GOVERNOR'S HURRICANE CONFERENCE®

The Combined Tropical Wind & Water Hazards

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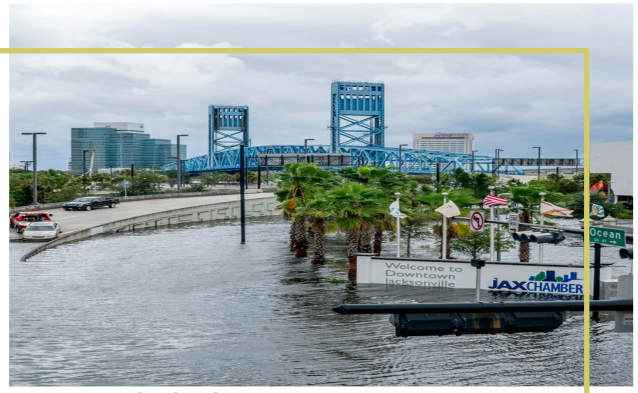
NATIONAL WEATHER SERVICE

Training Session 17

Session Goal

Showcase NHC & WFO products & practice proper product interpretation to help assess location specific tropical cyclone threat potential.

Storm & Impact Uniqueness

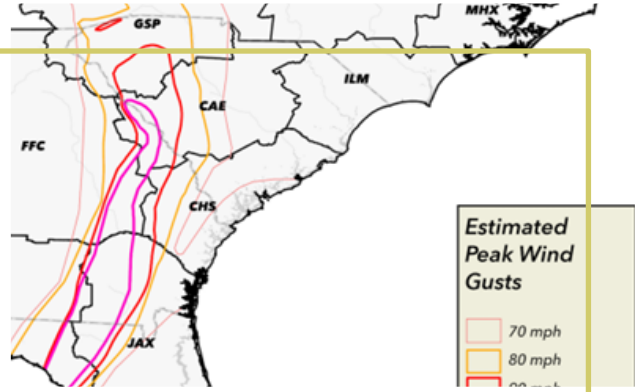


Irma 2017

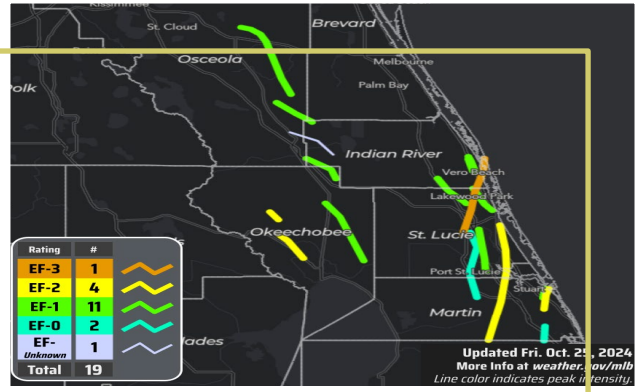
Michael 2018

Ian 2022

Debby 2024



Helene 2024

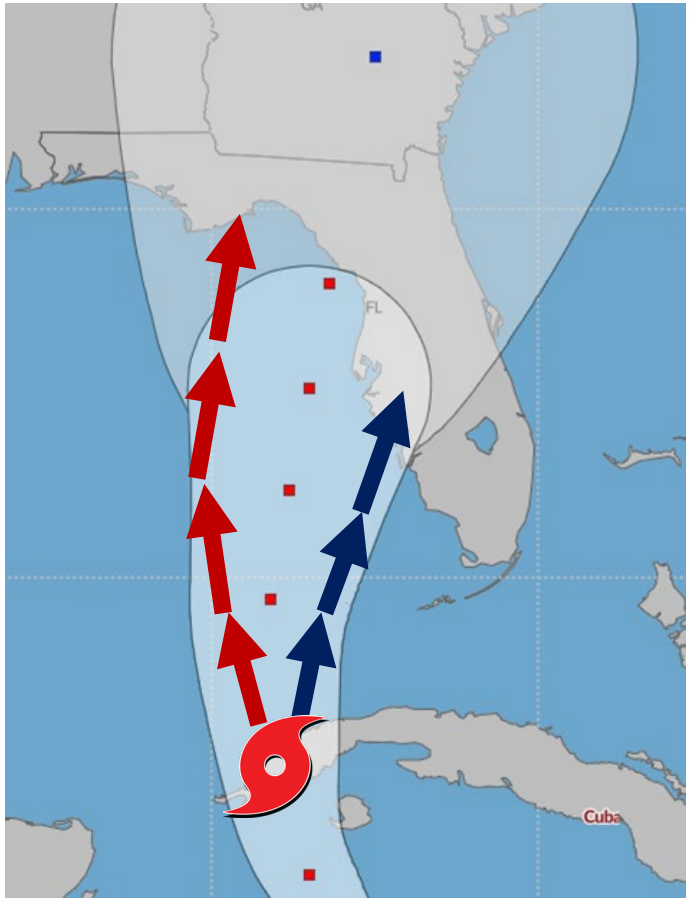


Milton 2024

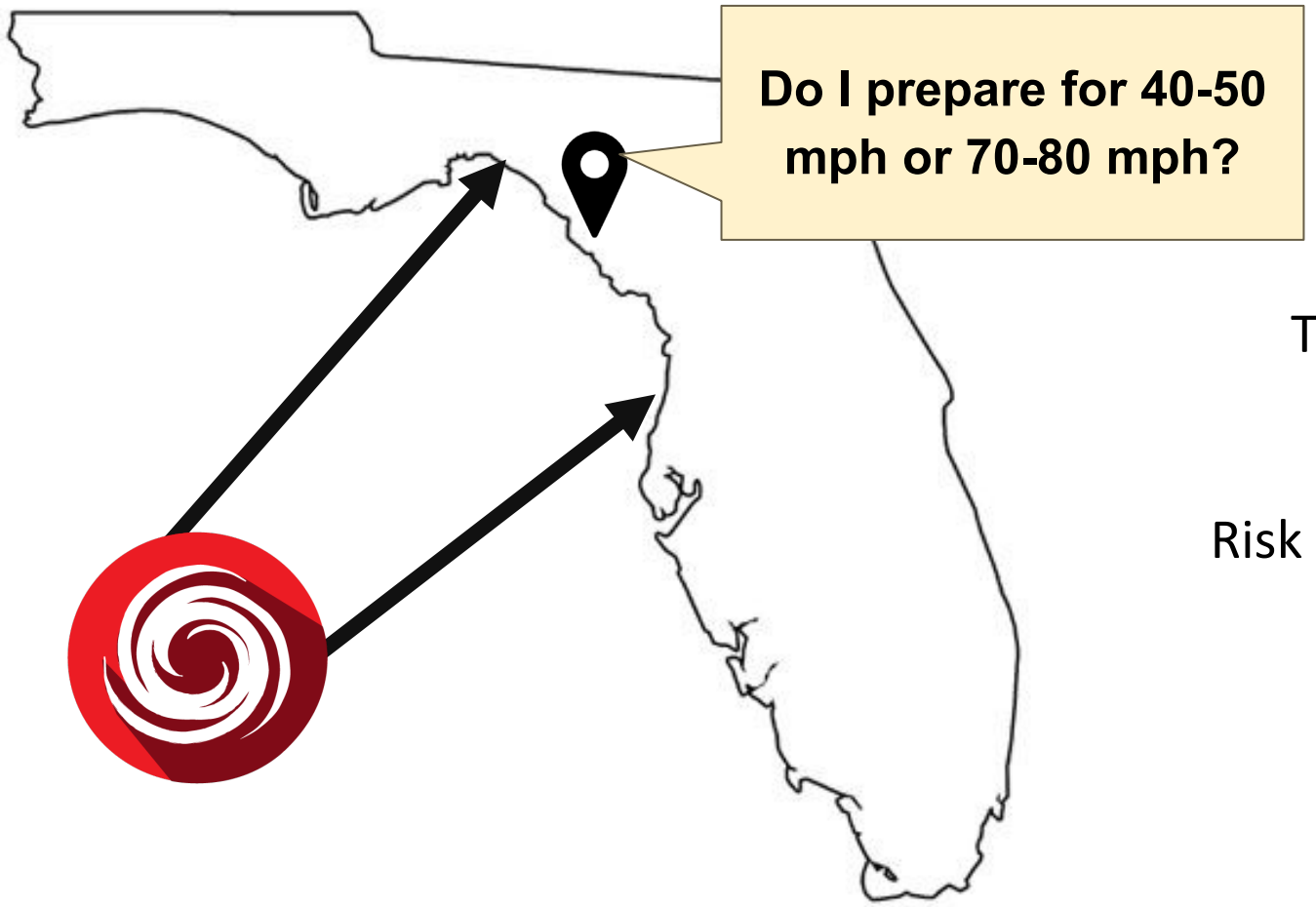
Forecast Adjustments

Track nudges ultimately influences landfall location & timing & local extent of impacts

	Track adjustment from north 360° to north-northwest 350°	Potential landfall somewhere FL panhandle – **in a few days**
	Track adjustment from north 360° to north-northeast 10°	Potential landfall somewhere SW FL peninsula **- in a day**



Tropical Cyclone Risk - Deterministic



Deterministic

Specific Values - “Most Likely”
Tropical Storm Conditions *Expected*

Does not Communicate RISK
Risk of motivating over/under preparation

If used alone - DANGER

Tropical Cyclone Risk - Probabilistic

Probabilistic

Range of values/outcomes

Upper bounds Considered
Hurricane Conditions *Possible*

Communicates reasonable worst case scenario
What we want folks to prepare for

Forecast of least regret

Could communicate over preparation

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Sustained Damaging Winds & Gusts

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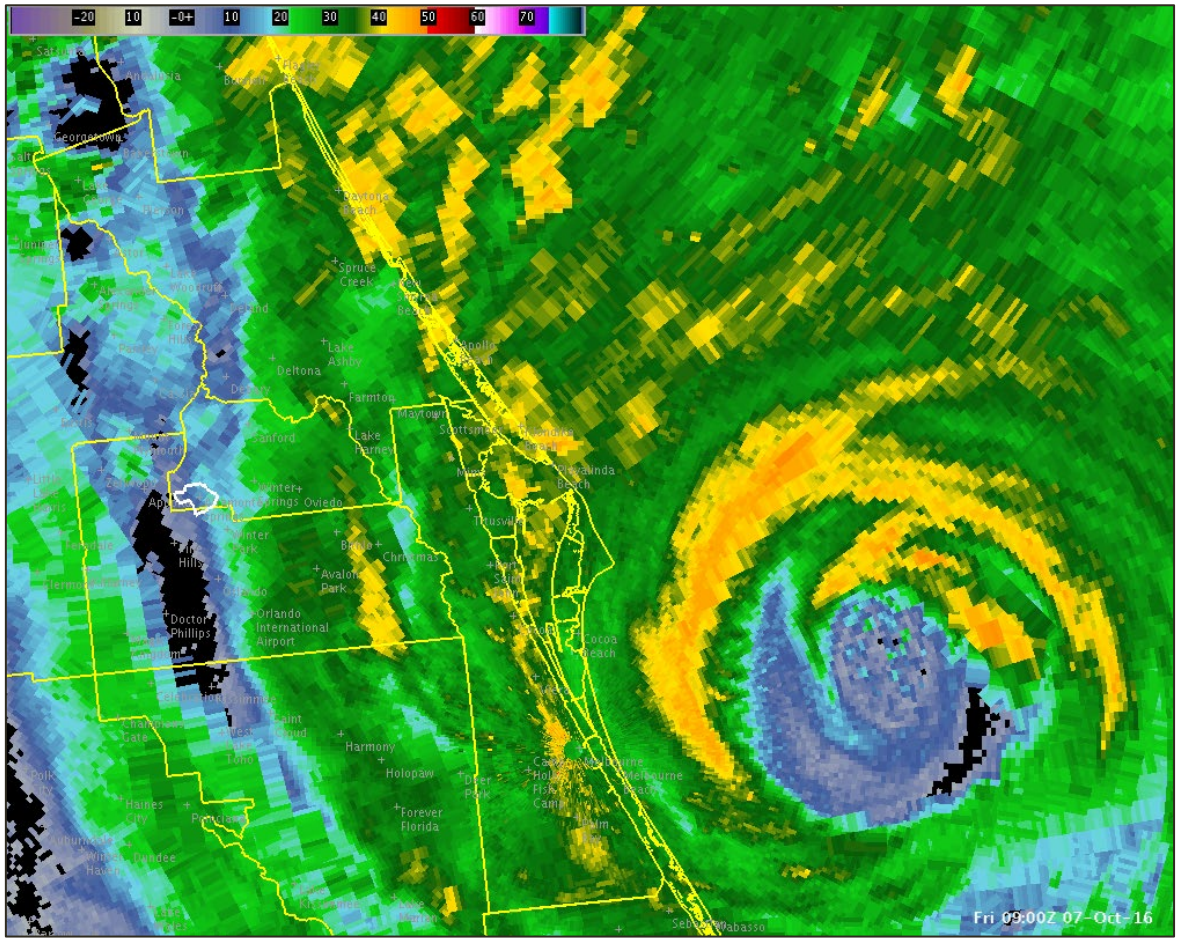
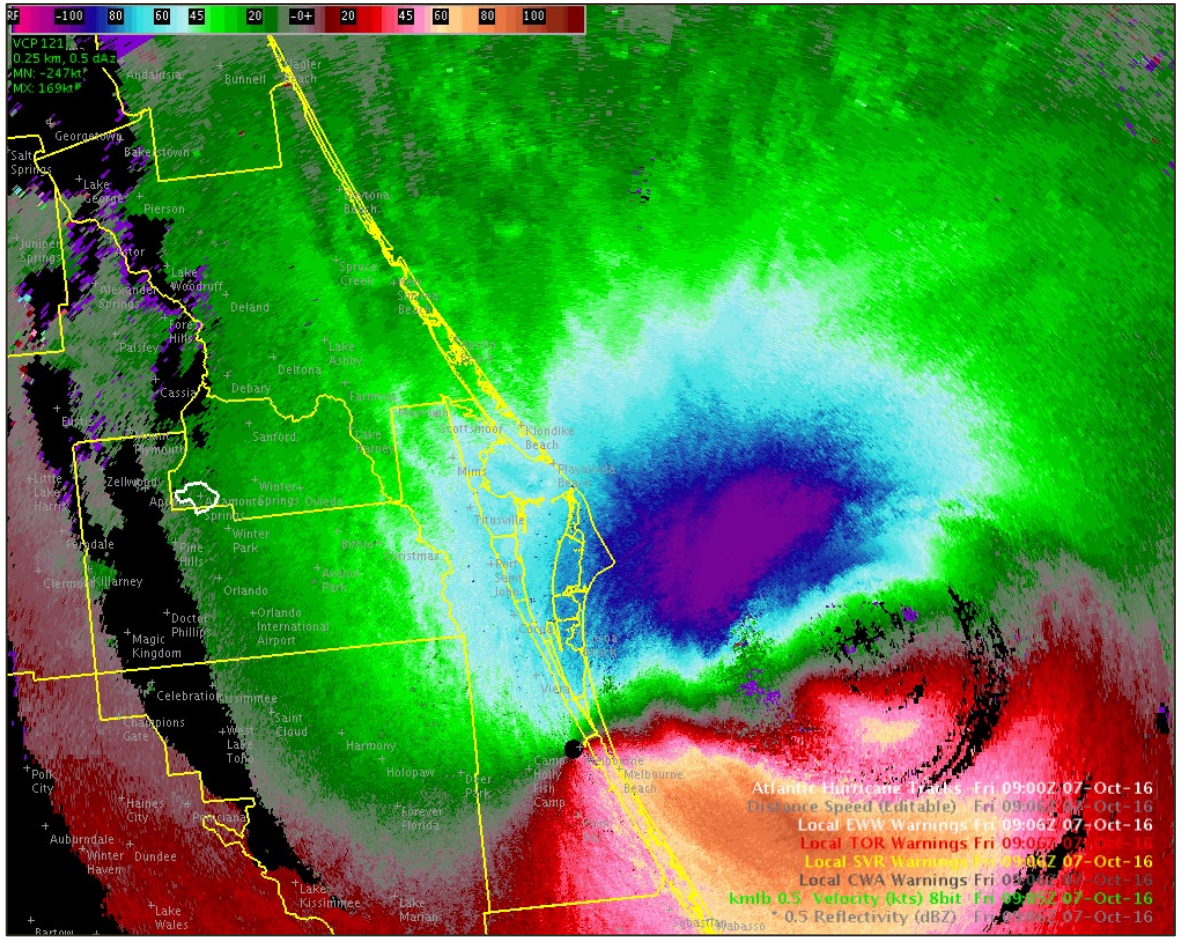
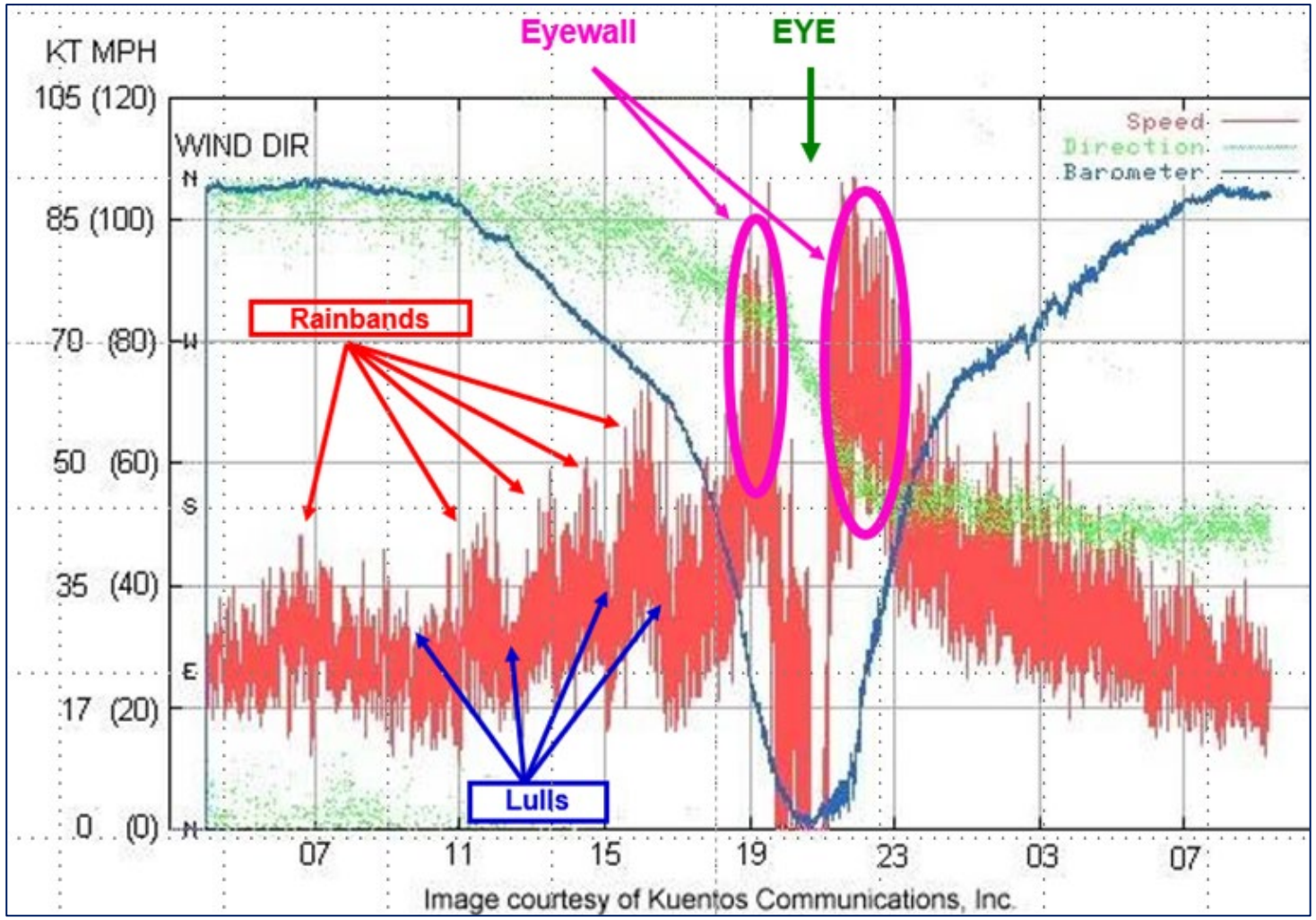
Training Session 17

