Warnings** are issued for these cells.

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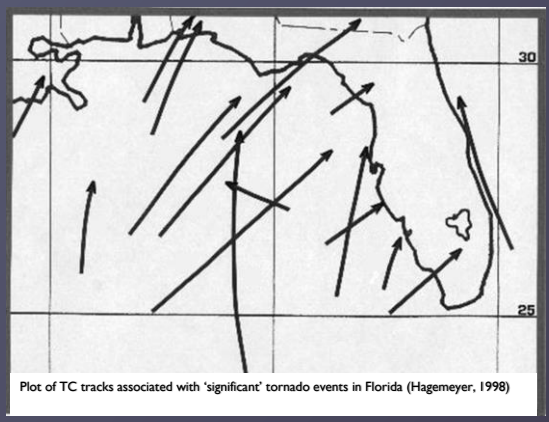
TC Tornado Climatology

What about for Florida, specifically?



Plot of TC tracks associated with 'significant' tornado events in Florida (Hagemeyer, 1998)

Figure shows TC (center) tracks during time of **significant tornado** production within Florida peninsula.

Historical data reveals north to northeast moving tropical cyclones are the most active tornado-producers for Florida.

A tropical system moving north to northeast over the Gulf of Mexico places Florida within the favored northeast quadrant of the circulation.

Significant tornado event *defined as one which produced 5+ tornadoes or an event with an F3 tornado.*

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TC Tornado Dangers

Florida Historical Data

10 Deadliest Florida Tornado Outbreaks

DATE	EVENT	DEATHS	INJURIES
February 1998	Non-Tropical	42	259
February 2007	Non-Tropical	21	76
March 1962	Non-Tropical	17	104
April 1966	Non-Tropical	11	530
June 1972	Hurricane Agnes	7	140
January 1936	Non-Tropical	7	25
September 2004	Hurricane Ivan	6	16
September 1882	Hurricane	6	17
April 1925	Non-Tropical	5	35
October 1992	Unnamed Hybrid	4	77
March 1939	Non-Tropical	4	8

- Since 1882, 38 TC tornado deaths occurred in FL, with 761 injuries.
- The 4 deadliest events accounted for 61% of all FL TC Tornado deaths and 33% of injuries.

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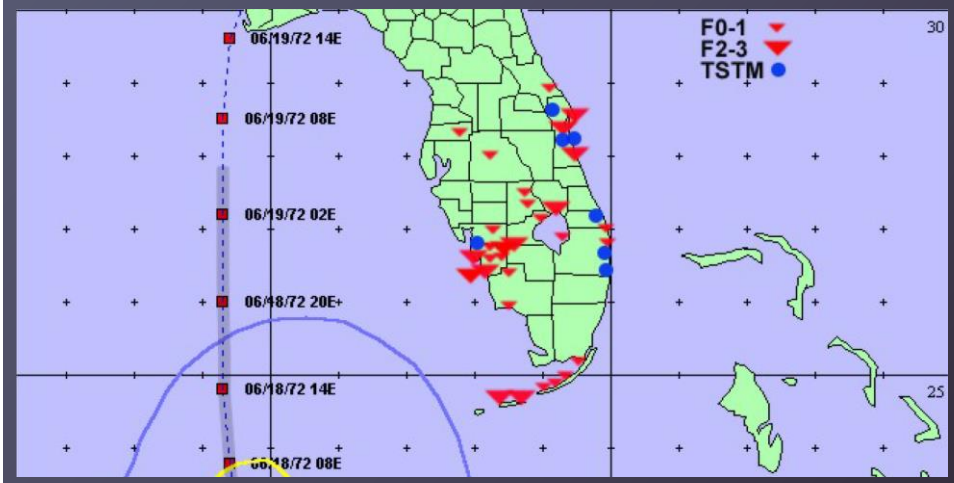
Hurricane Agnes (1972) Event

Worst-Case Scenario?



*Reanalysis by Hagemeyer and Spratt (2002)

- *28 Tornadoes (2 F3, 9 F2, 11 F1, 6 F0) in 38 hours; upgraded from 15 tornadoes and numerous "windstorms"
- 7 deaths and 140 injuries
- FL population was 7.5M, now 21.6M

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Poll Question

Tropical Cyclone Rain band Tornadoes

Which statement about tornadoes embedded within hurricane rain-bands is TRUE?