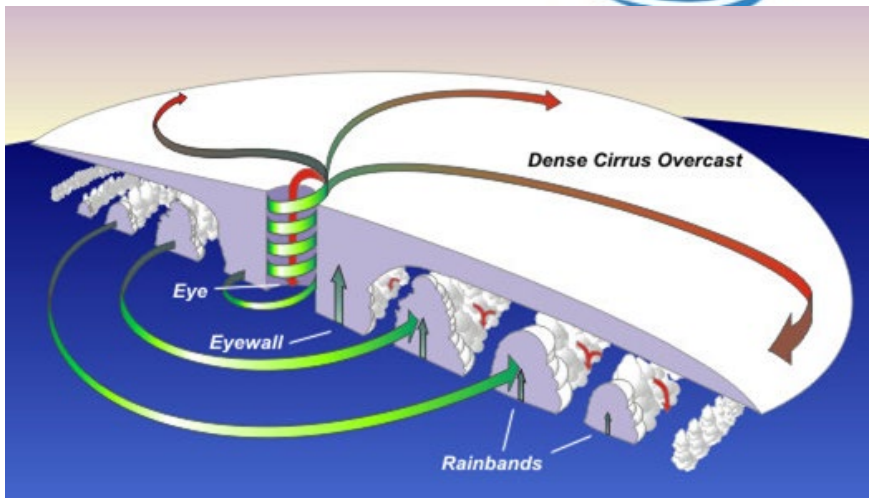
Complex Wind Field





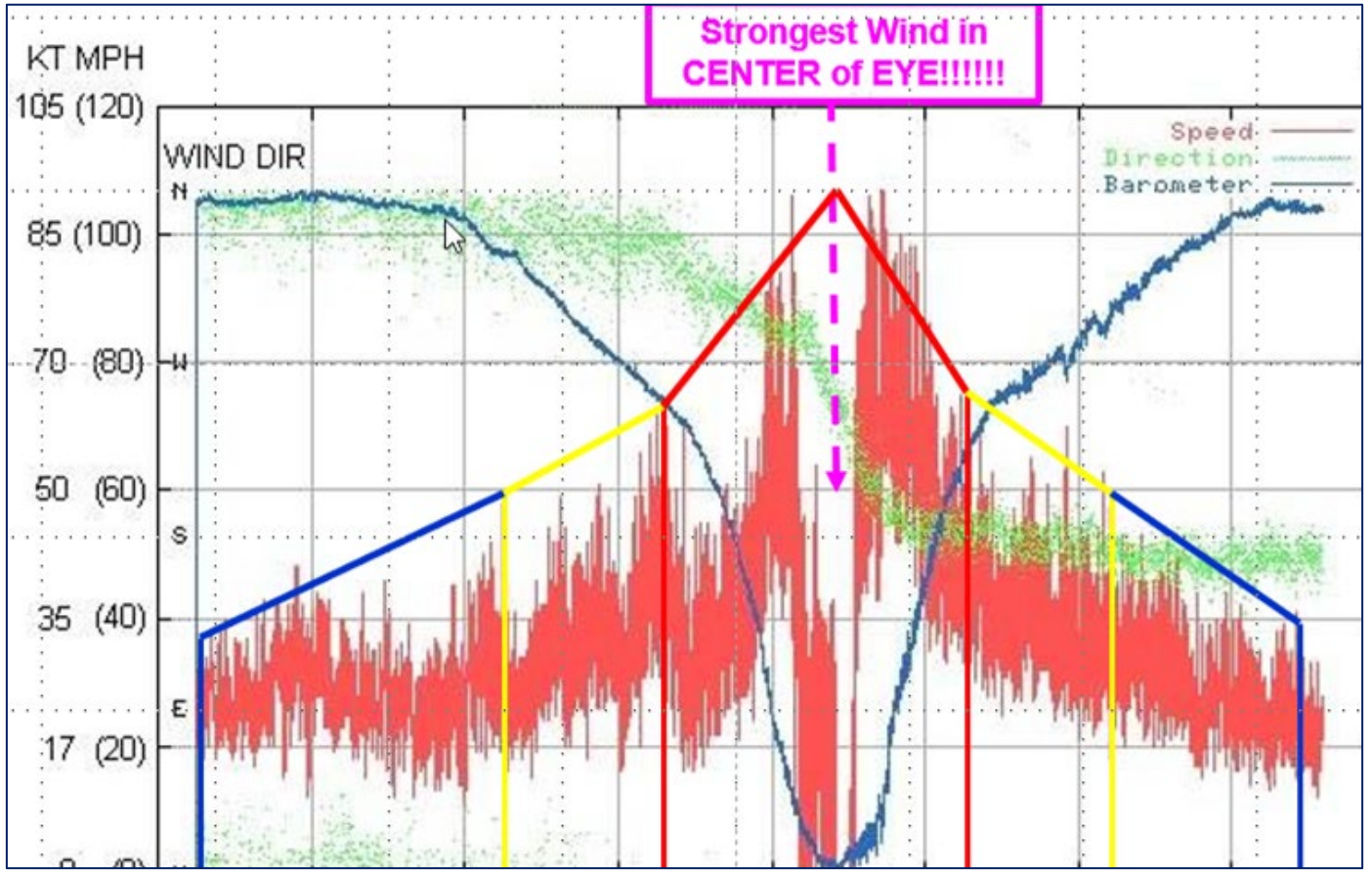
Tropical Cyclone Structure



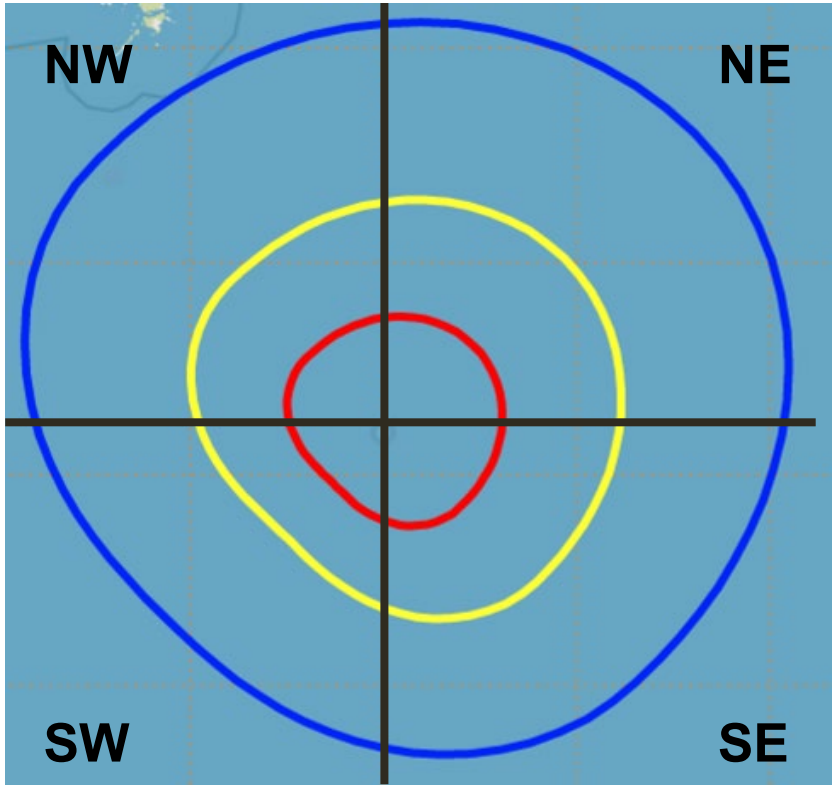


- Complex 3D system
- Non-continuous wind field
- Peaks & Lulls

TC Wind Field Modeling



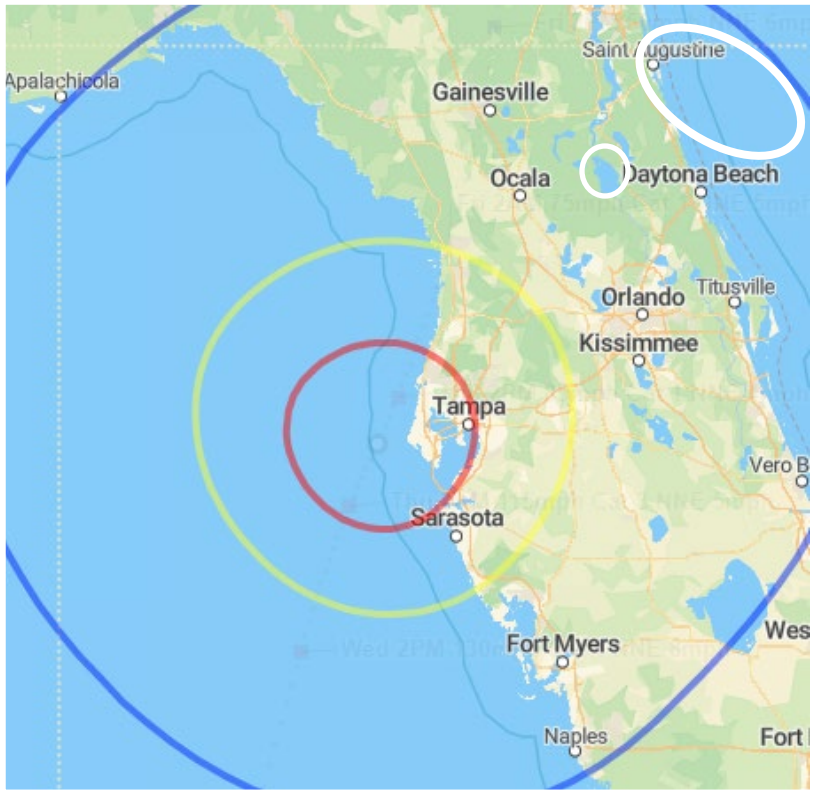
HURREVAC – 2D Structure



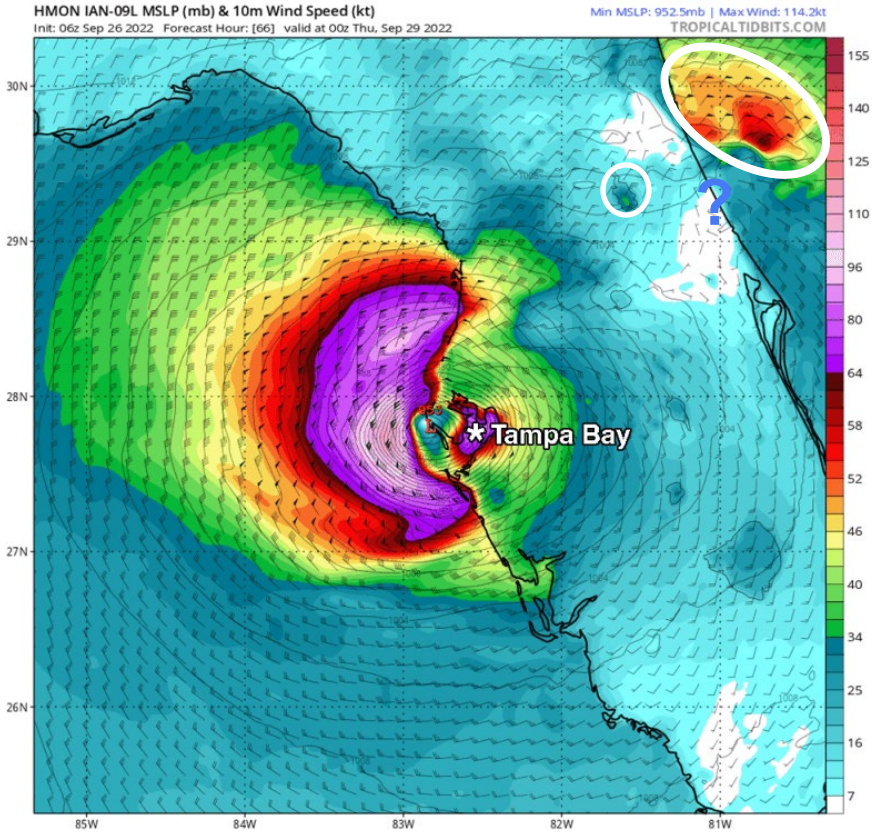
Wind Field Modeling Caution

Terrain Influence – Water, Open Spaces

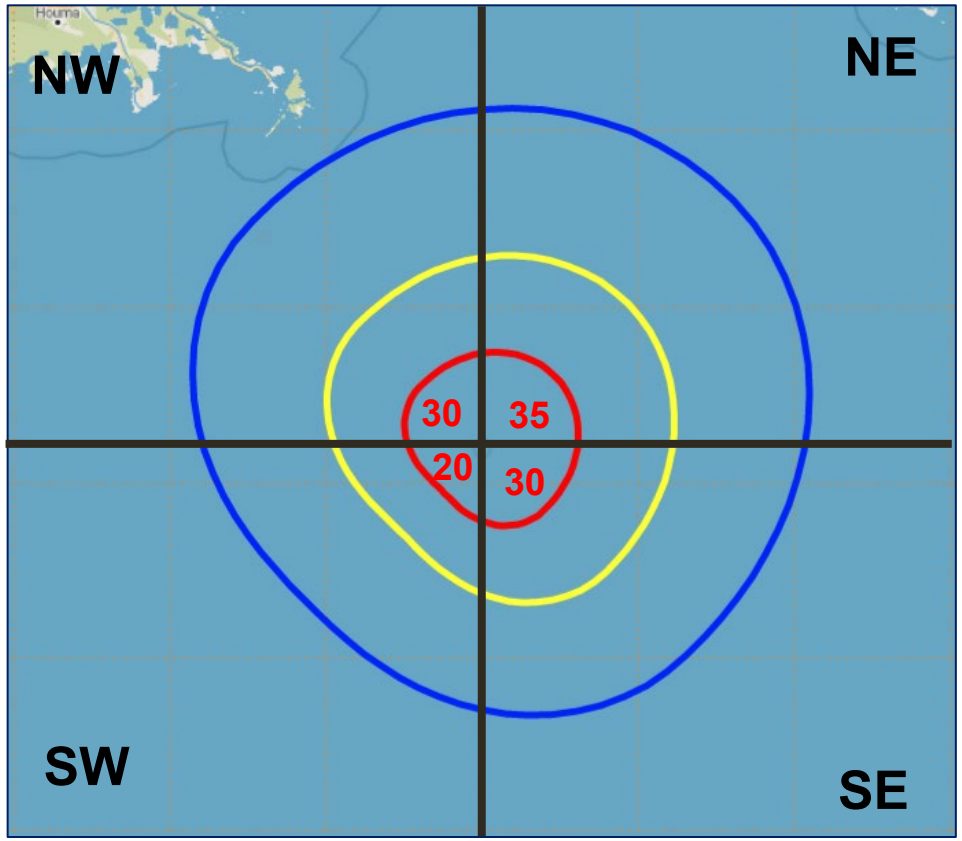
IAN Adv 15, 64 hr



HWRF Forecast Model



Hurricane Software



NHC TCM Product Provides Wind Radii

```
ESTIMATED MINIMUM CENTRAL PRESSURE 964 MB
MAX SUSTAINED WINDS 90 KT WITH GUSTS TO 110 KT
64 KT....... 35NE  30SE  20SW  30NW.
50 KT....... 70NE  60SE  40SW  60NW.
34 KT.......120NE 100SE  80SW 110NW.
12 FT SEAS..180NE 180SE 150SW 120NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT. RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.
```

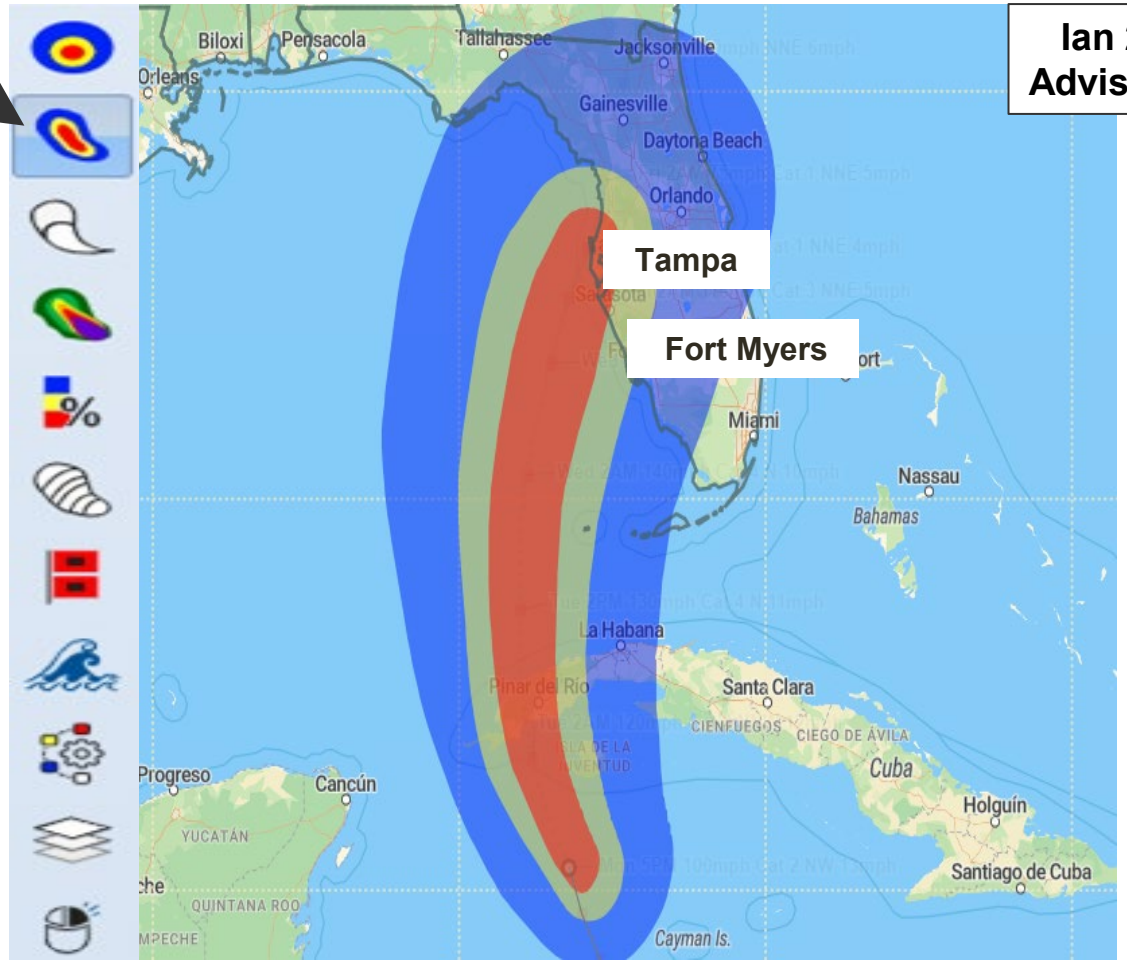
Considerations

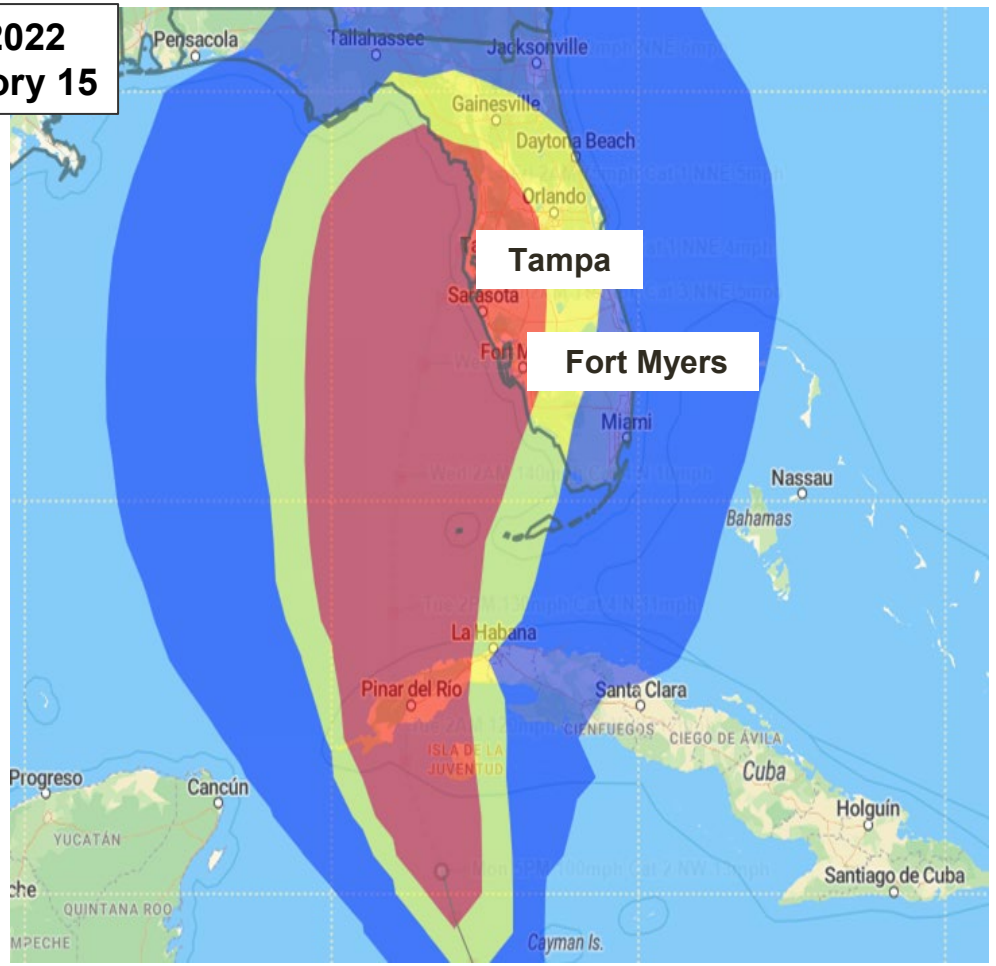
- Simplified structure
- Smooths wind field
- Does not show peak winds near eye

COMPLETE Wind Risk Assessment

Deterministic

Probabilistic





Wind Risk Tools & Availability

> 2 days Out	Within 48 hours
Forecast Cone - Deterministic & Probabilistic	Tropical Storm/Hurricane Watches & Warnings
Wind Speed Probabilities - Probabilistic	
Hurricane Threat & Impact Graphics	