A) Tornadoes often occur in "families" (multiple events in close proximity)

B) Tornadoes are always weak (i.e. EF-0)

C) Tornadoes occur only during the daytime

D) Tornado Warning lead-times tend to be large (i.e. averaging 15+ minutes)

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Poll Answer

Tropical Cyclone Rain Band Tornadoes

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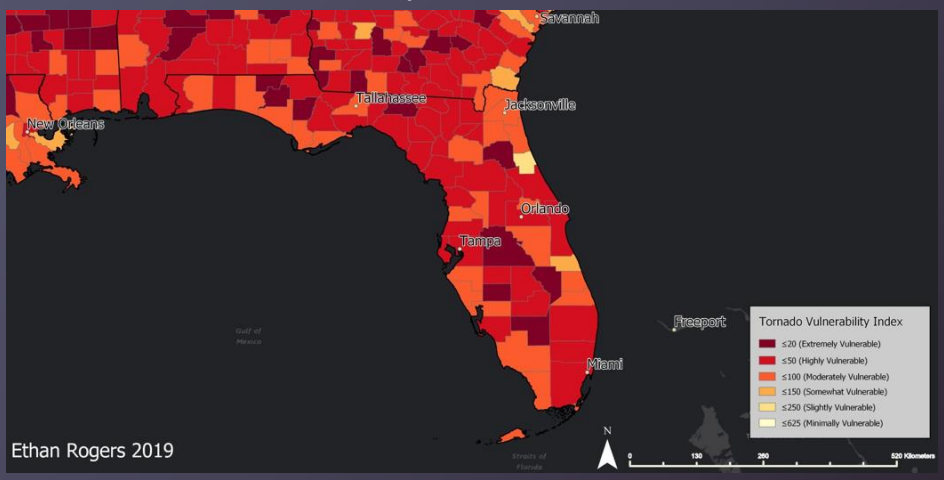
TC Tornado Risk

Risk = Likelihood X Consequence X Vulnerability

Risk = Numerous circulations X EF2/EF3 X Population density; wealth; mobile homes; exposure



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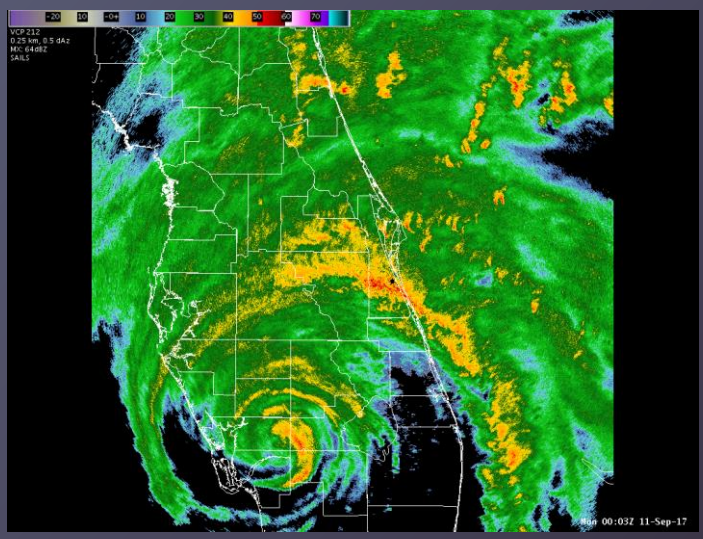
Hurricane Irma (2017) Event

Dozens of circulations developed within/ahead of primary rain band



Highest FL Tornado Production:

Agnes (1972):	28
Debby (2012):	24
Frances (2004):	24
Irma (2017):	23*

Most events are comprised of multiple tornadoes (often in "families")

An average of 5 tornadoes confirmed per TC event.