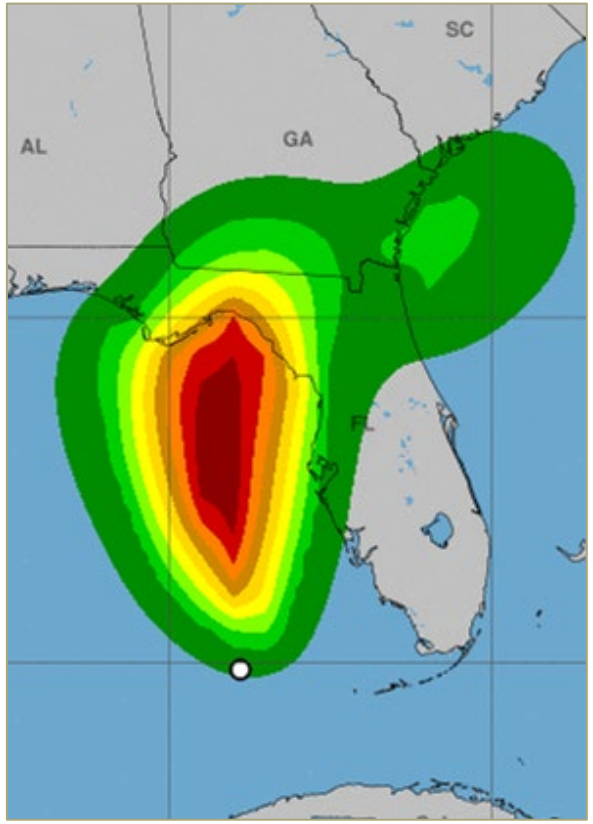
Wind Risk Tools & Availability

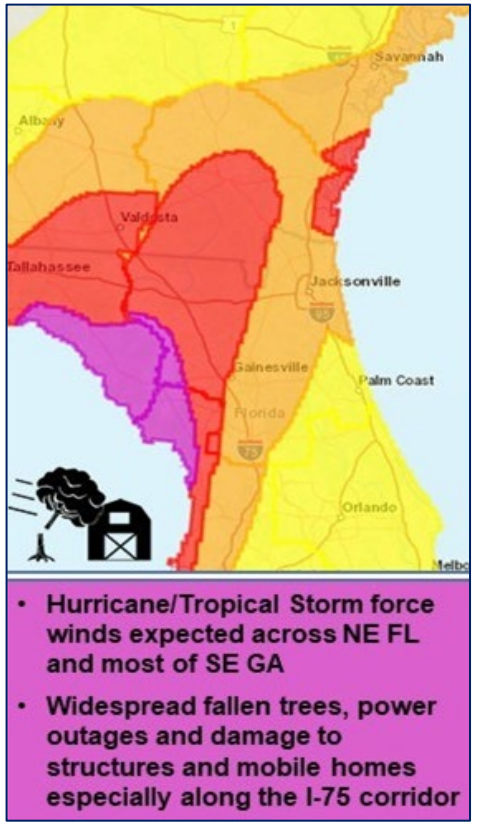
> 2 days Out

Forecast Cone -
Deterministic & Probabilistic

Wind Speed Probabilities -
Probabilistic

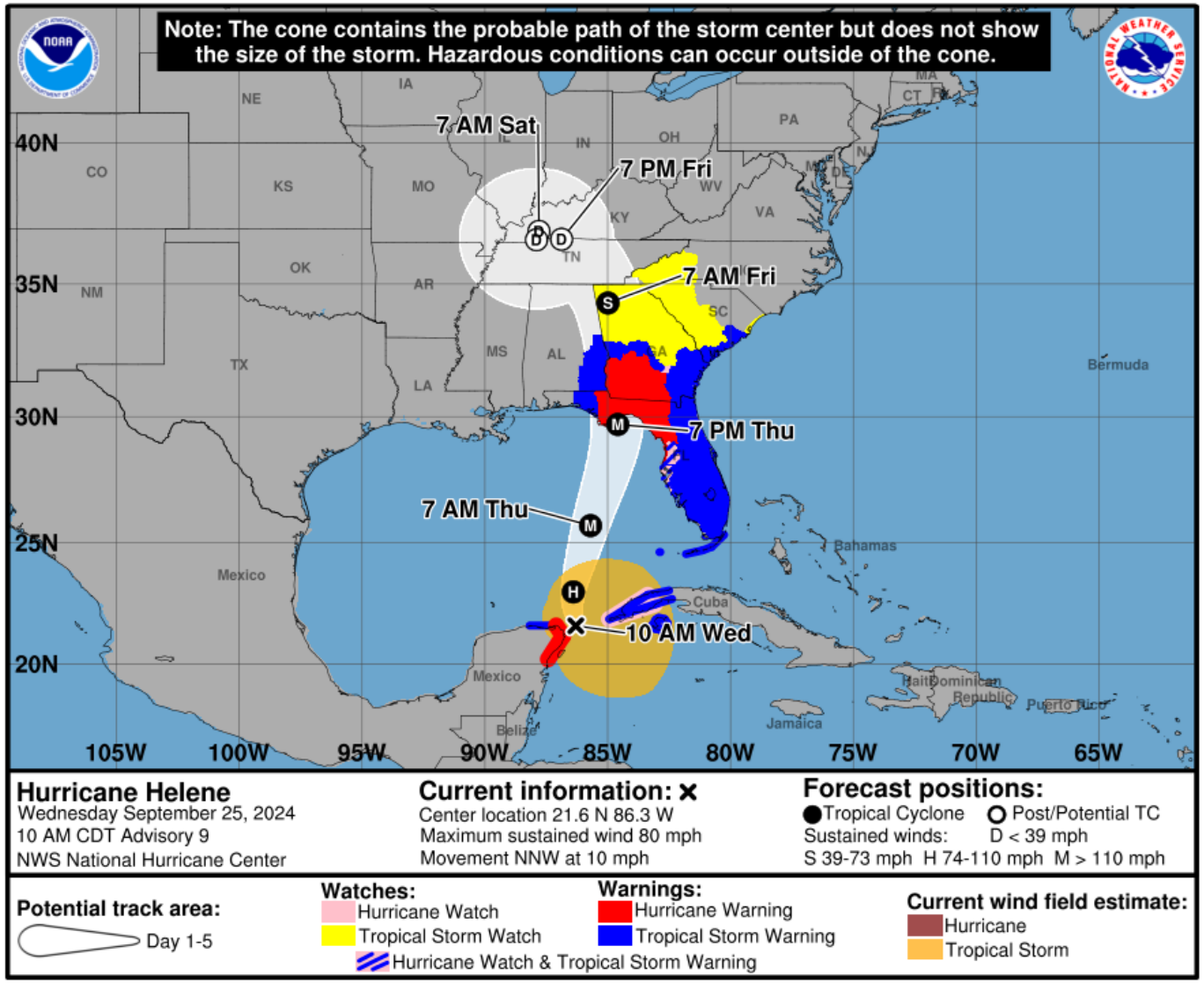
Hurricane Threat &
Impact Graphics





Forecast Cone

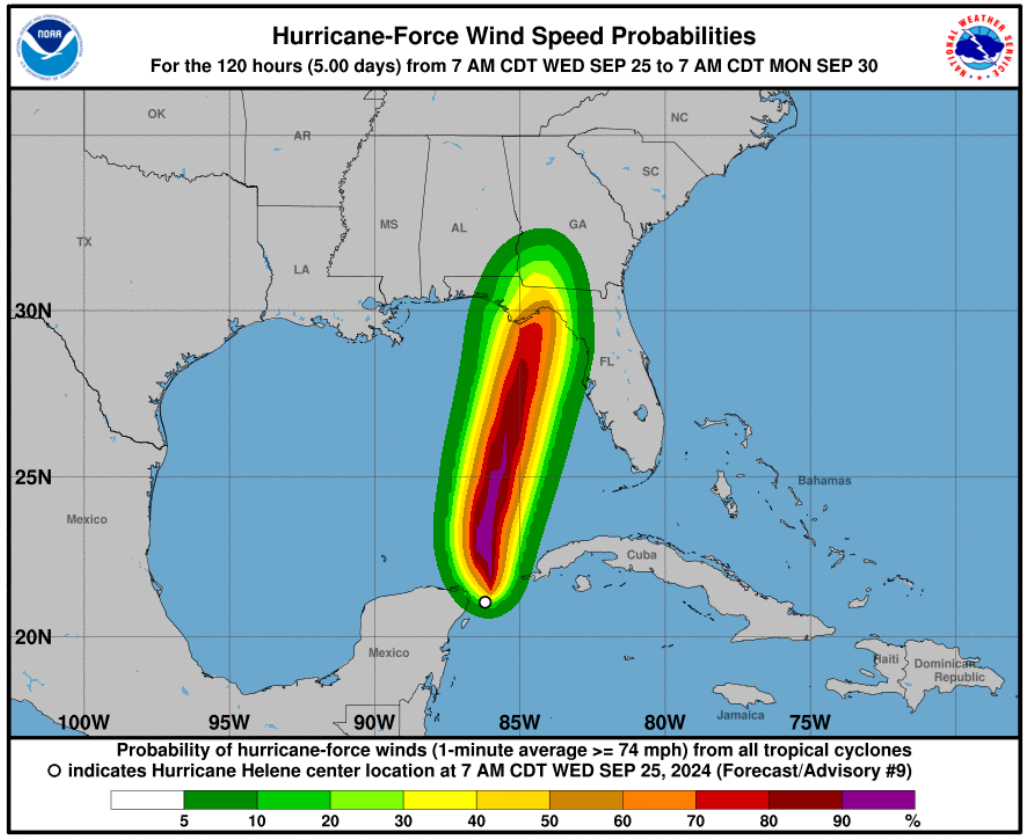
- ➔ Likely forecast track of storm center (67% of the time)
- ➔ Deterministic wind risk vulnerability tool ONLY
- ➔ 2026 Update:
  Inland Tropical Storm & Hurricane Watches & Warnings plotted over cone



Wind Speed Probabilities

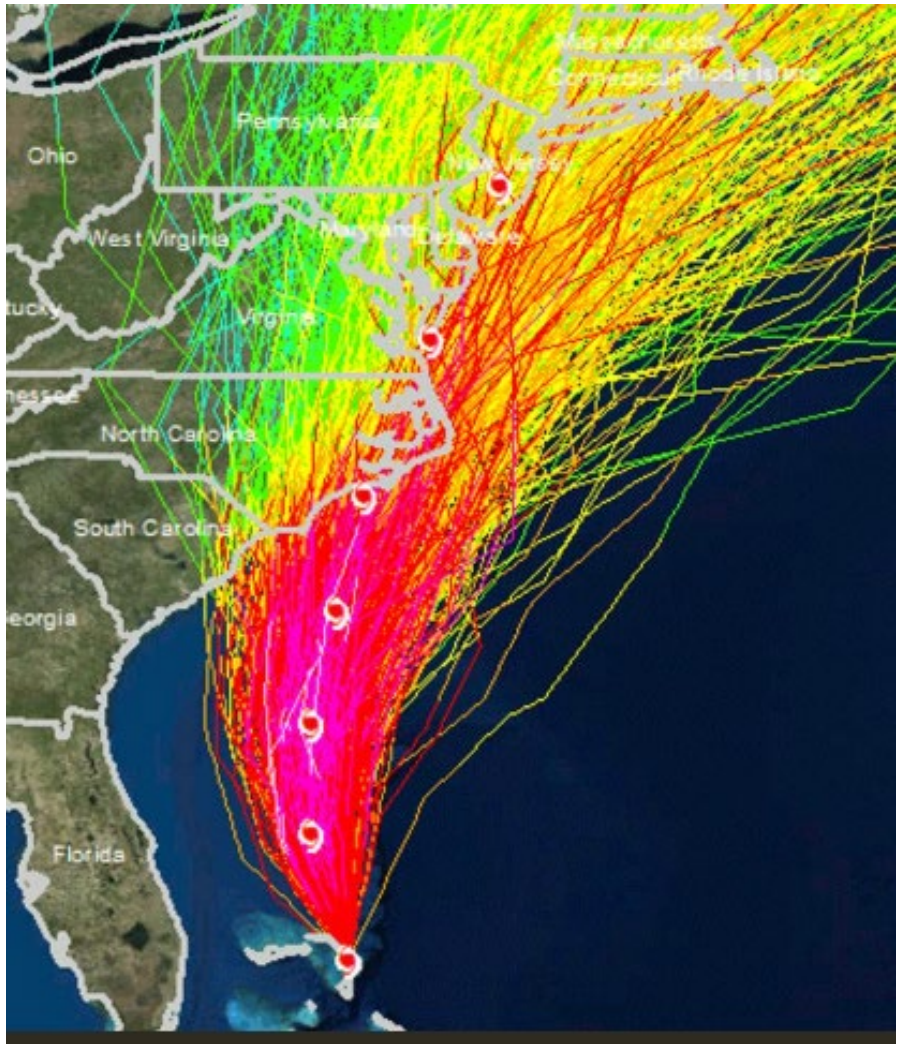
➔ The chance of sustained speeds at specific locations through 5 days (cumulative probabilities)

➔ Application - Use to monitor probability trends, if increasing, your localized risk is increasing.



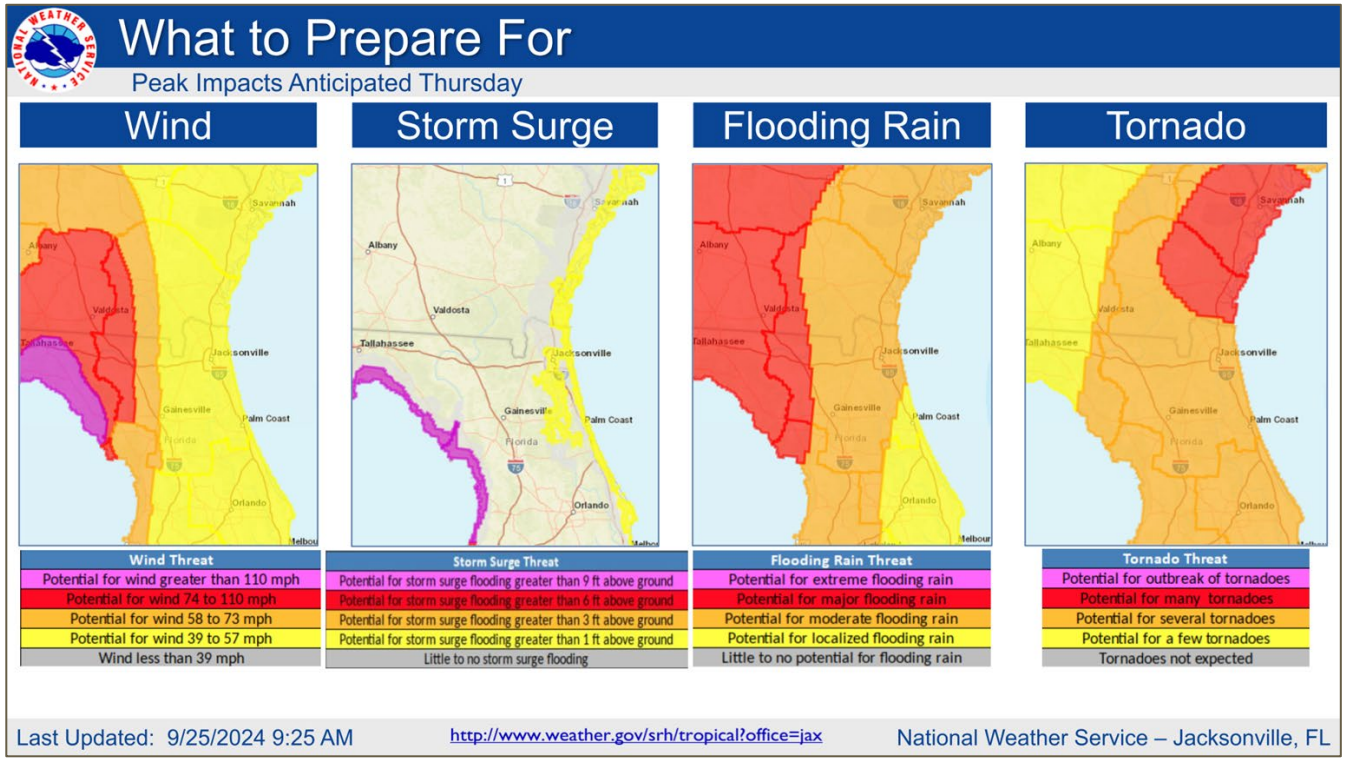
Wind Speed Probabilities

- 1,000 realistic alternative scenarios created
  - Official NHC forecast
  - Historical NHC track & intensity errors
  - Climatology & persistence wind radii model
  - Point Based Probabilities
- Accounts for Inland wind decay
- *Track model spread*
  Past NHC track forecast errors correlated to spread of track model guidance



Hurricane Threat & Impacts Graphics

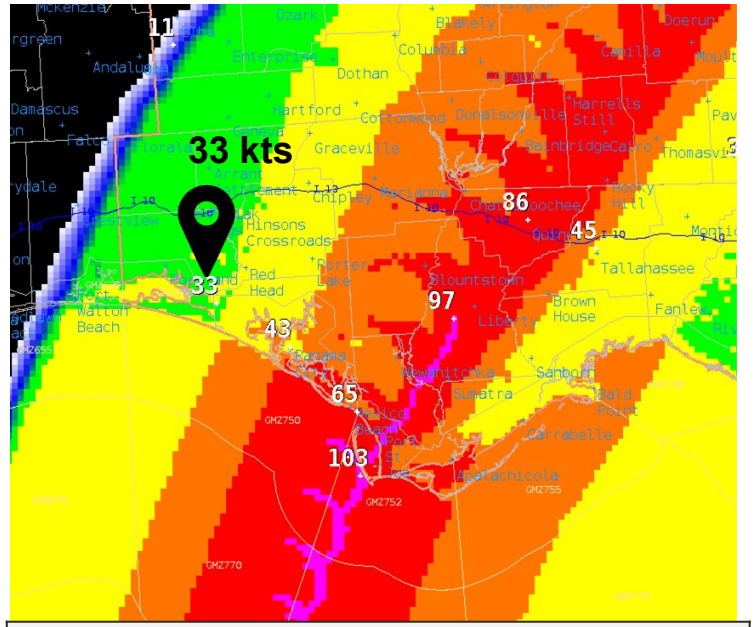
- **Communicates Risk with Safety Margin = What to Prepare For**
- **Potential impacts to motivate appropriate preparedness**
- **Specific Hazard Graphics:**
  - **Wind Threat**
  - **Storm Surge Threat**
  - **Flooding Rain Threat**
  - **Tornado Threat**



Hurricane Threat & Impact Graphics

Deterministic

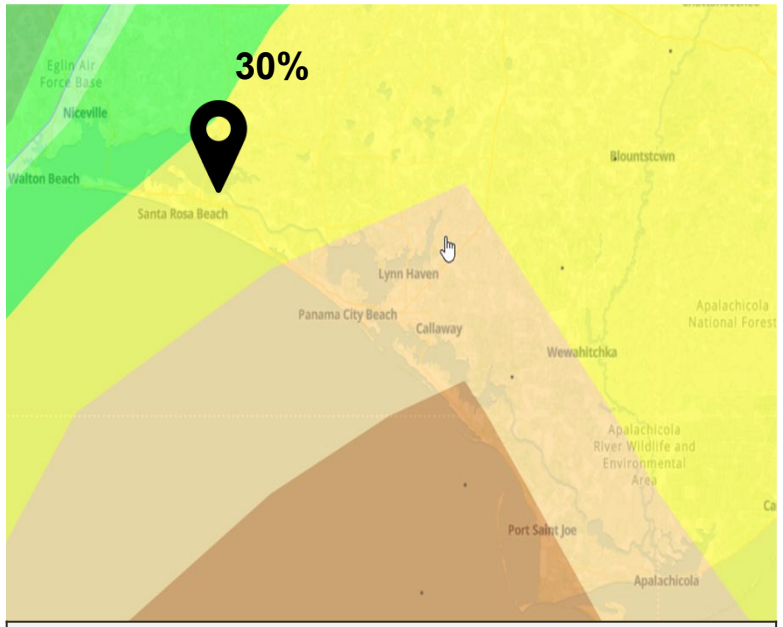
Forecast Uncertainty
Not Accounted



Forecast Wind Speed (knots)				
< 35	35-50	50-64	> 64	> 100

Probability POWER

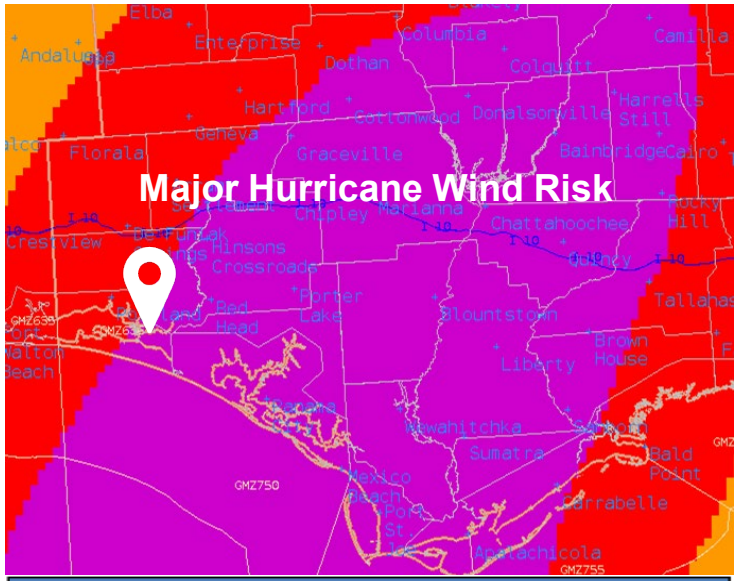
Accounts for Track Uncertainty



Hurricane WInd Speed Probability			
20%	30%	40%	50%

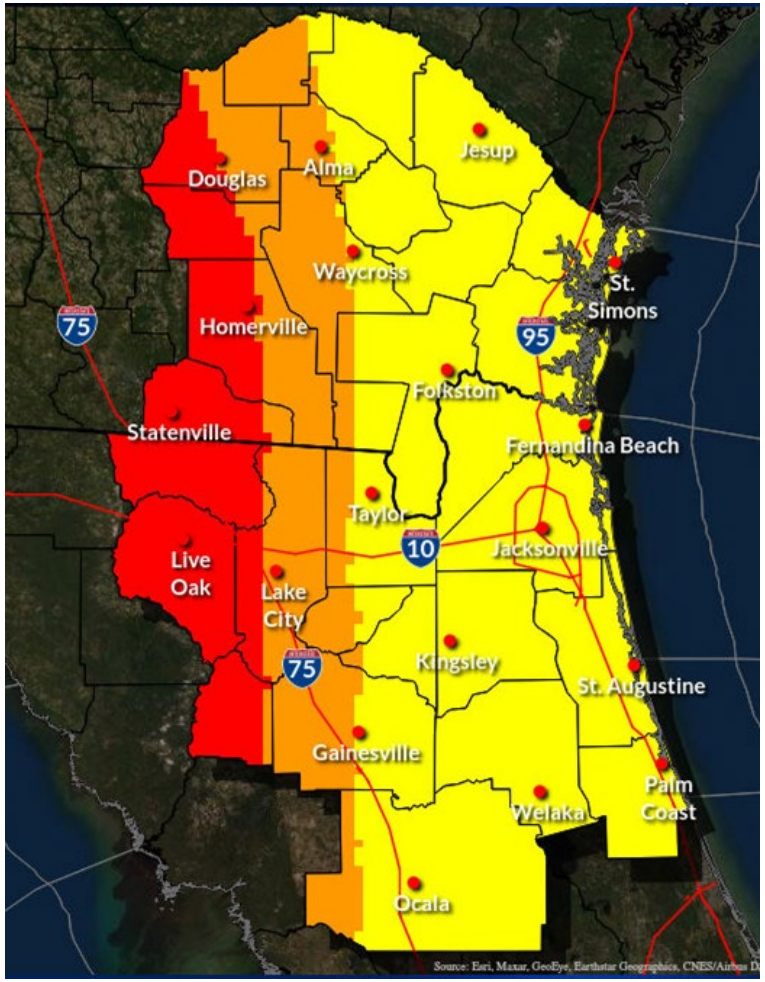
Wind Threat

WHAT TO PREPARE FOR



Wind Threat
Potential for wind greater than 110 mph
Potential for wind 74 to 110 mph
Potential for wind 58 to 73 mph
Potential for wind 39 to 57 mph
Wind less than 39 mph