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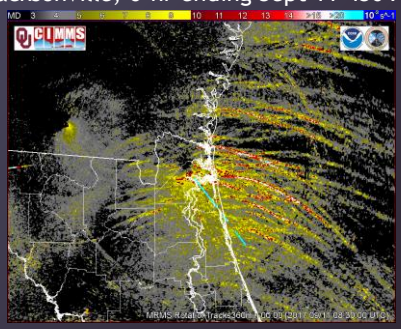
Hurricane Irma (2017) Tornadoes

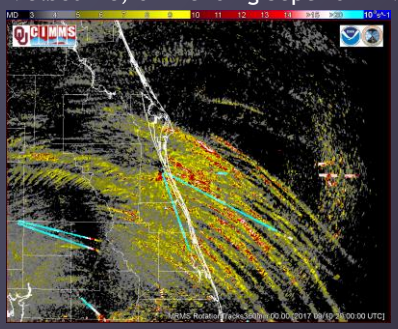
100+ sustained circulations tracked on radar, moving toward coast

Radar-based Rotation Tracks (yellow = weak rotation; red, pink, blue reveal increasingly stronger rotation).

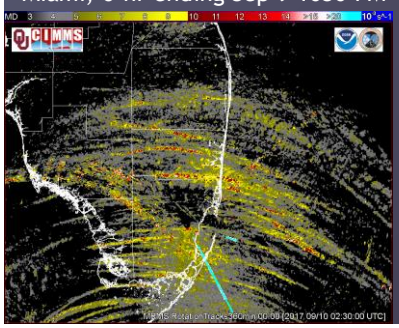
Jacksonville; 6-hr ending Sept 11 430 AM



Melbourne; 6-hr ending Sept 10 4 PM



Miami; 6-hr ending Sep 9 1030 PM



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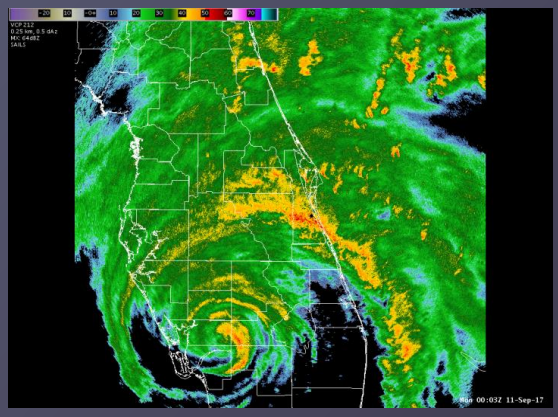
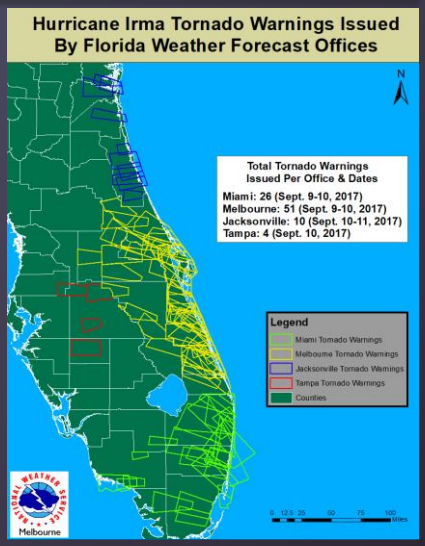
Hurricane Irma (2017) Tornado Warnings

91 Warnings issued in 48-hr by NWS Miami, Melbourne, Tampa & Jacksonville

East-Central Florida:
51 Tornado Warnings





Numerous Warnings = Information Overload + Saturated Communications Systems

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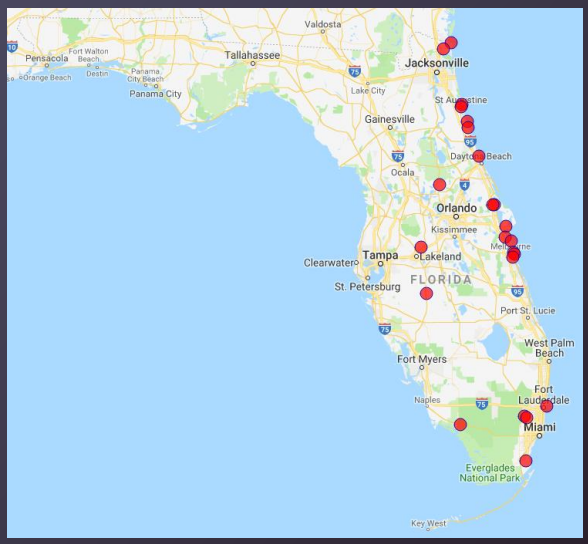
Hurricane Irma (2017) Damage Surveys

Most tornado-producing tropical event in Florida since Agnes (1972)

23 FL Tornadoes confirmed

EF-0 (65-85 mph):	6
EF-1 (86-110 mph):	14
EF-2: (111-135 mph)	3

- Widespread sustained hurricane force wind (or gusts) across peninsula likely masked confirmation of many more weak (EF-0) tornadoes due to rain-band squalls producing damage from winds of similar magnitude.
- No deaths/injuries; coastal hurricane evacuations may have helped alleviate casualties.



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Hurricane Irma (2017) Damage Surveys

Tornadoes resulted in many swaths of greatly enhanced damage

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TC Tornado Messaging – The Dilemma

Threat Recognition, Impacts & Messaging

Hurricane Evacuation Message

"Evacuation orders are in effect. Leave soon as possible if you are in a mandatory evacuation zone."

Tornado Warning Call-to-Action

"Take cover now! Move to an interior room on the lowest floor of a sturdy building."

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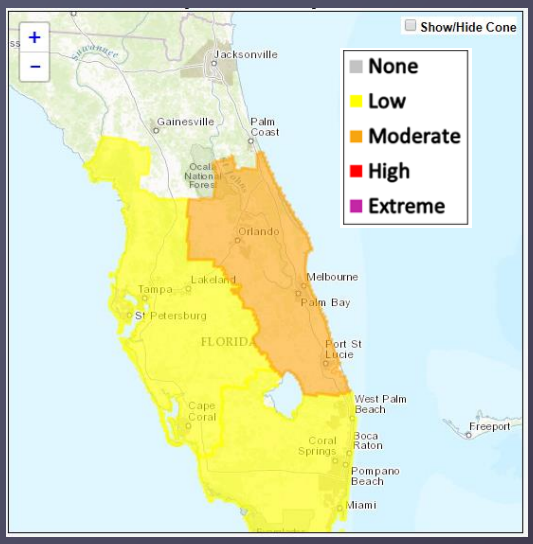
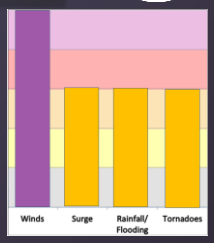
Hurricane Threat and Impact Graphics

Wind, Storm Surge, Flooding and **Tornadoes**





Consistent with NHC forecasts.

Downscaled from SPC guidance.

Provides “quick look” of relative threat impact levels.

Excellent <u>local</u> planning tool.

Updated every 6-hours; monitor for increasing or decreasing trend.

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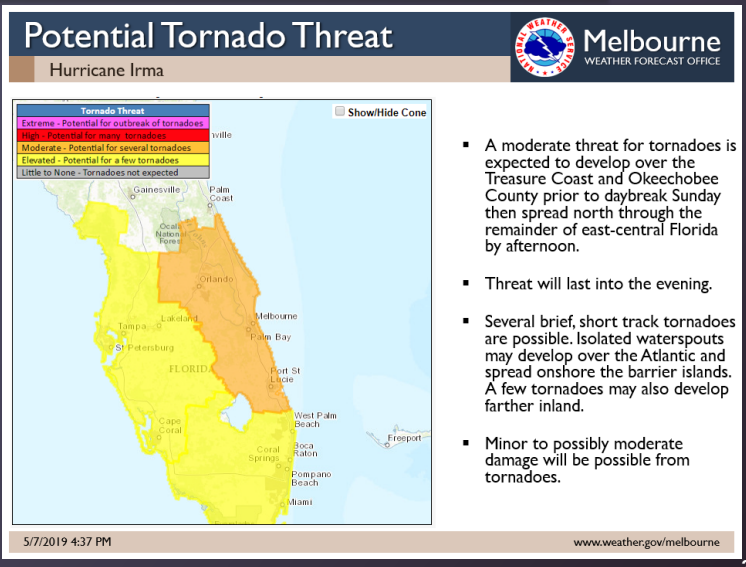
Decision Support Service (DSS) Briefings