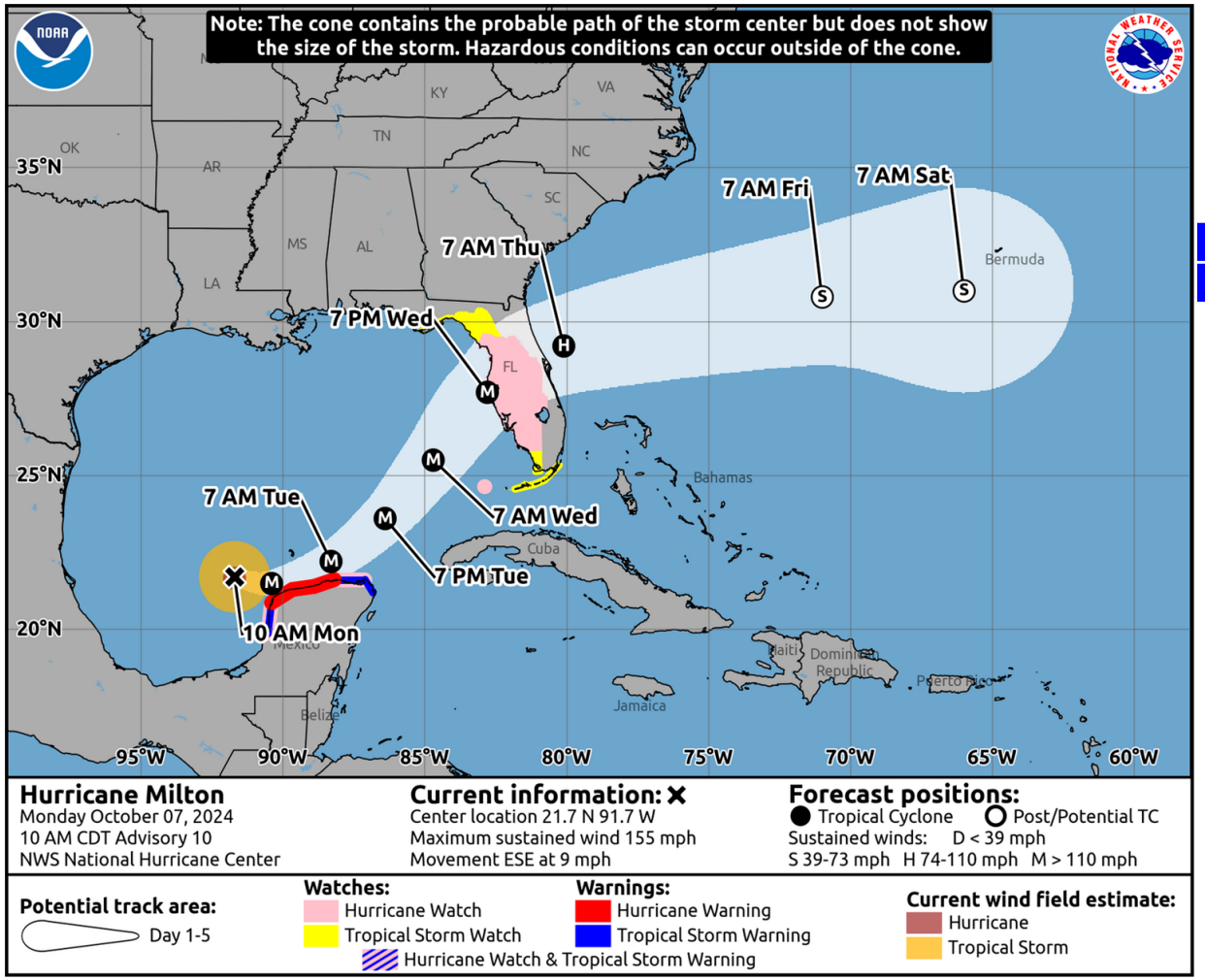
Hurricane Wind *Threat*



Wind Threat	
Potential for wind greater than 110 mph	Major Hurricane
Potential for wind 74 to 110 mph	Hurricane
Potential for wind 58 to 73 mph	Strong Tropical Storm
Potential for wind 39 to 57 mph	Tropical Storm
Wind less than 39 mph	

Residents of Suwannee, Hamilton and Gilchrist counties should prepare for widespread hurricane force winds.

Wind Risk Tools & Availability

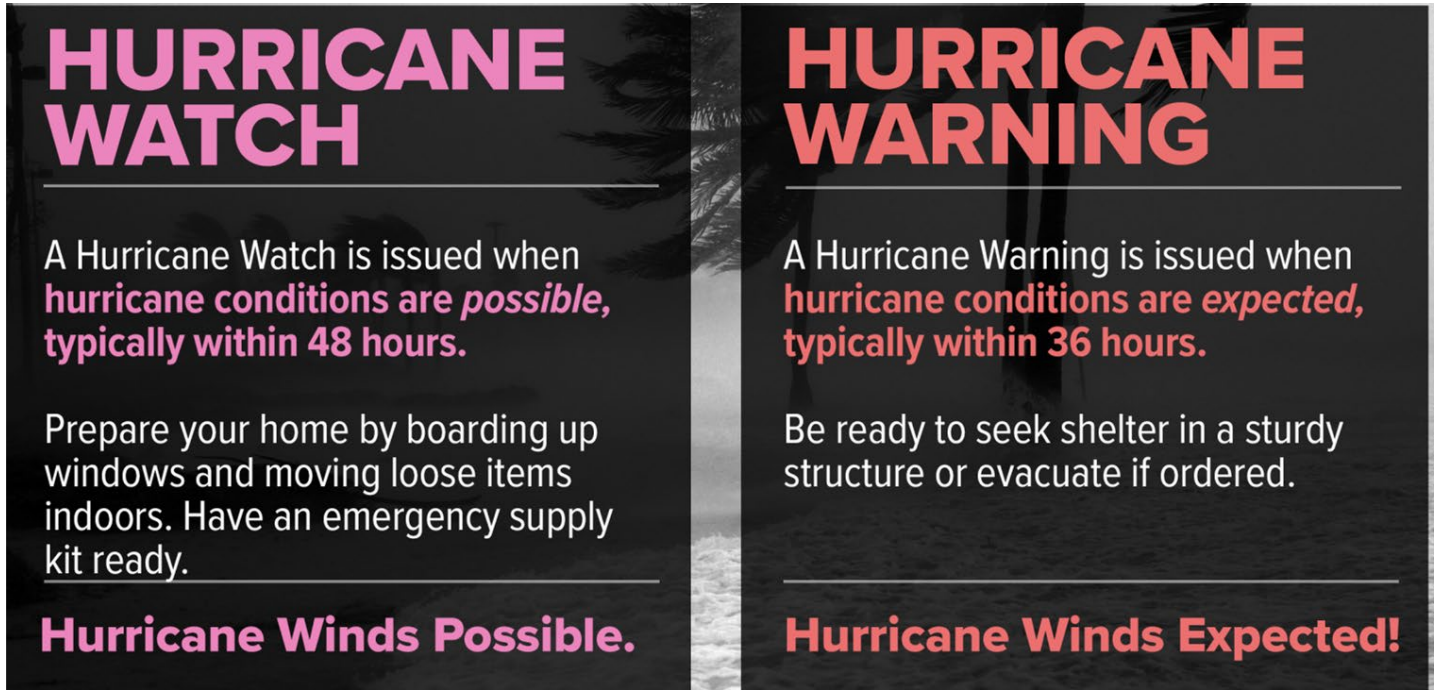


Within 48 hours

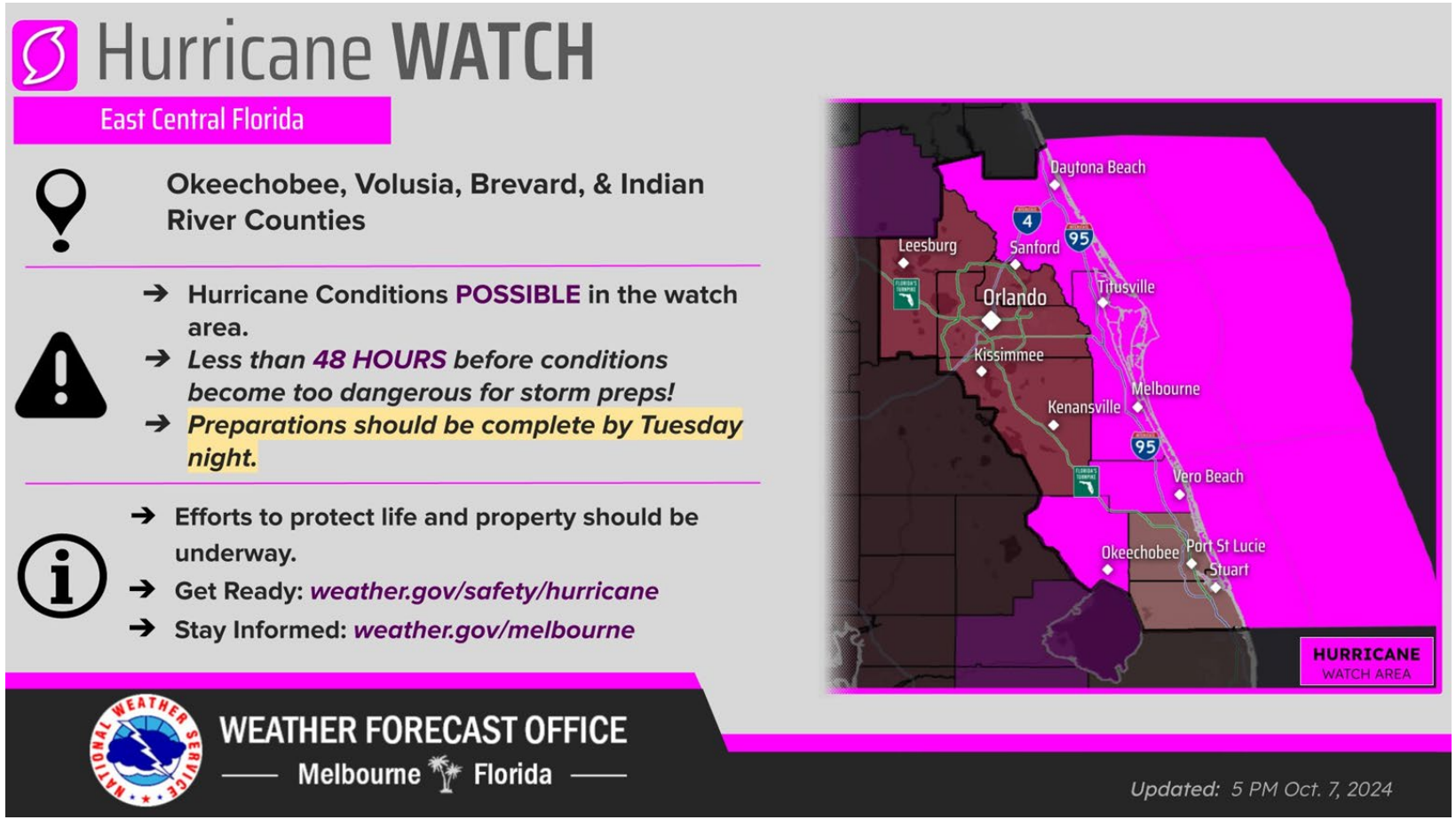
Tropical Storm/Hurricane Watches & Warnings

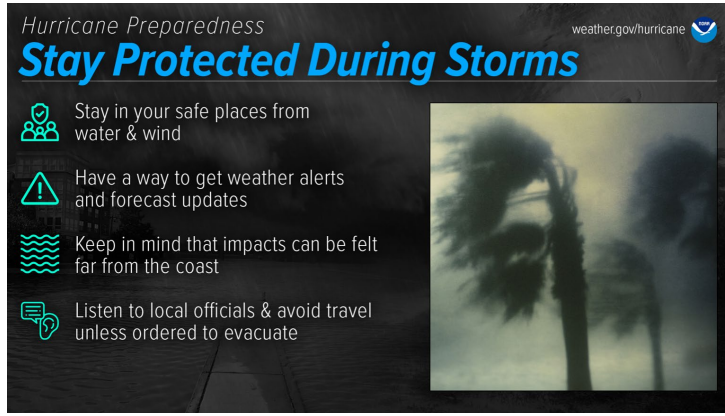
Tropical Storm & Hurricane Watches & Warnings

Sustained Winds	Tropical Storm ≥ 39 mph	Hurricane ≥ 74 mph
Watch	Potential within 48 hrs	
Warning	Expected within 36 hrs	



Wind Risk Messaging





Recap…

What are some dangers with using just deterministic wind speed data for tropical cyclones?

Does not account for forecast uncertainties

Does not account for risk

Could motivate under preparedness

Recap…

What are some tools available to help you assess wind risk?

Forecast Cone (deterministic caution!)

NHC Wind Speed Probabilities (probability power)

Hurricane Threat & Impact Graphics (probability power)

HURREVAC (deterministic radii caution!)

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Extreme Winds & Tornadoes

When Hurricane Winds Turn Violent

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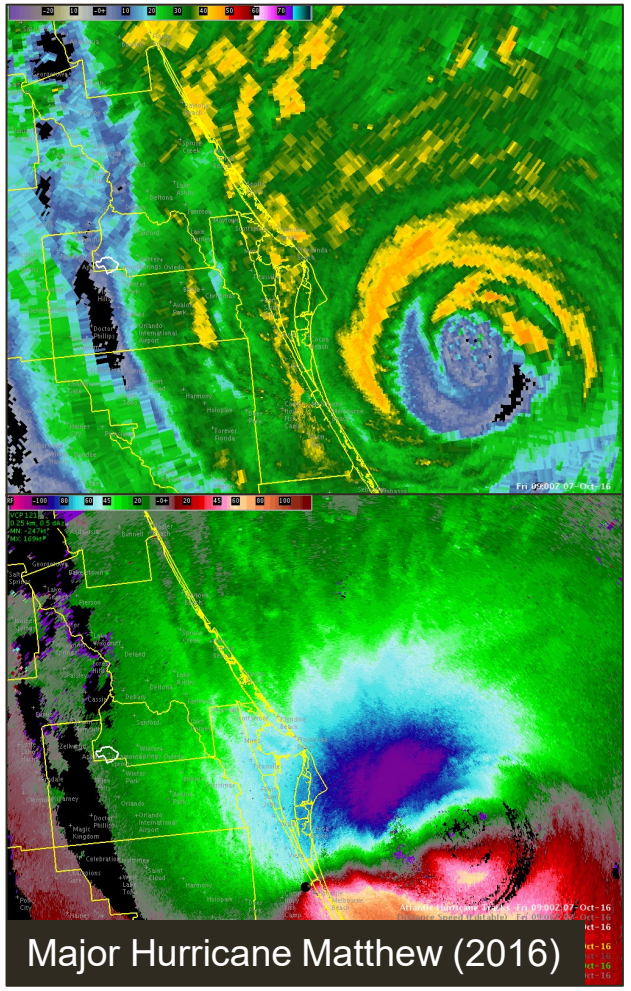
Training Session 17

The Nature of Extreme Winds

- Occurrence in any one location is a rare event
- Lives greatly imperiled; devastating/catastrophic damage
- Exponential increase in impacts; increased projectile loading
- Numerous rescues; difficult initial response
- Collapsed community infrastructure; longer-term recovery



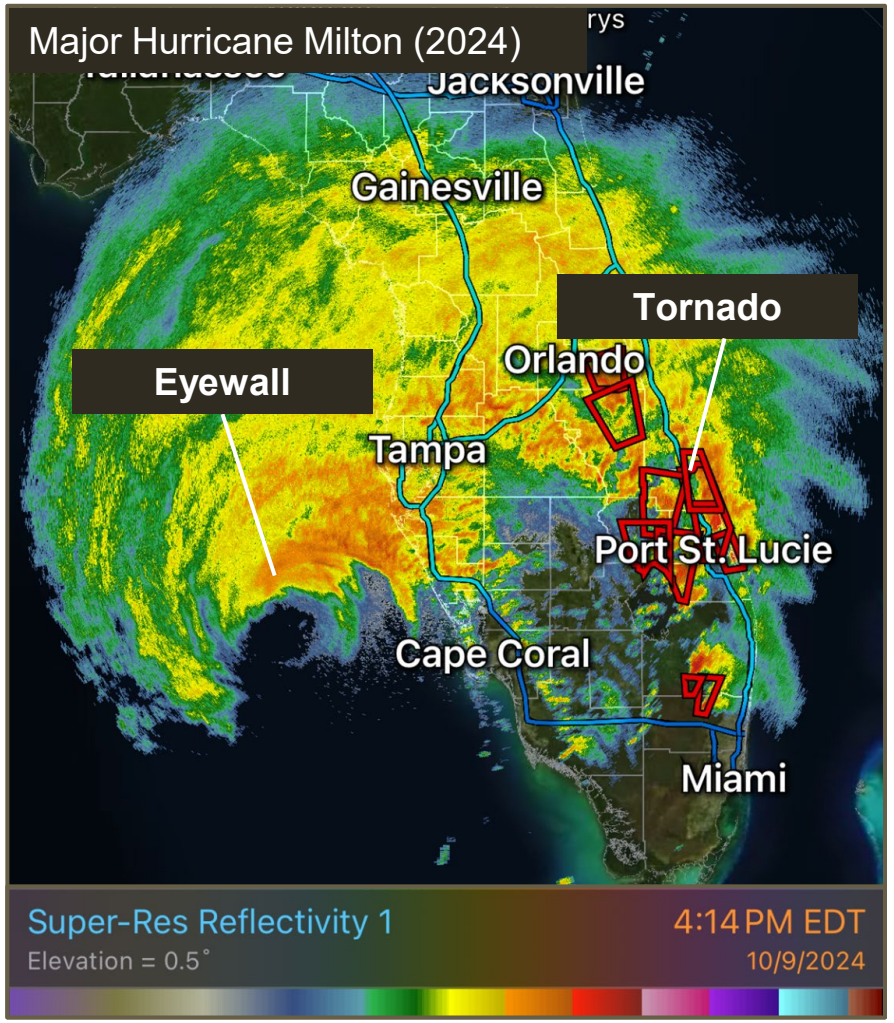
Major Hurricane Matthew (2016)

Wind-Related Deaths in Hurricanes

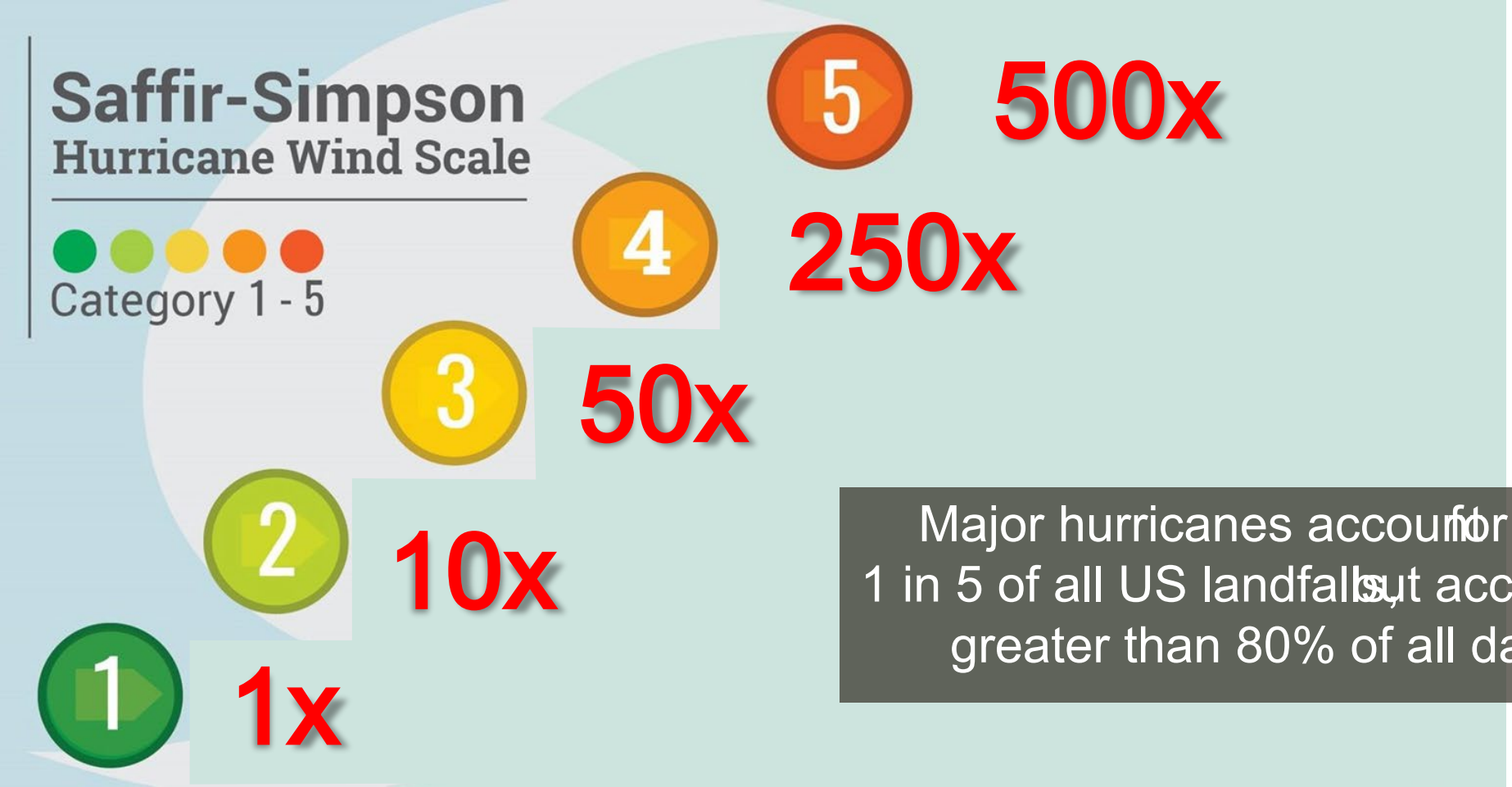
Occur in two well-defined areas

1. The **strongest and most-damaging winds** occur in the eyewall, associated with the innermost rainband.

2. **Tornadoes** often develop within one or more primary outer rainbands, several hundreds of miles from the center, within the right-front quadrant of a storm.