For emergency management decision-making



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Decision Support Service (DSS) Briefings

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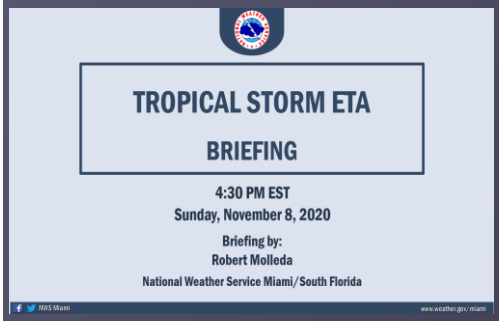
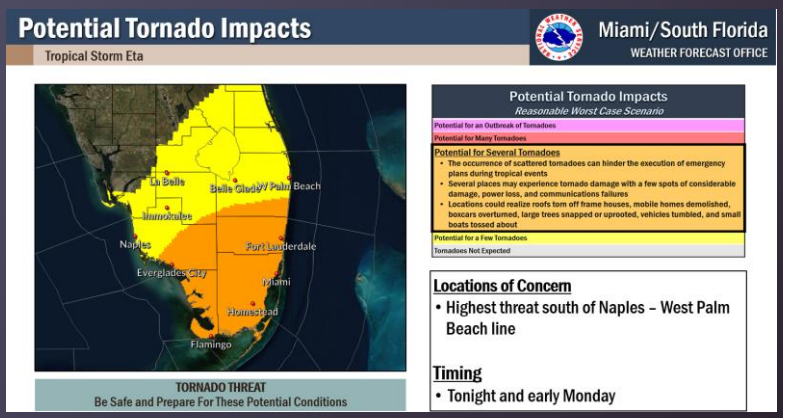
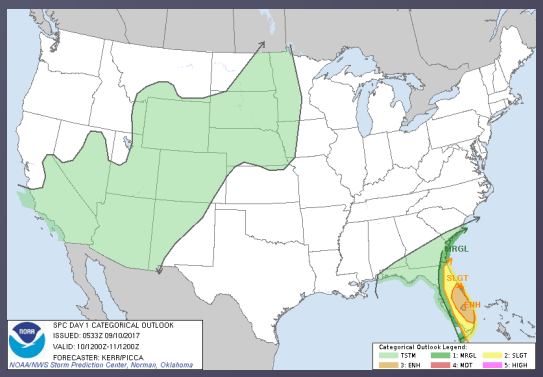




Forecasting TC Tornadoes

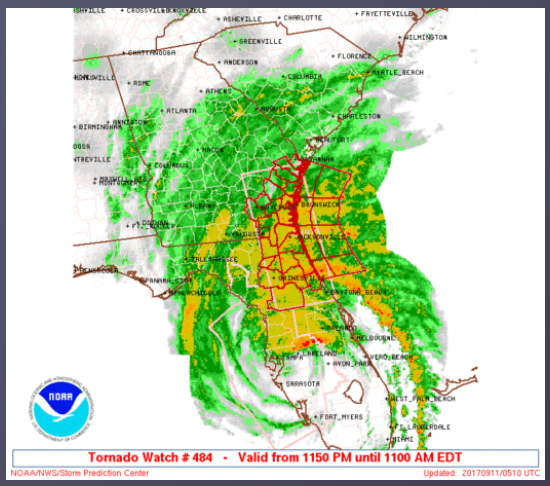
SPC Severe Weather Outlooks



- Storm Prediction Center (SPC) issues severe thunderstorm outlooks, beginning 8 days out.
- Forecast confidence in track (i.e. NE quadrant position) typically not high enough to include within SPC outlook until day 2.
- Forecasts based on probability of damaging thunderstorm winds and/or tornadoes within 25 miles of a single point.
- Forecasts better define threatened area as time to impact lessens.