Hurricane Damage Potential

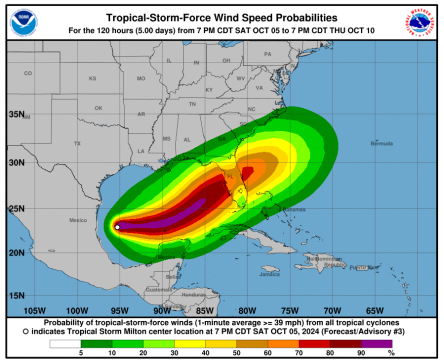


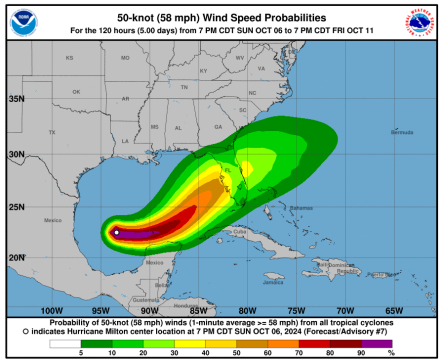
Major hurricanes account for only 1 in 5 of all US landfalls, but account for greater than 80% of all damage

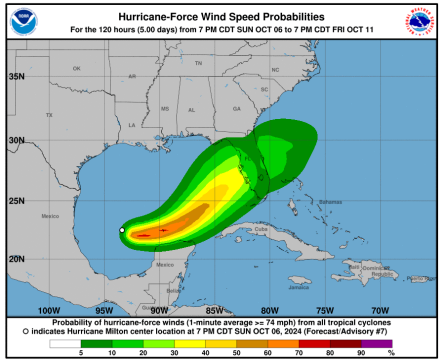
Extreme Winds - Hurricane Michael

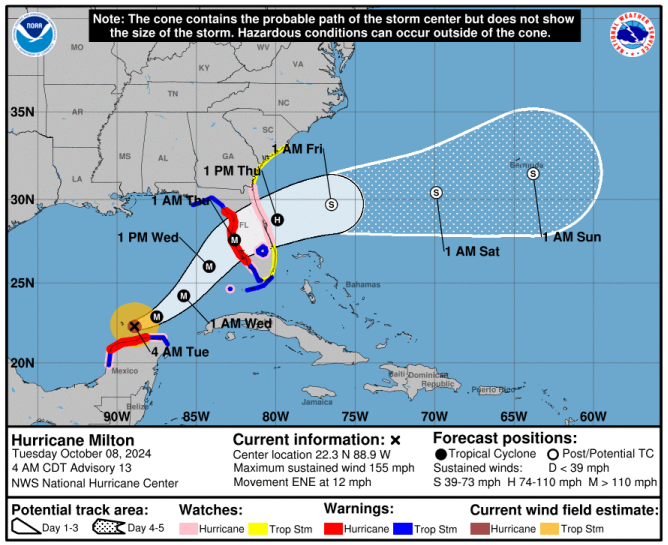
Helping those who are trying desperately to *“hide from extreme winds.”*

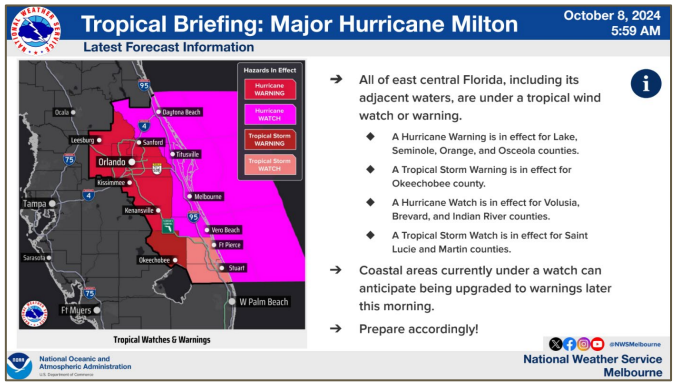
Gauging Risk of Extreme Winds

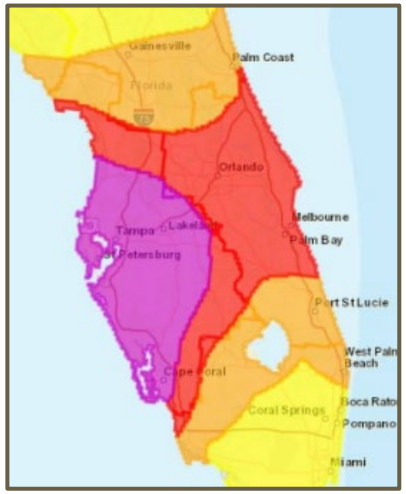








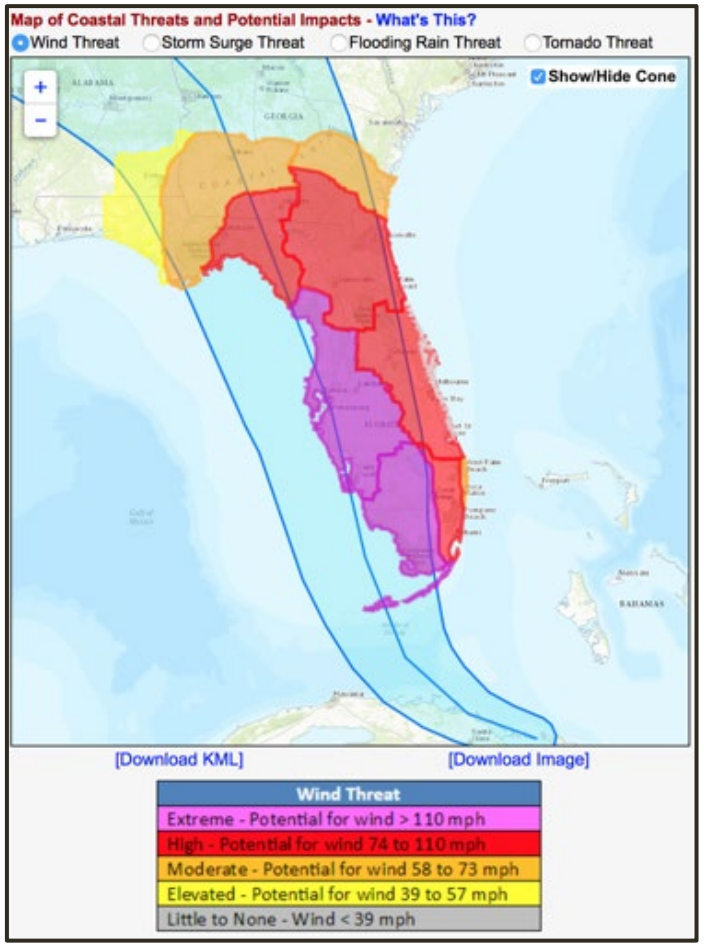




Wind Threat	Potential Impacts From Wind
EXTREME Potential for wind greater than 110 mph	DEVASTATING TO CATASTROPHIC To be safe, aggressively prepare for the potential of devastating to catastrophic wind impacts from major hurricane force wind of equivalent Category 3 intensity or higher.
HIGH Potential for wind 74-110 mph	EXTENSIVE To be safe, aggressively prepare for the potential of extensive wind impacts from hurricane force wind of equivalent Category 1 or 2 intensity.
MODERATE Potential for wind 58-73 mph	SIGNIFICANT To be safe, earnestly prepare for the potential of significant wind impacts from strong tropical storm force wind.
ELEVATED Potential for wind 39-57 mph	LIMITED To be safe, prepare for the potential of limited wind impacts from tropical storm force wind.
LITTLE TO NONE Wind less than 39 mph	LITTLE TO NONE No immediate preparations needed; little to no wind impacts

Examples of NHC & NWS Products from Major Hurricane Milton (2024)

HTI - Hurricane Threats & Impacts



Community Plans and Preparations
Potential for Extreme Wind greater than 110 mph • Plan for extremely dangerous and life-threatening winds of major hurricane force. Prepare for the possibility of devastating to catastrophic wind damage.
Potential for Wind 74-110 mph • Plan for dangerous and life-threatening winds of hurricane force. Prepare for the possibility of considerable wind damage.
Potential for Wind 58-73 mph • Plan for dangerous winds of strong tropical storm force. Prepare for the possibility of significant wind damage.
Potential for Wind 39-57 mph • Plan for hazardous winds of tropical storm force. Prepare for the possibility of limited wind damage.
Potential for Wind less than 39 mph

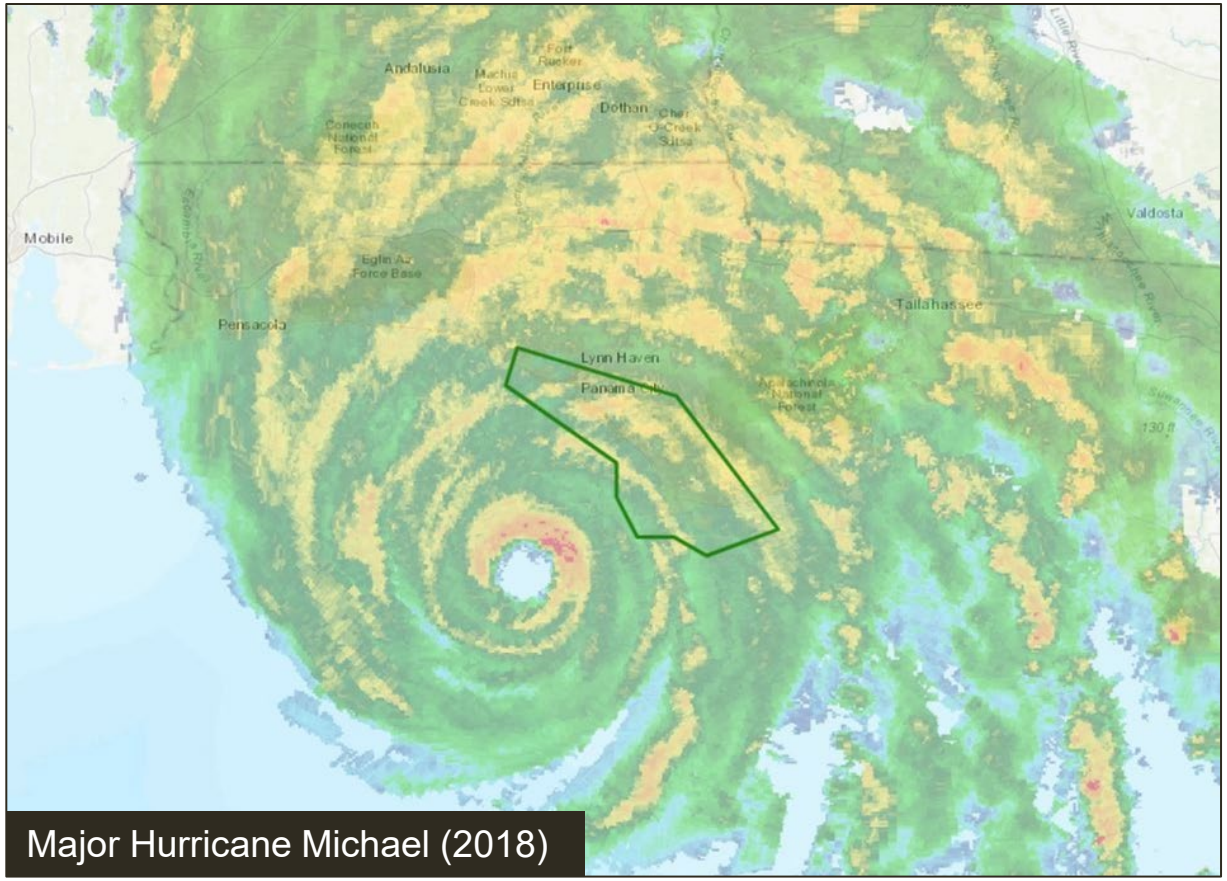
HTI Products from Major Hurricane Ian (2022)

Extreme Wind Warning - Product

"...a short-term, "short-fused" alert issued to signal an imminent threat to life and property, requiring immediate shelter."

Issuance Criteria (*both must be met*)

- **The hurricane is category 3 or greater**
- **Sustained winds of 100 kt (115 mph) or greater are expected within 1 hour**



Major Hurricane Michael (2018)

Extreme Wind Warning - Messaging

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BULLETIN - EAS ACTIVATION REQUESTED
Extreme Wind Warning
National Weather Service Tallahassee FL
808 AM EDT Wed Aug 30 2023

The National Weather Service in Tallahassee has issued a

* Extreme Wind Warning for...
  North central Taylor County in Big Bend Florida...
  Madison County in Big Bend Florida...

* Until 1115 AM EDT.

* At 808 AM EDT, National Weather Service Doppler radar and surface
  observations indicated extreme winds, associated with the eyewall
  of Hurricane Idalia, were moving onshore 9 miles east of Perry,
  moving northeast at 35 mph. THIS IS AN EXTREMELY DANGEROUS AND
  LIFE-THREATENING SITUATION!

* Locations impacted include...
  Madison, Lee, Lake Bird, Moseley Hall, Hopewell, Cherry Lake,
  Hamburg, Hanson, Pinetta, and Shady Grove.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

The safest place to be during a major landfalling hurricane is in a
reinforced interior room away from windows. Get under a table or
other piece of sturdy furniture. Use mattresses, blankets or pillows
to cover your head and body. Remain in place through the passage of
these life-threatening conditions.

&&

A Tornado Watch remains in effect until 300 PM EDT for Big Bend
Florida.

LAT...LON 3037 8319 3035 8319 3035 8321 3031 8321
      3029 8323 3026 8324 3026 8347 3031 8348
      3016 8371 3064 8350 3063 8328 3059 8326
      3055 8326 3052 8324 3047 8324 3046 8322
      3042 8322 3041 8319 3039 8317
TIME...MOT...LOC 1208Z 217DEG 32KT 3015 8343

$$

21-HANER
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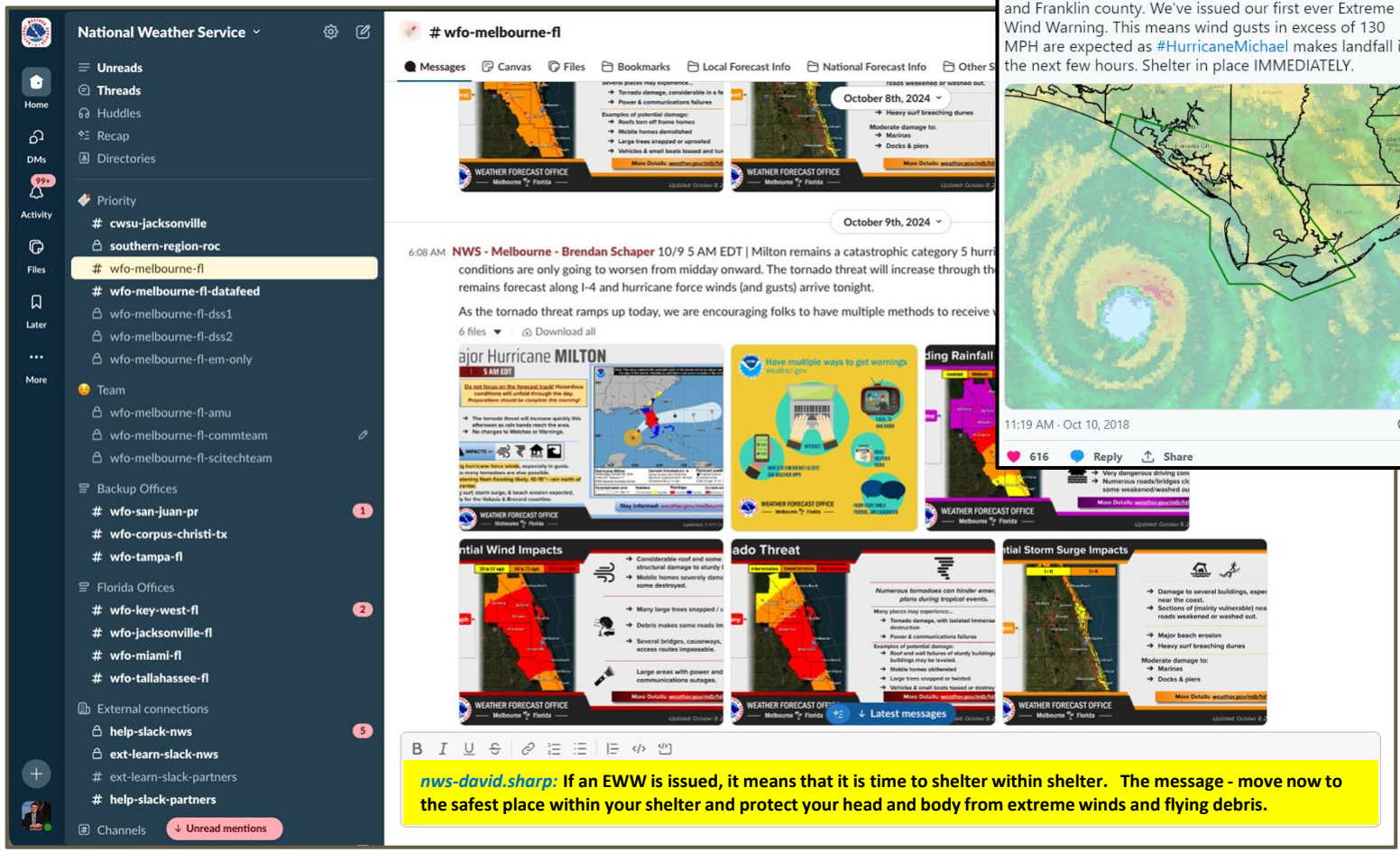


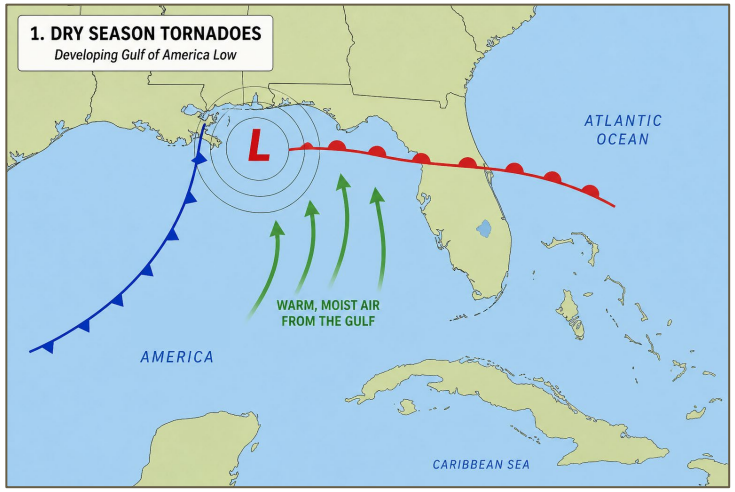
GOVERNOR'S HURRICANE CONFERENCE®

Tropical Cyclone Tornadoes

Will Ulrich, NWS Melbourne
william.ulrich@noaa.gov

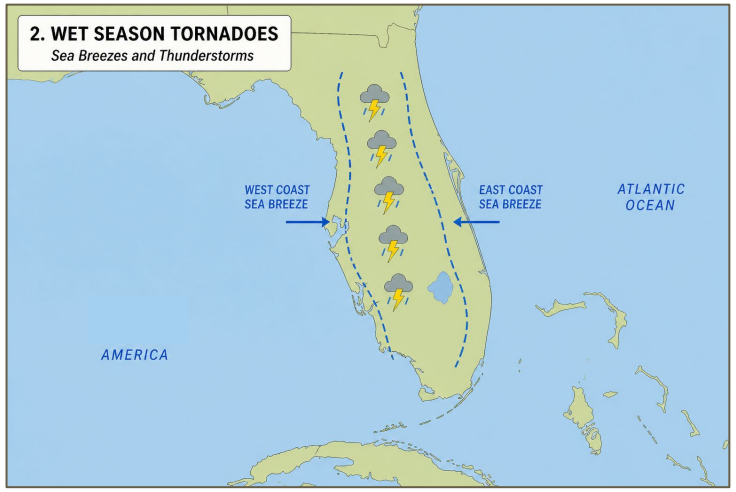
Training Session 17

Florida Tornado Conceptual Models



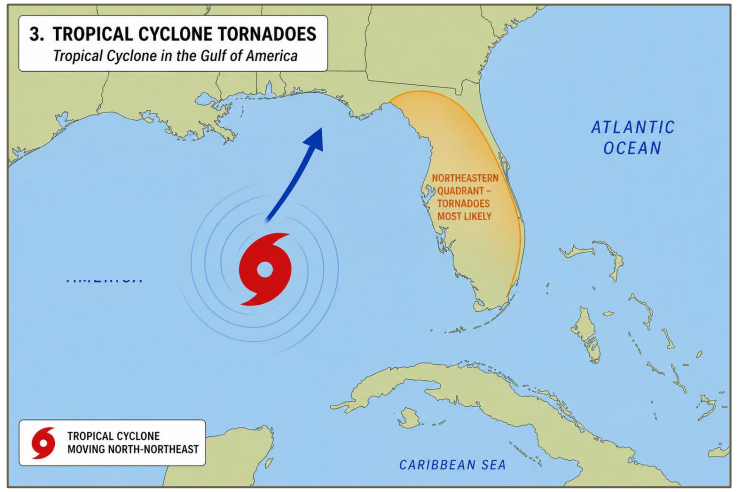
Dry Season Tornadoes

- November - April
- Often the deadliest and strongest
- Driven by large-scale (synoptic) weather systems, particularly frequent during El-Nino winters
- Strong to violent EF-2 & EF-3 more common
- February 1998 & 2007



Wet Season Tornadoes

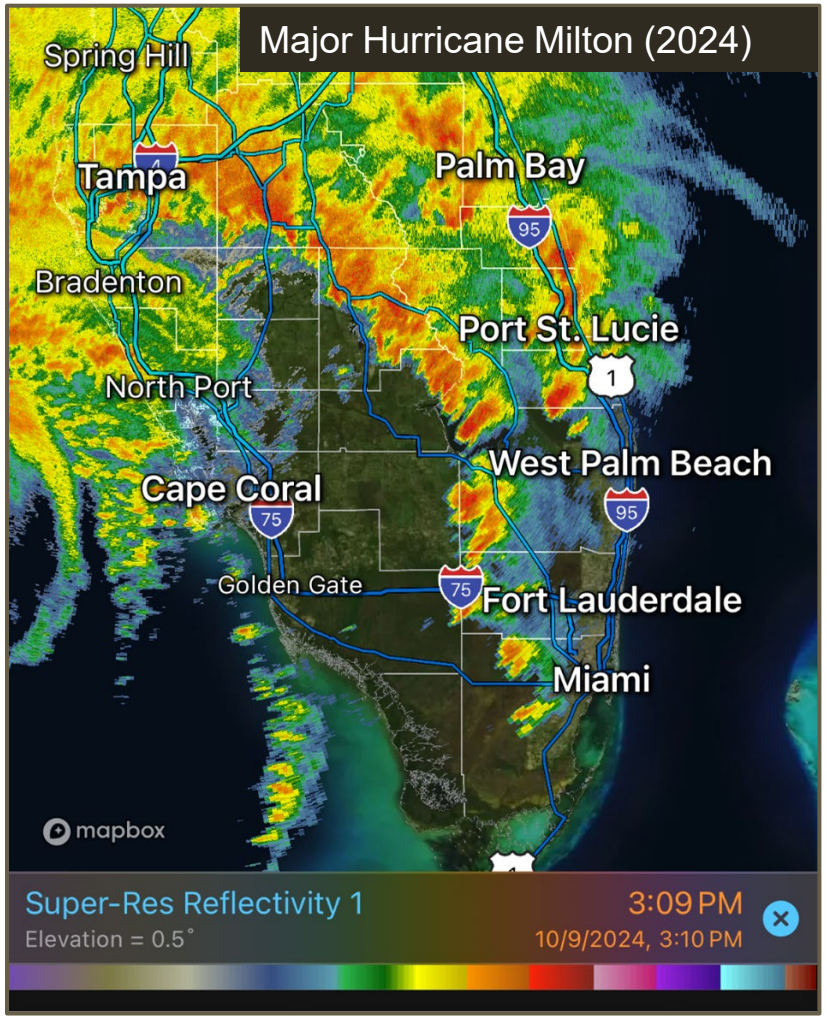
- May - October
- Localized, often short-duration
- Often associated with daily sea-breeze thunderstorms
- Tornadoes most common, but often EF-0 & EF-1



Tropical Cyclone Tornadoes

- August - October
- Most common in northeast quadrant of storm where wind shear is maximized
- Often fast-moving and occur in families
- Can occur well away from the center of the storm!