Forecasting TC Tornadoes

SPC/WFO-Coordinated Tornado Watches



- Issued by SPC in close coordination with local NWS offices.
- Often issued for the favored “right front” quadrant of the TC circulation.
- Watches are typically issued for most hurricanes (and sometimes tropical storms and tropical depressions) as they threaten the coast.
- Tornado Watches during TC events are often issued for 12-hours (vs 8-hours for non TC events).

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Forecasting TC Tornadoes

WFO Tornado Warnings

BULLETIN - EAS ACTIVATION REQUESTED
Tornado Warning
National Weather Service Melbourne FL
1112 AM EDT SUN SEP 10 2017

The National Weather Service in Melbourne has issued a

* Tornado Warning for...
  Southern Brevard County in Florida...

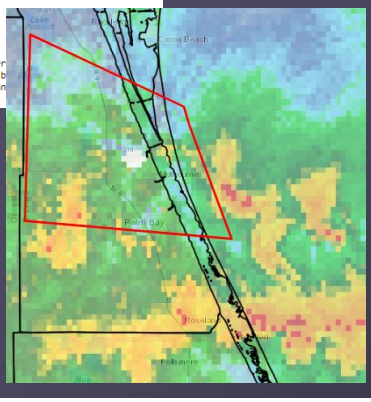
* Until noon EDT

* At 1110 AM EDT, a severe thunderstorm capable of producing a tornado was located 11 miles east of Melbourne Beach, or 11 miles east of Indialantic, moving west at 35 mph.

  HAZARD...Tornado.

  SOURCE...Radar indicated rotation.

  IMPACT...Flying debris will be danger
           shelter. Mobile homes will b
           Damage to roofs, windows, an
           damage is likely.



- CHALLENGING to issue lead-time warnings!
- Cells are fast-moving (60+ mph forward motion).
- Cells develop and dissipate quickly (short-lived radar signatures).
- Can be sustained over water, then dissipate as land is approached (or not!).
- Multiple simultaneous circulations.
- Can lead to over-warning (false alarms).

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Poll Question

Tropical Cyclone Tornado Messaging - WEA

Which NWS Warning below is NOT activated upon Wireless Emergency Alert (WEA) capable smart phones:

A) Severe Thunderstorm Warning

B) Tornado Warning

C) Flash Flood Warning

D) Extreme Wind Warning

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Poll Answer

Tropical Cyclone Tornado Messaging - WEA

Which NWS Warning below is NOT activated upon Wireless Emergency Alert (WEA) capable smart phones:

A) Severe Thunderstorm Warning

B) Tornado Warning

C) Flash Flood Warning

D) Extreme Wind Warning

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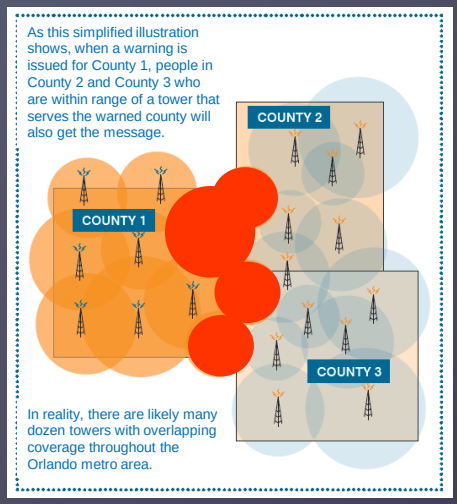
TC Tornado Messaging

Wireless Emergency Alert (WEA) Notifications



- Because cell towers broadcast in a radius, their coverage areas don't line up neatly with county boundaries. This means you could receive warnings if outside the actual threat area (even within an adjacent county).
- Geo-targeting is improving and WEA messages are likely to become more localized within later FEMA IPAWS software updates.

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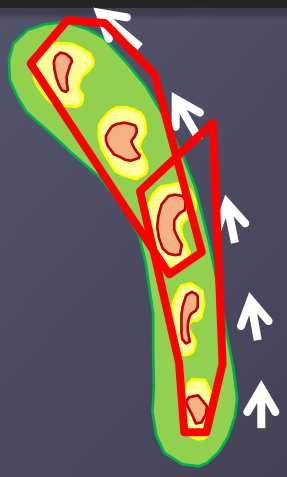
Imminent Tornado Threat

Impact-Based Warnings (IBW)



THE NATIONAL WEATHER SERVICE IN MELBOURNE HAS ISSUED A

* TORNADO WARNING FOR…
  ORANGE COUNTY…

* UNTIL 1100 AM EDT

* AT 1017 AM EDT...SEVERAL TORNADO PRODUCING STORMS WERE LOCATED NEAR ORLANDO...AND MOVING NORTHWEST AT 35 MPH.

HAZARD...DAMAGING TORNADOES.

SOURCE...EMERGENCY MANAGEMENT CONFIRMED TORNADO.

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.

* LOCATIONS IMPACTED INCLUDE… ORLANDO...PINE HILLS...OCOEE… APOPKA AND ZELLWOOD.

PRECAUTIONARY/PREPAREDNESS ACTIONS…

A TORNADO IS ON THE GROUND. TAKE COVER NOW! MOVE TO AN INTERIOR ROOM ON THE LOWEST FLOOR OF A STURDY BUILDING. AVOID WINDOWS. PROTECT YOUR HEAD.

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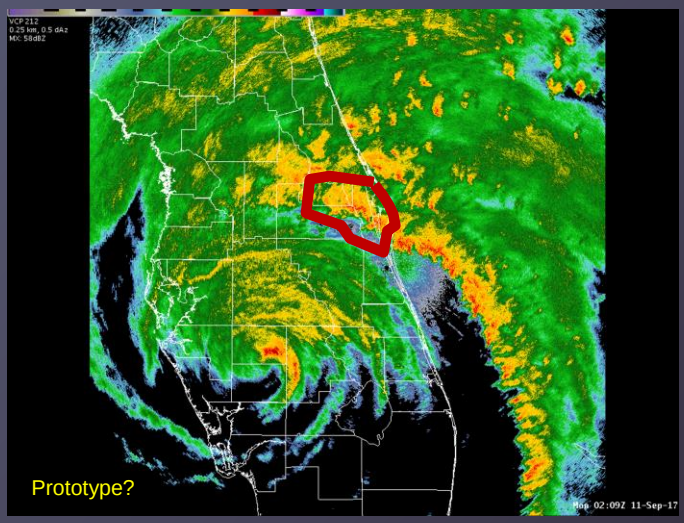
Imminent Tornado Threat

Possible Future Tornado Warning Option?



Tornado Warning Example – Larger area to account for significant threat area for short-term tornado development

Tornado Warning
Valid Time: 60 min

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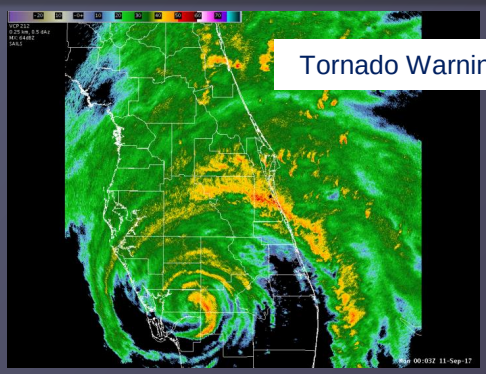
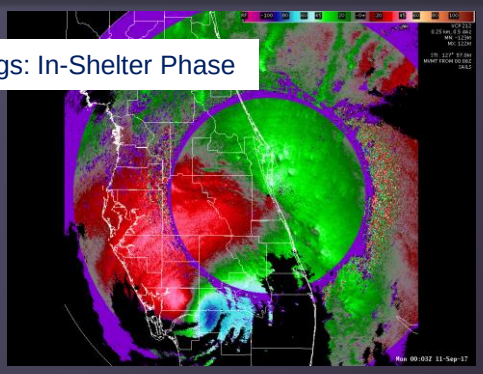
Tornado Warnings during Hurricane Winds

Possible Future Tornado Warning Strategy?





Should/can warnings only be issued when threat exceeds that posed by winds?

EM Focus Groups:

If hurricane warnings are in effect, should tornado warnings only be issued when the immediate threat to life exceeds that posed by the hurricane wind field itself?

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TC Tornadoes

FDEM Discussion

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Questions/Comments?

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We appreciate your partnerships!

Tropical Topics Week 2021

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