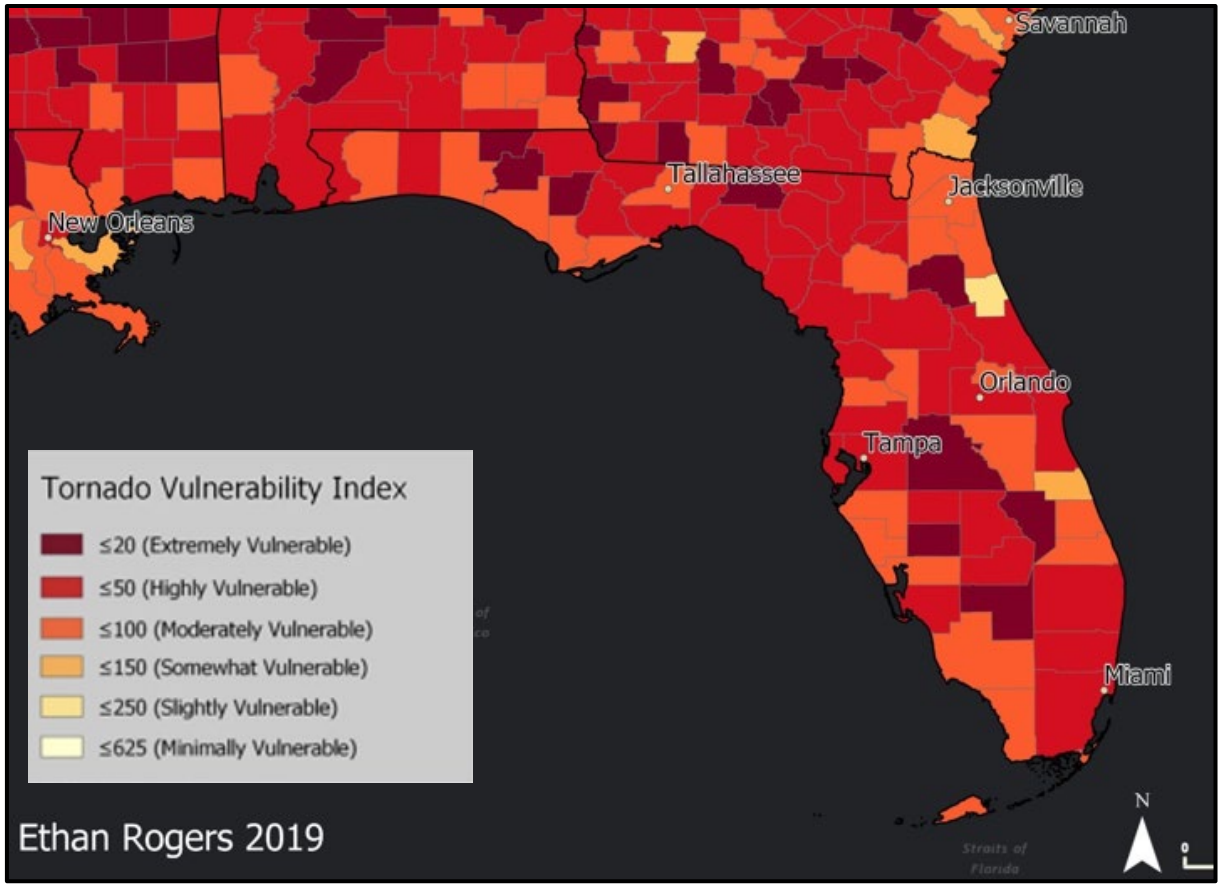
Tropical Cyclone Tornadoes



The Challenge…

- Predicting tornadoes outside of areas where people are prepared for hurricane conditions
- Predicting tornadoes from weaker systems
- Minimize the amount of over-warning
- Successfully messaging all of the above

Understanding Risk



Risk =

Likelihood x

frequency, numerous circulations

Consequence x

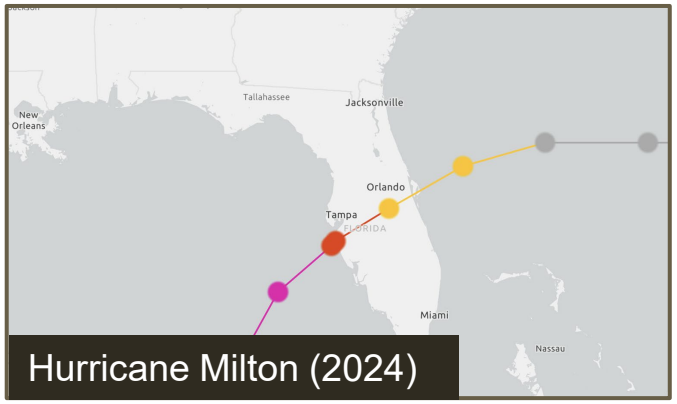
storm intensity, EF0-EF1-EF2-EF3 damage

Vulnerability

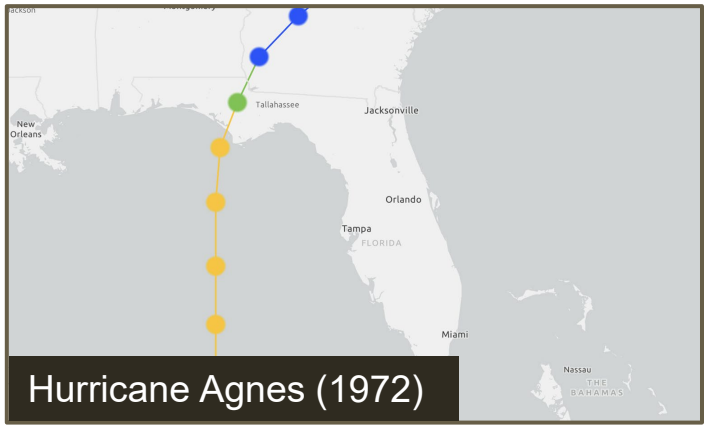
community considerations, i.e. population density, wealth, mobile homes, exposure

Deadliest Tropical Tornado Events

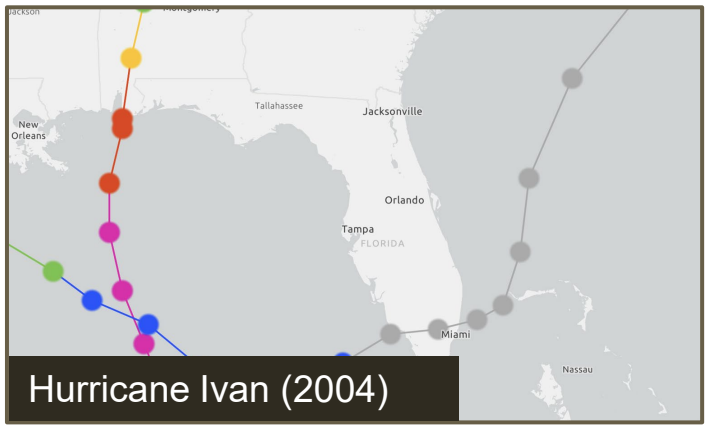
Event	Date	Deaths	Injuries
Hurricane Agnes	Jun. 1972	7	140+
Hurricane Milton	**Oct. 2024**	**6**	**30+**
Hurricane Ivan	Sep. 2004	6	15+
Hurricane (Unnamed)	Sep. 1882	6	15+



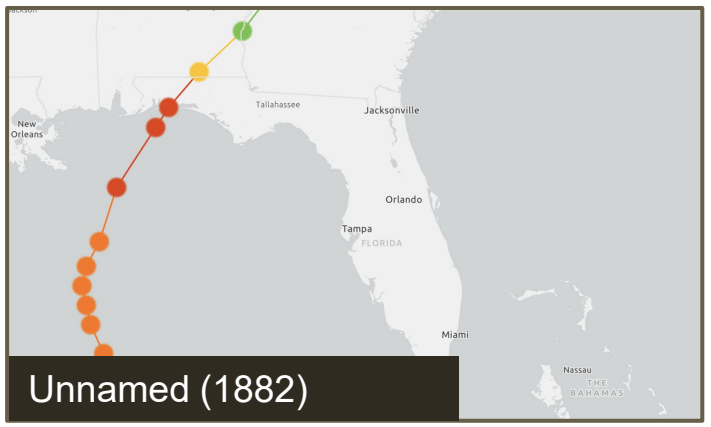
Hurricane Milton (2024)



Hurricane Agnes (1972)

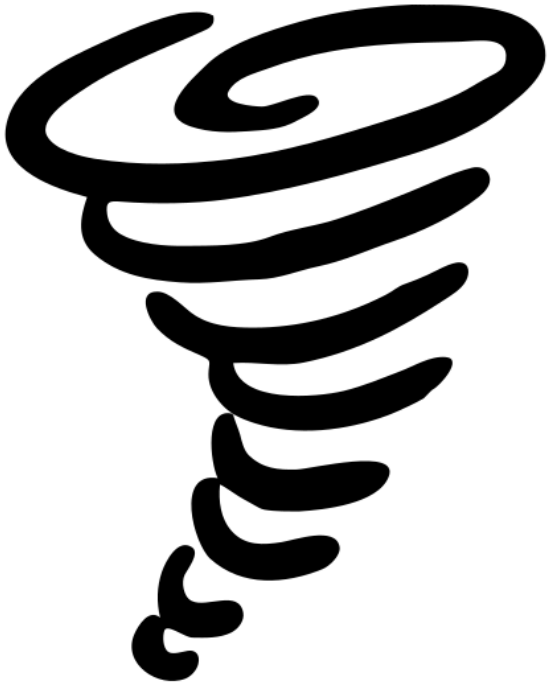


Hurricane Ivan (2004)



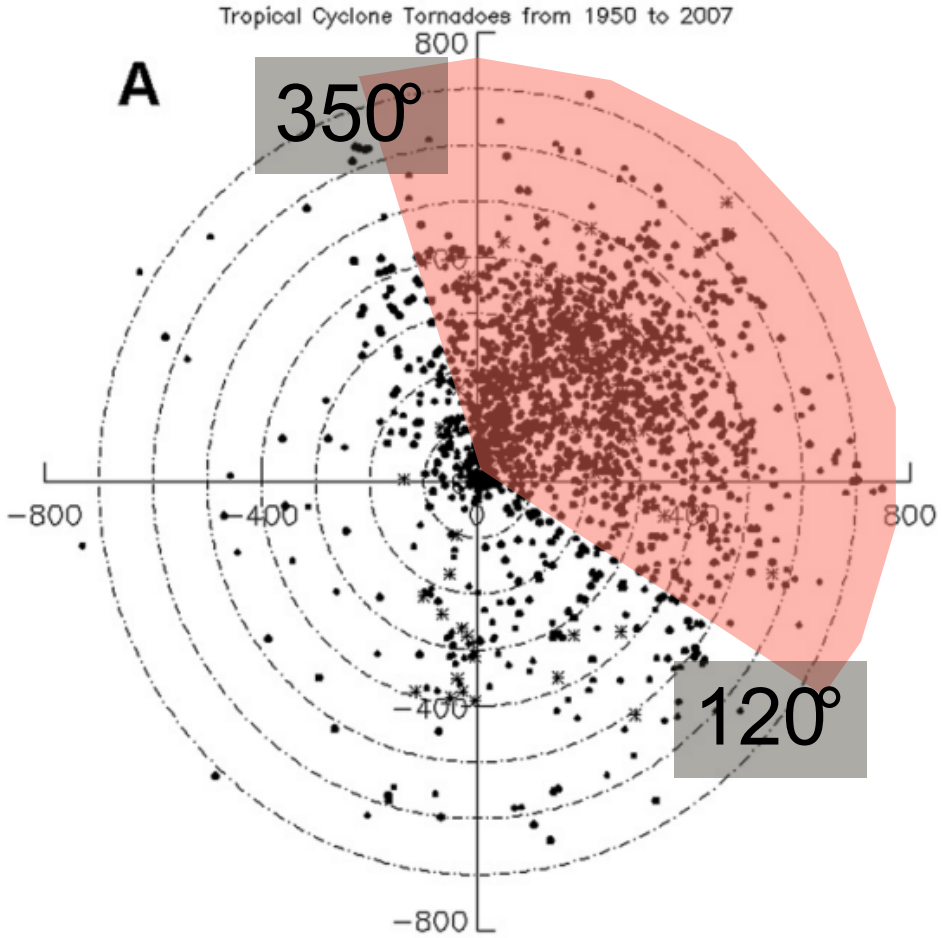
Unnamed (1882)

Forecasting TC Tornadoes



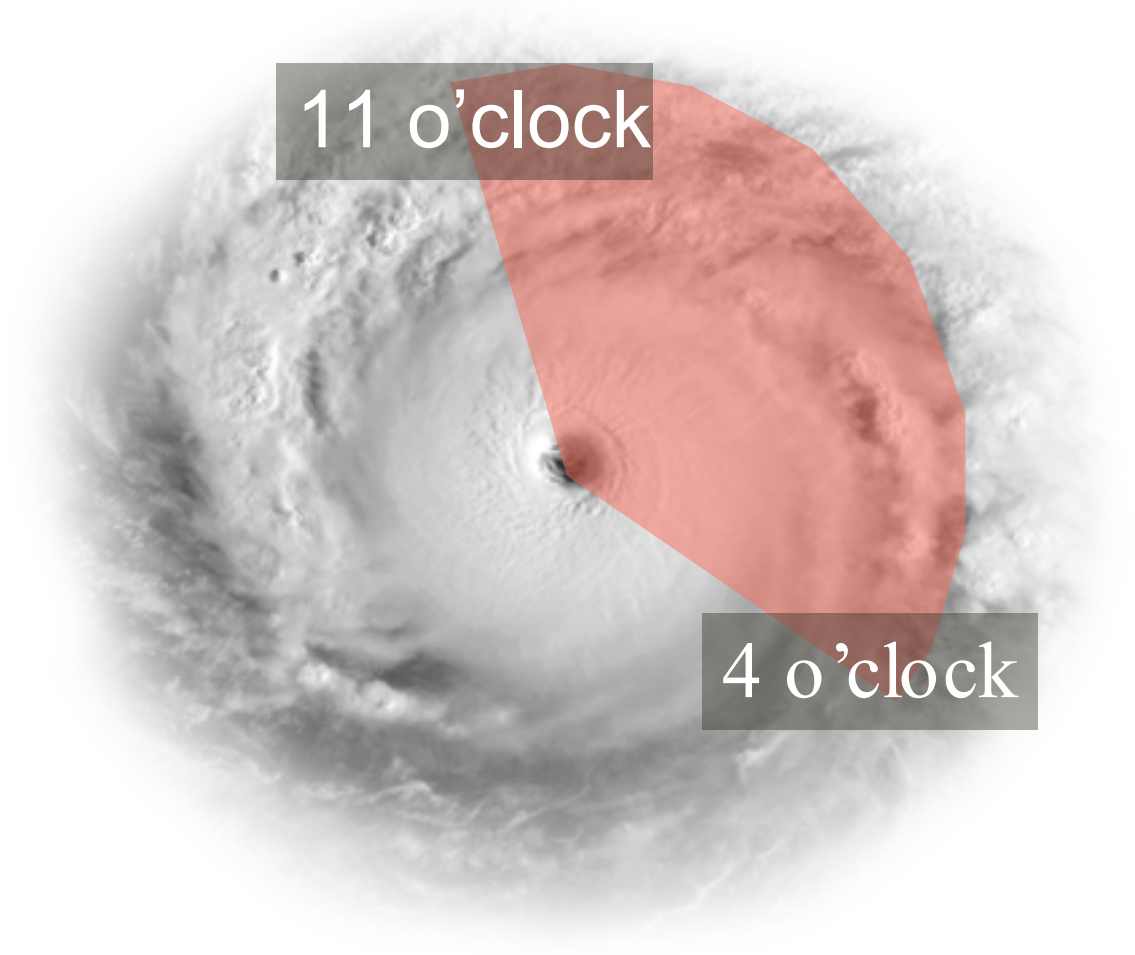
- **Diagnosing the local tornado hazard**
  - Strong low-level wind shear is maximized in the right-front quadrant of a storm
  - Pockets of dry air enhance instability and isolate cells
  - Interactions with other weather features like fronts, boundaries, troughs, etc.
- **Threat can linger for days**
  - Multiple 12-hour Tornado Watches possible, especially for slow-moving systems

Forecasting TC Tornadoes



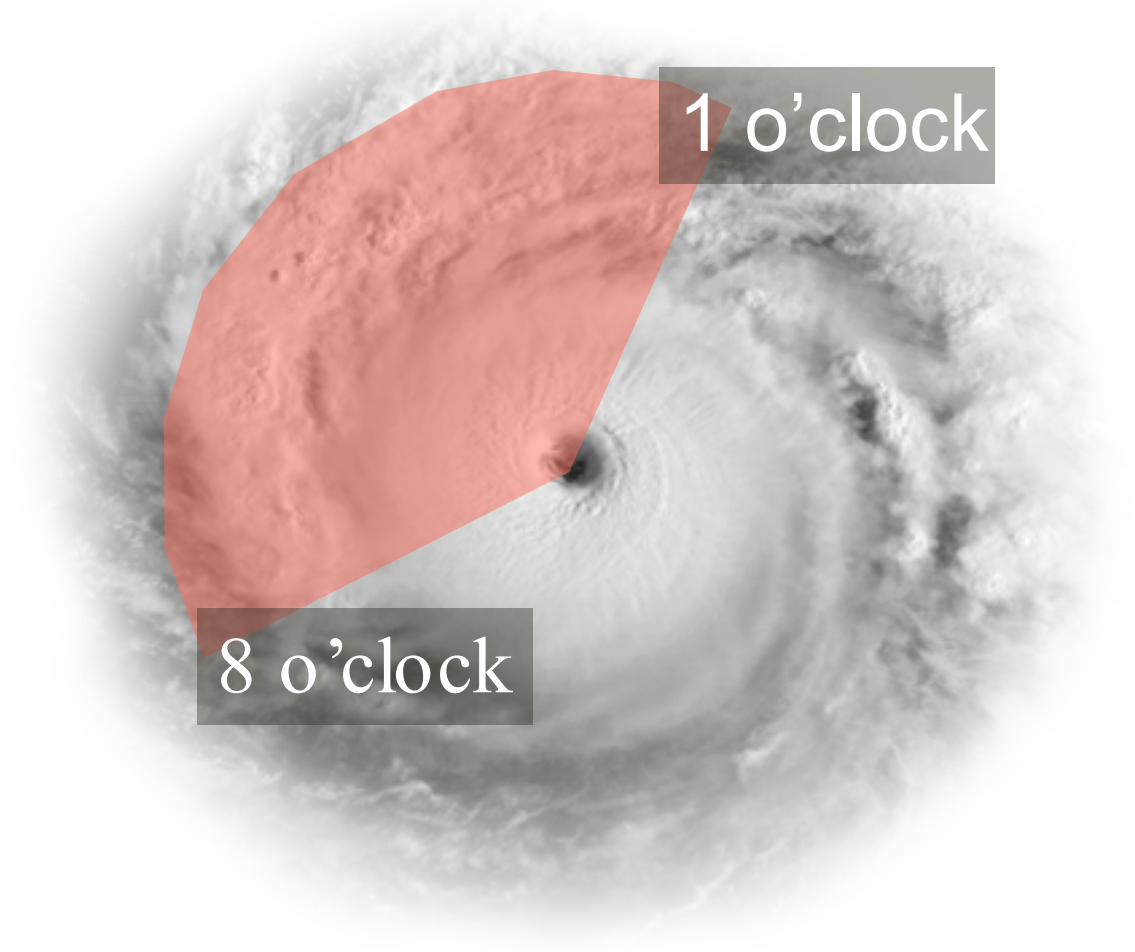
- **Most tornadoes occur within the right-front quadrant of a tropical cyclone**
- **80% of tornadoes occur within 350° to 120° relative to the storms motion**

Example - Northeast Quadrant



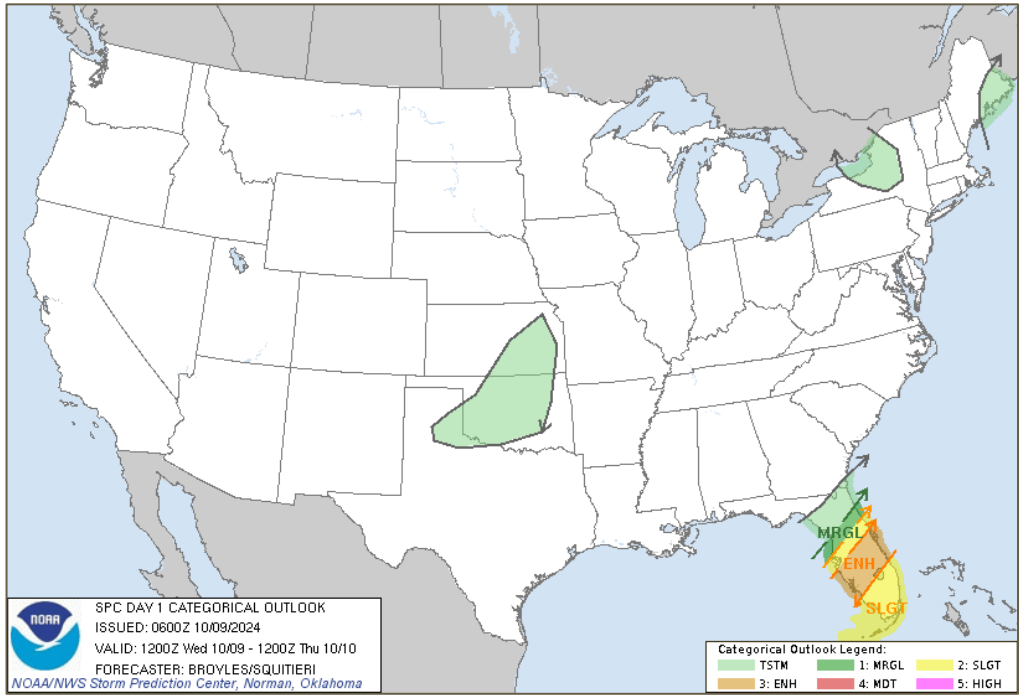
Northward Moving System

Forecasting TC Tornadoes



Westward Moving System

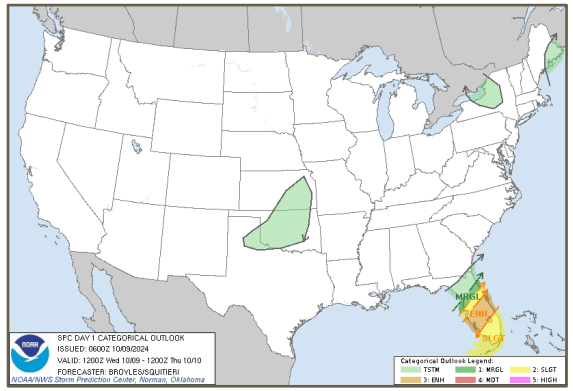
SPC Severe Weather Outlooks

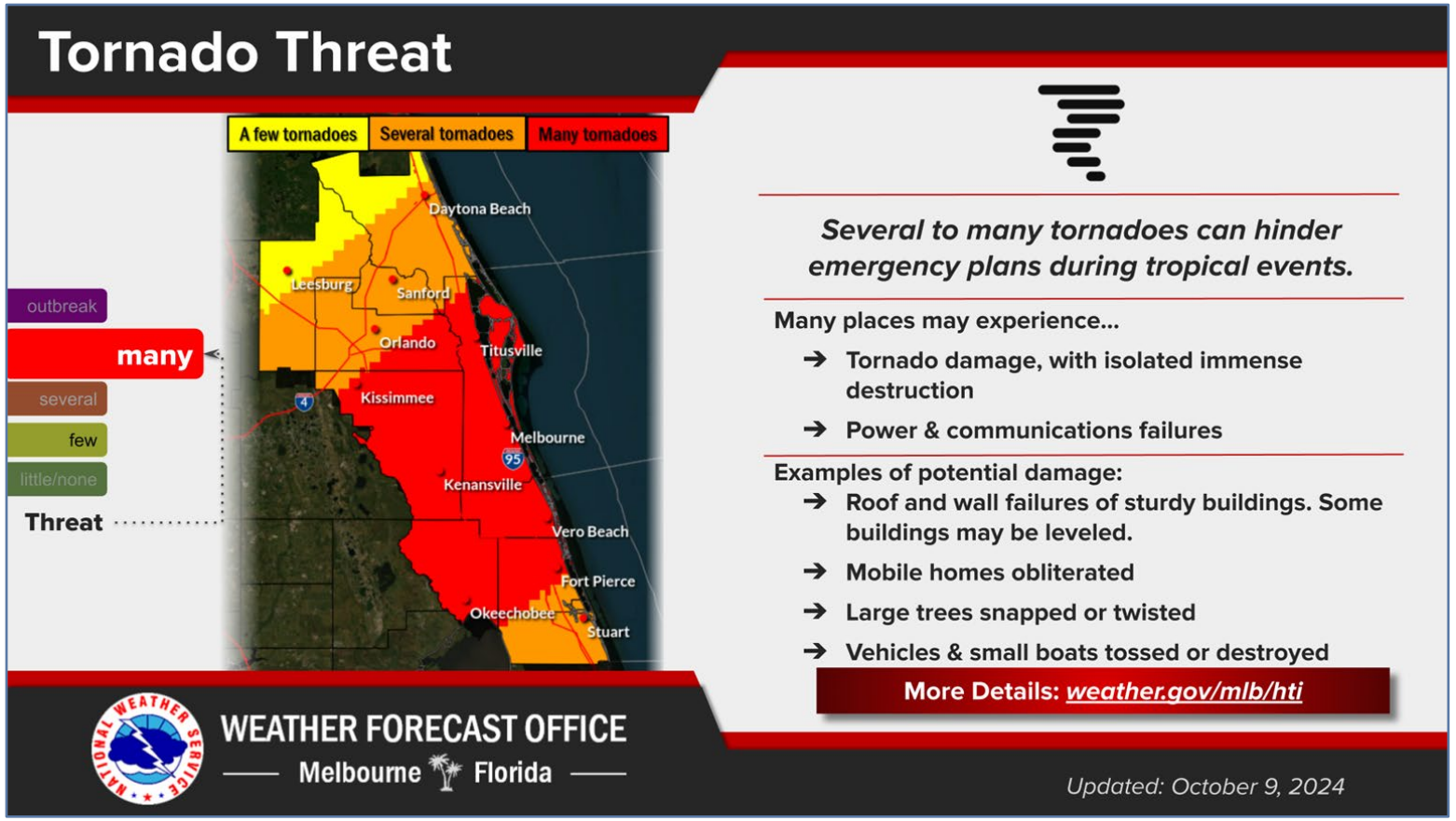


SPC Day 1 Severe Weather Outlook
Hurricane Milton
October 9, 2024

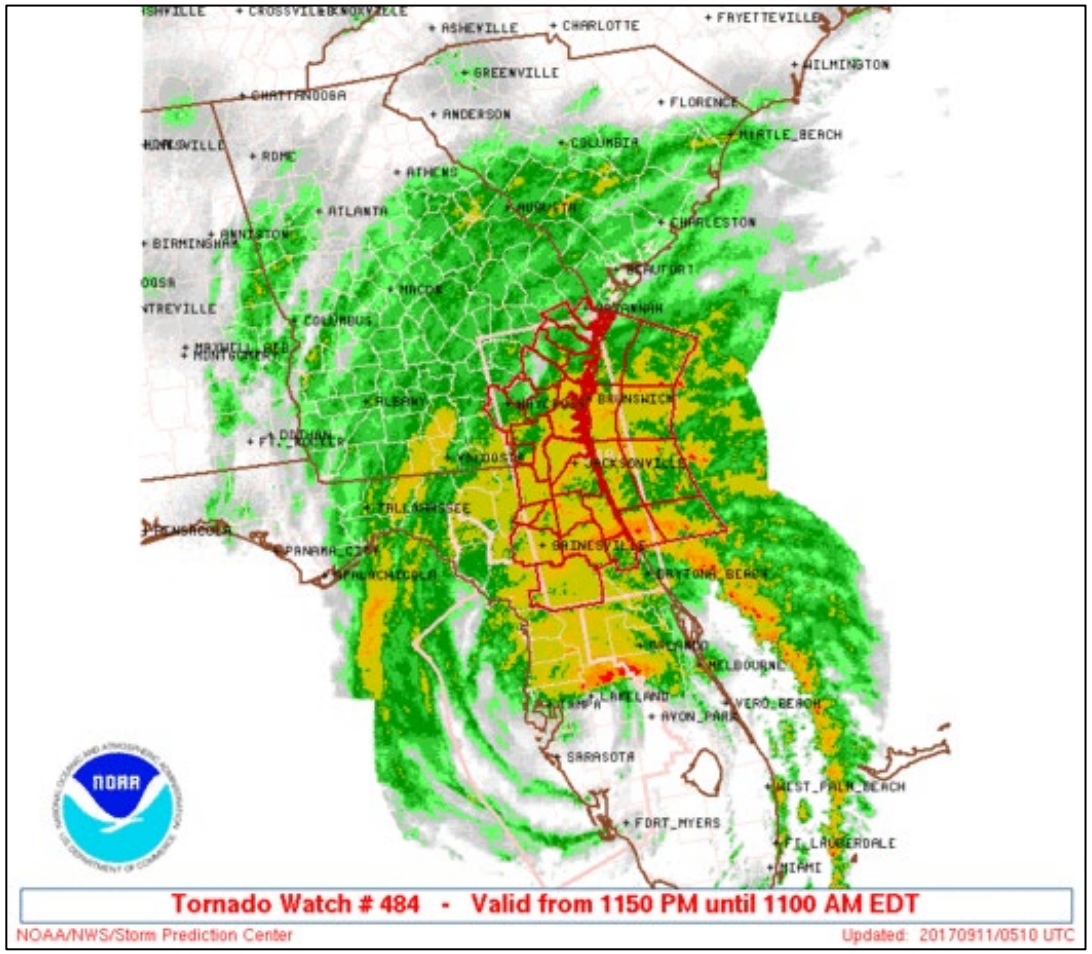
- **Based on probabilities of severe thunderstorms or tornadoes within 25 nm of a point.**
- **Day 1, 2, 3, 4-8 products**
- **Threat area usually not defined until Day 2 or 3 given track uncertainty**
- **Areas better defined as time to impact lessens**

Local Threat Assessment





Tornado Watches



- Issued by SPC in close coordination with local NWS offices
- Often issued for the favored “right front” quadrant of a storm
- Typically issued for 12-hours (vs. 8-hours for non-TC events)

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...

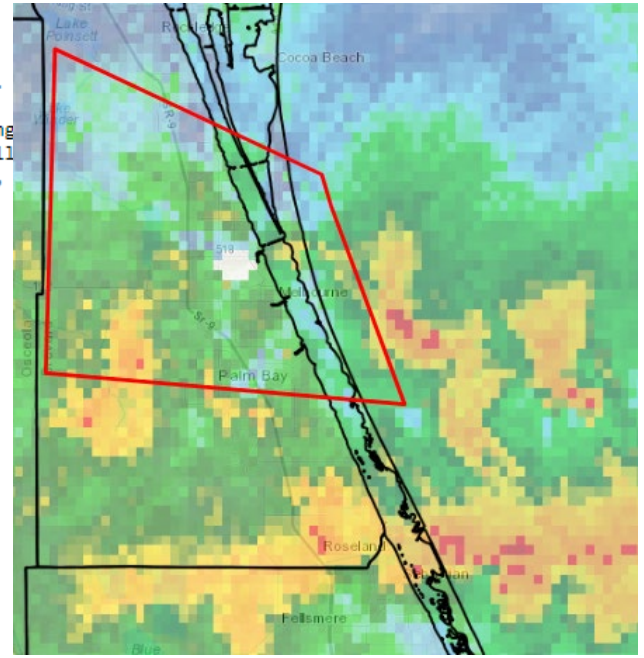
* Until noon EDT

* 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 dang
           shelter. Mobile homes will
           Damage to roofs, windows,
           damage is likely.



- **Challenges**
  - Cells are fast moving (often 60+ mph)
  - Circulations develop and dissipate quickly
  - Multiple circulations at the same time
- **Can lead to over-warning and can be difficult to issue with long-lead times!**

GOVERNOR'S HURRICANE CONFERENCE®

The Combined Tropical Water Hazards

Jon Rizzo - NWS Key West jonathan.rizzo@noaa.gov

Kelly Godsey - NWS Tallahassee kelly.godsey@noaa.gov

Training Session 17

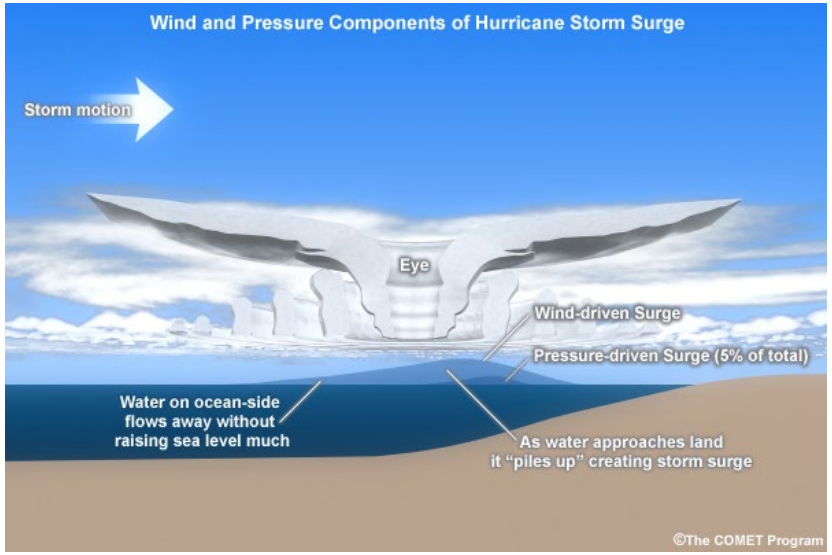
Tropical Cyclone Storm Surge Topics

Storm Surge and Influencing Factors

Ensemble and Probabilistic Forecasts

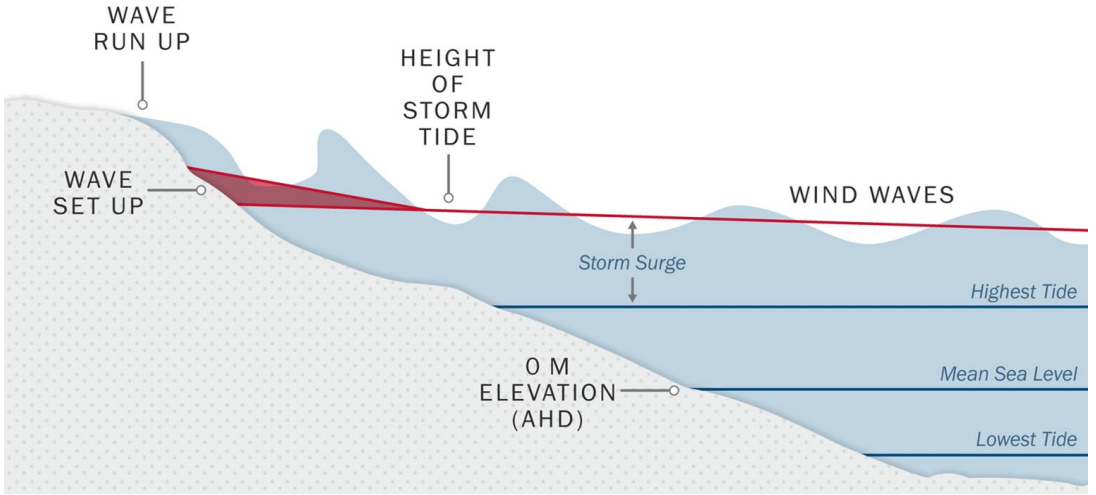
Storm Surge Risk Forecasts & Applications

Storm Surge and Total Water Level

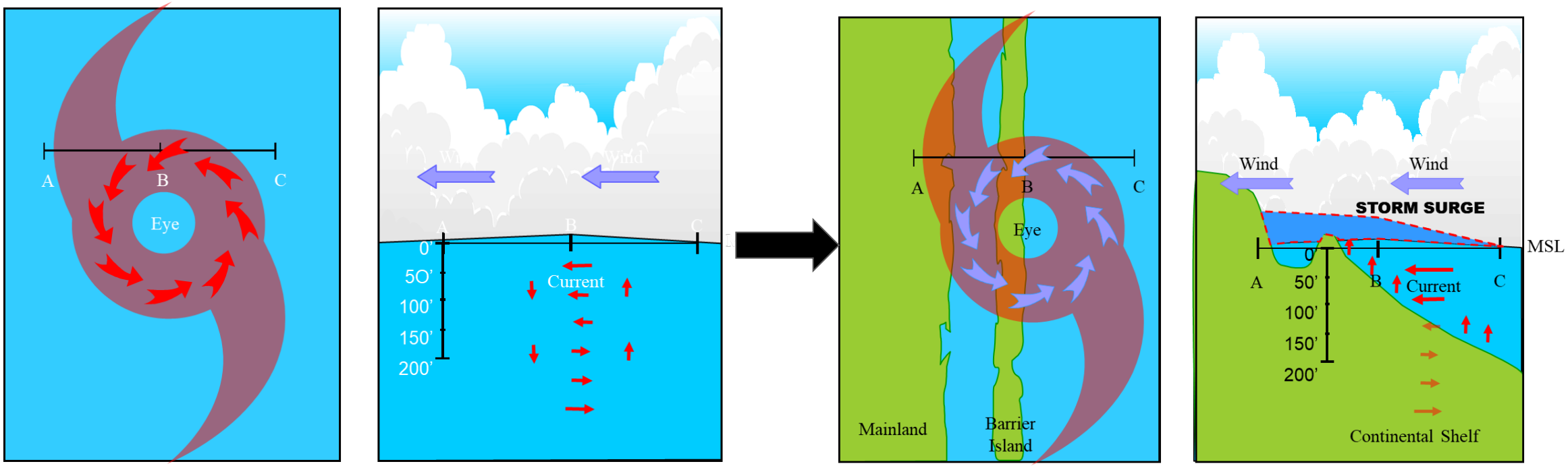


- Definition: An abnormal water level rise generated by a hurricane or tropical storm over and above the predicted astronomical tide.
- Cause: Primarily by the strong onshore winds produced by a hurricane or tropical storm.
- Duration: As long as the winds blow onshore, the water continues to rise. Waters may not recede until winds are well-below tropical storm force.

- Storm Tide: The water level rise due to the combination of storm surge & astronomical tide.
- Wave set-up: The increase in average water level at the shoreline caused by breaking waves in the surf zone.
- Wave run-up: The maximum height reached by waves as they rush up a breach, structure, or dune.



How Storm Surge Forms



Over the open ocean, the strong winds blowing across the water surface sets the water at and below the surface in motion. This sets up a deep circulation over 250 feet deep, and is nearly undetectable over open water.

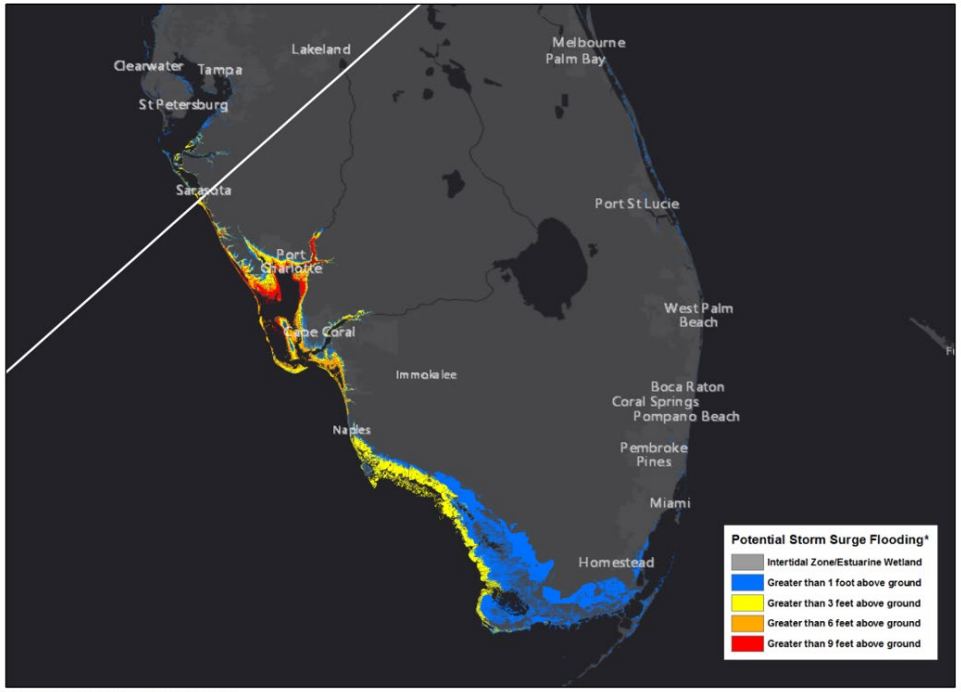
Once the hurricane reaches shallower waters near the coast, the vertical circulation in the ocean becomes disrupted by the ocean bottom. Since the water can no longer circulate downward, it has nowhere else to go but up and inland.

Factors Influencing Storm Surge

- Storm Intensity
- Forward Speed
- Size (Radius of Maximum Winds)
- Angle of Approach to Shore
- Width and Slope of the Ocean Bottom
- Shape of the Coastline and Local Features

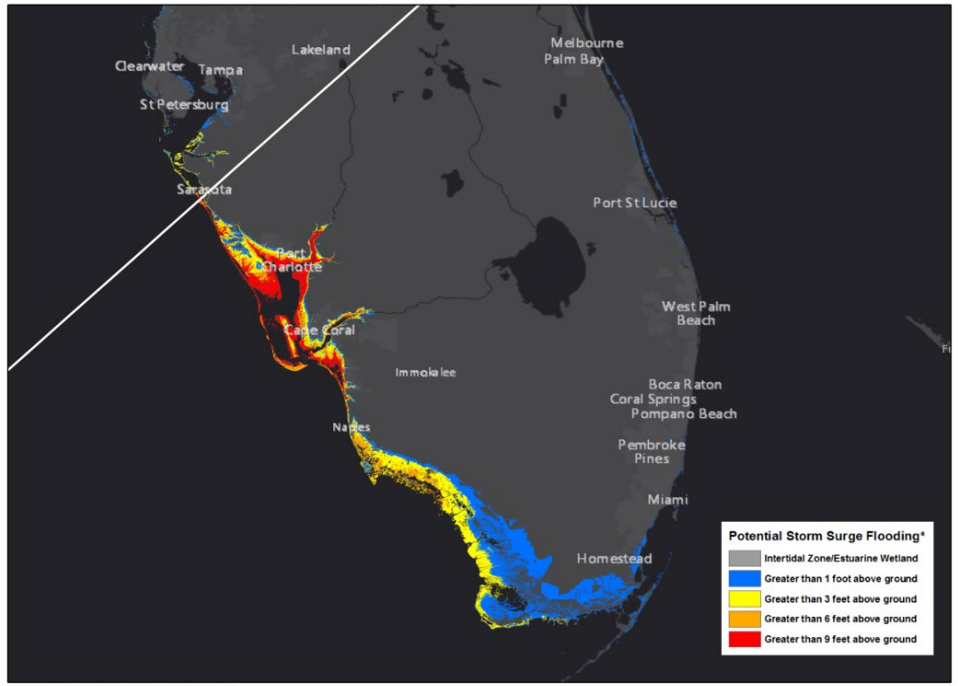
Storm Surge Influencers: Intensity

The stronger the wind; the higher the storm surge.



Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Example 1: Category 2

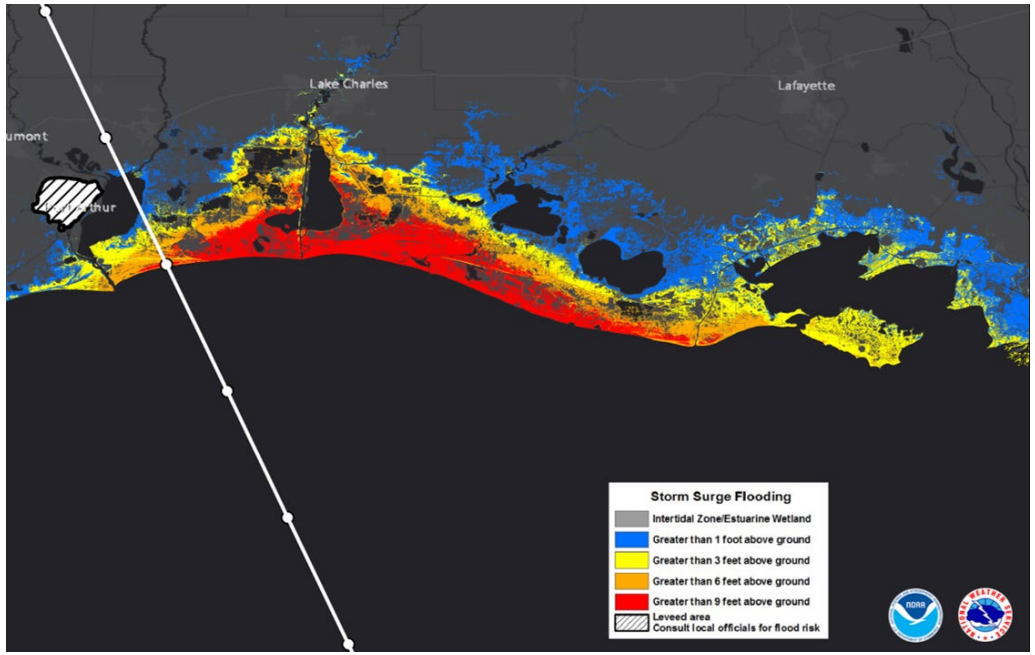


Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

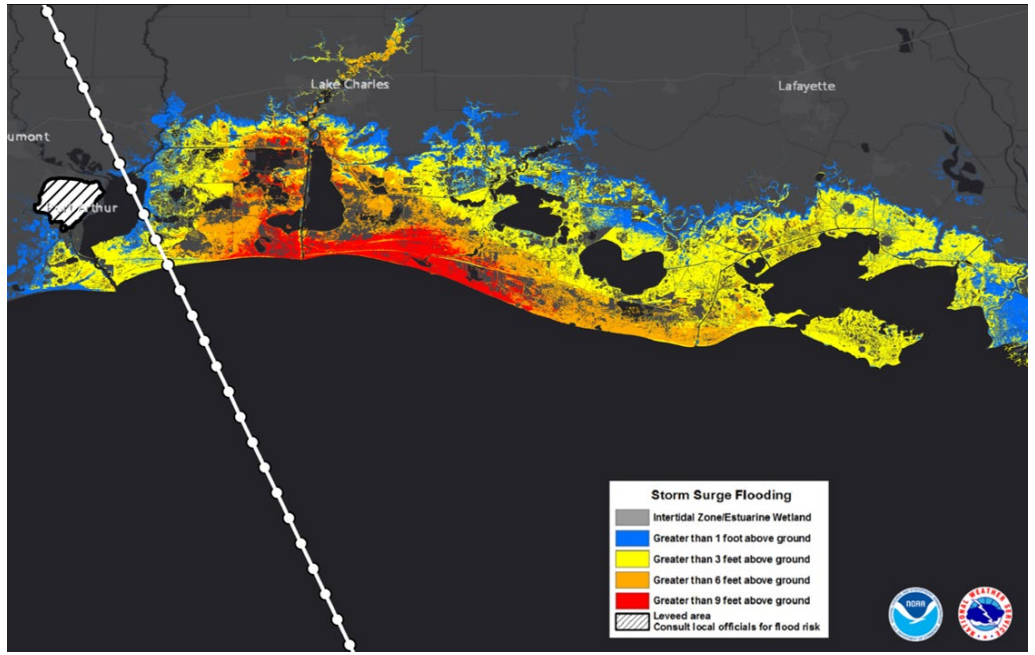
Example 1: Category 3

Storm Surge Influencers: Forward Motion

Faster storms produce higher surge at the immediate coastline; slower storms produce a surge that penetrates farther inland.



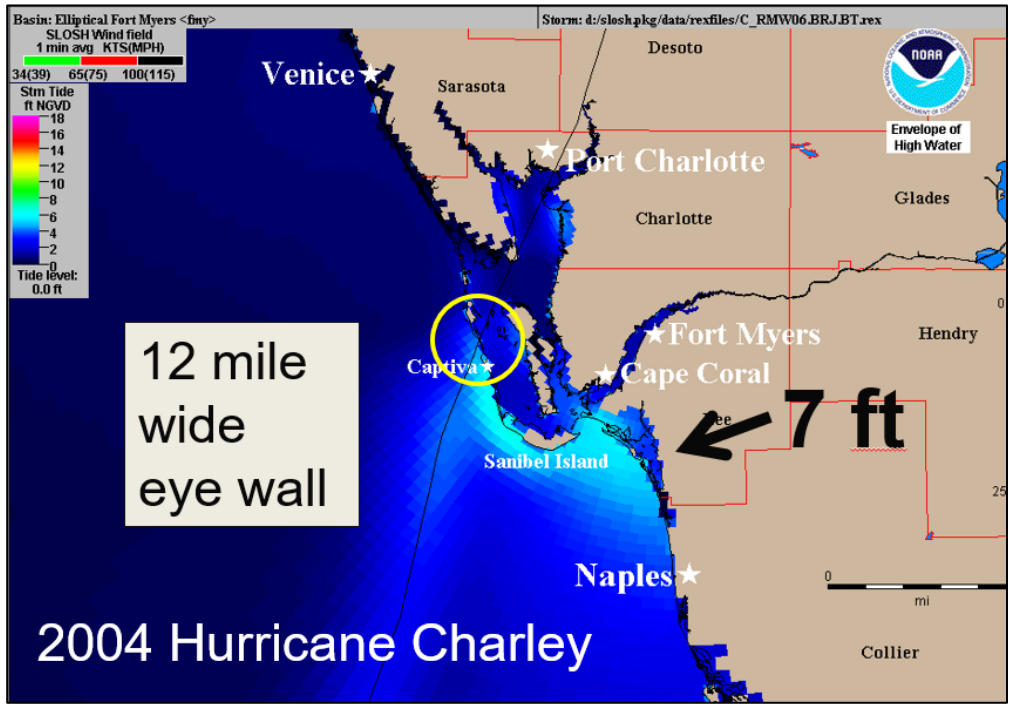
Example 1: Faster forward motion



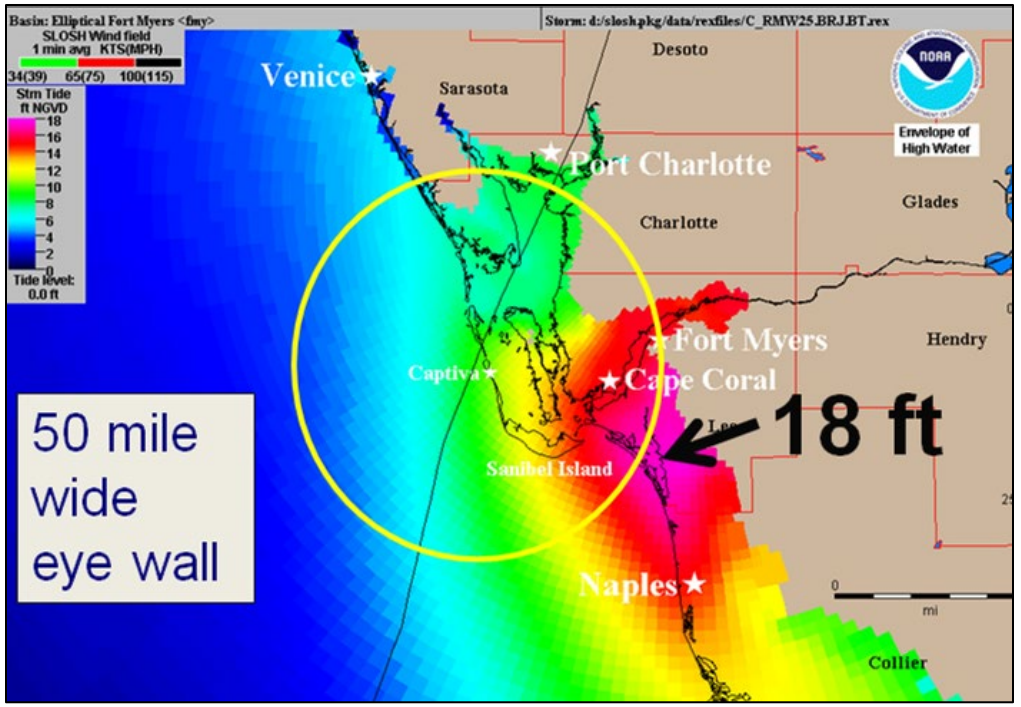
Example 2: Slower forward motion

Storm Surge Influencers: Size

The larger the storm, the higher the surge. Note the maximum storm surge will likely be further from the center of the storm.



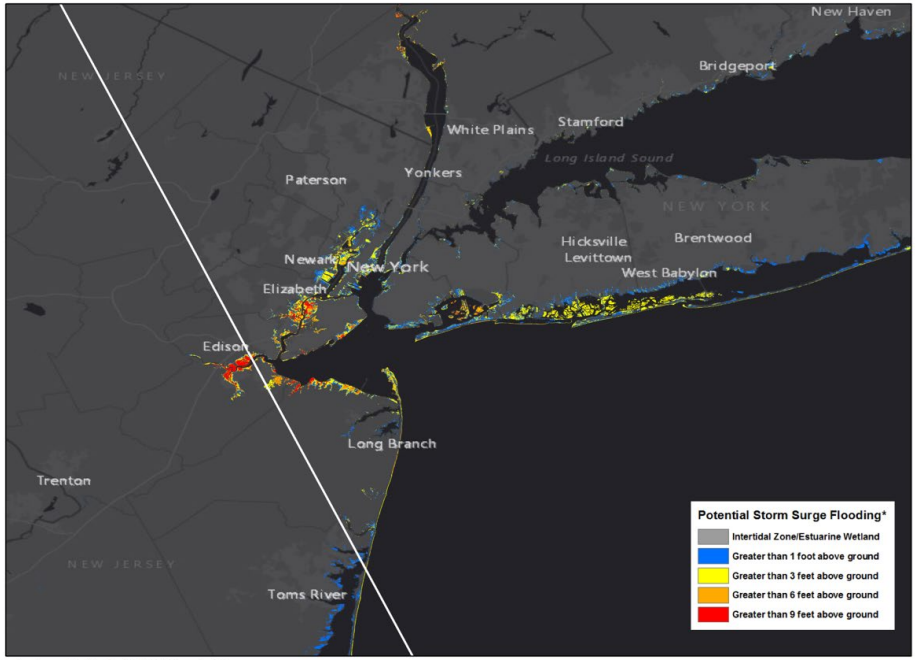
Example 1: Smaller Radius of Maximum Winds



Example 2: Larger Radius of Maximum Winds

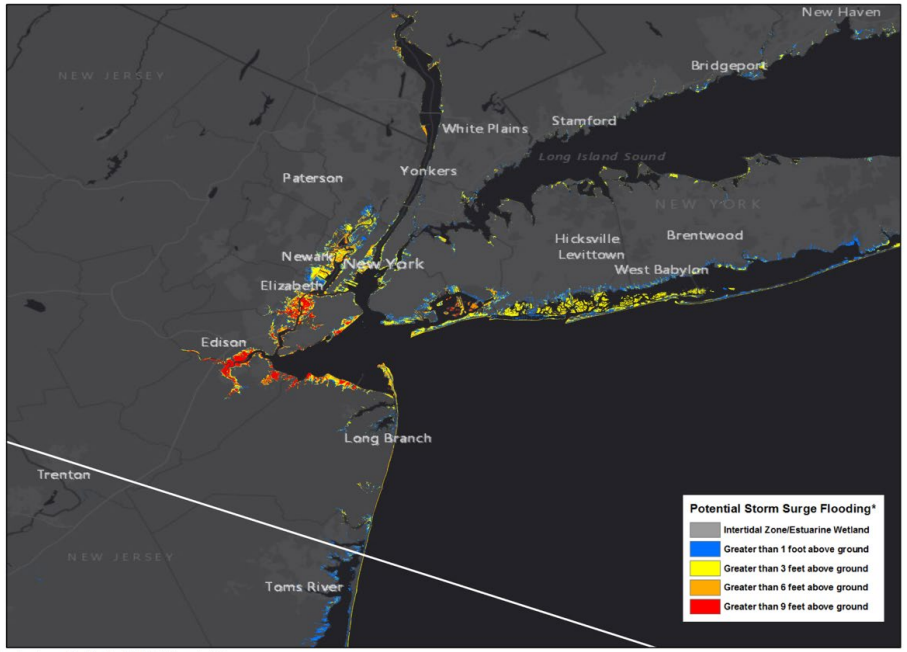
Storm Surge Influencers: Angle of Approach

The more perpendicular the angle of the storm's approach, the greater likelihood of a higher storm surge.



Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Example 1: Oblique Angle of Approach

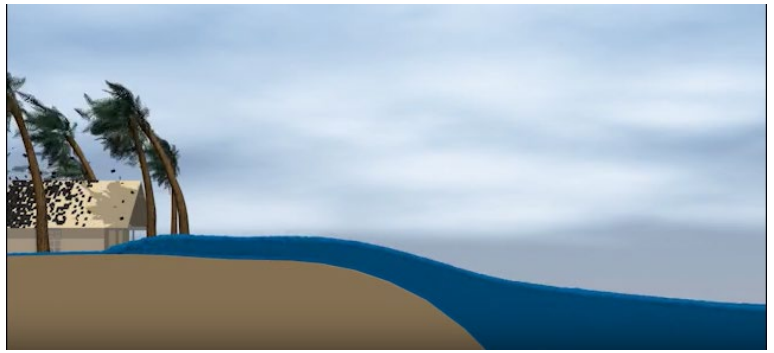


Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

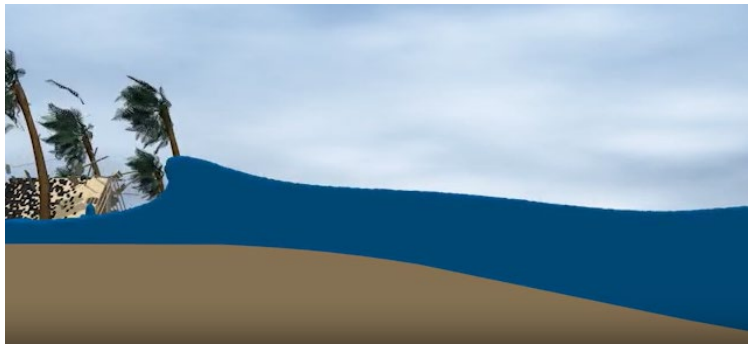
Example 2: Perpendicular Angle of Approach

Storm Surge Influencers: Slope of the Ocean Bottom & Shape of the Coastline

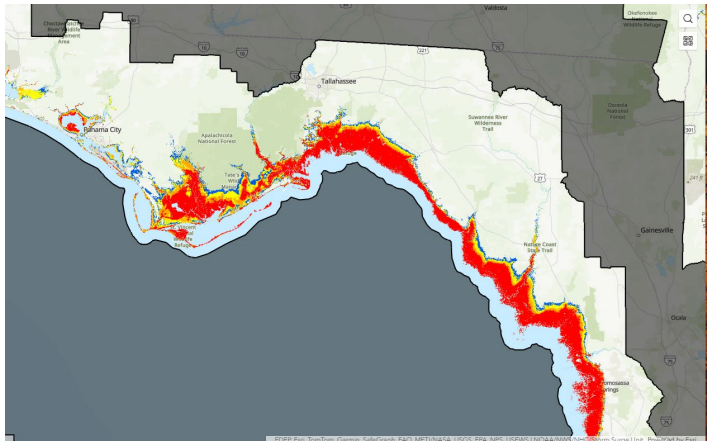
Gently-sloping continental shelf allows for higher storm surges, and concave coastlines and bays can locally enhance storm surge levels.

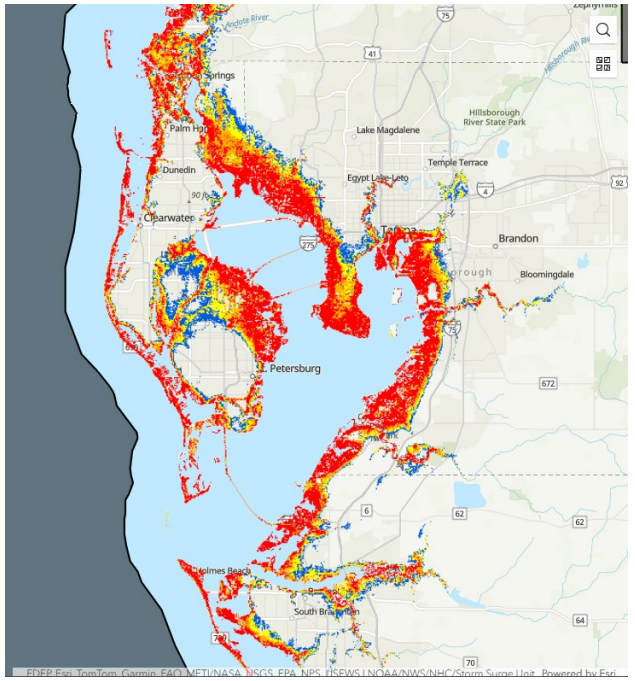


Example 1: Steep Slope



Example 2: Shallow Slope



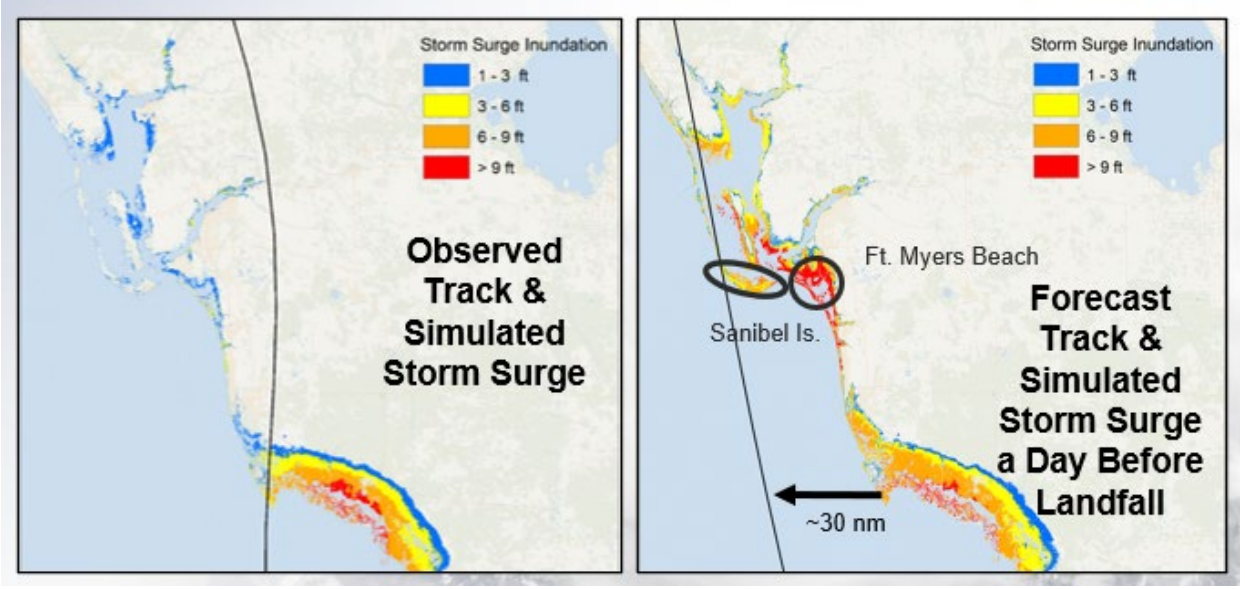


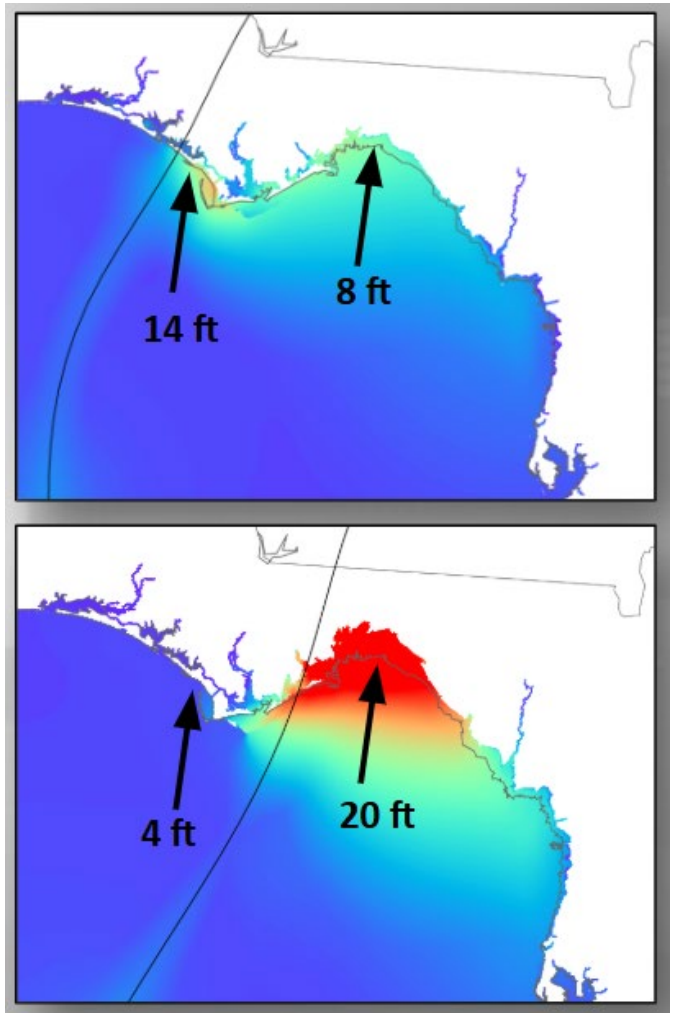
Concave Coastline, Bays, River Entrances, and Barrier Islands

“Deterministic” Dilemma

Forecast track adjustments as may be realized within the final 24 hours prior to landfall are likely to result in major differences in potential storm surge.

The examples here indicate great variation in the magnitude, areal extent and peak heights for life-threatening storm surge.



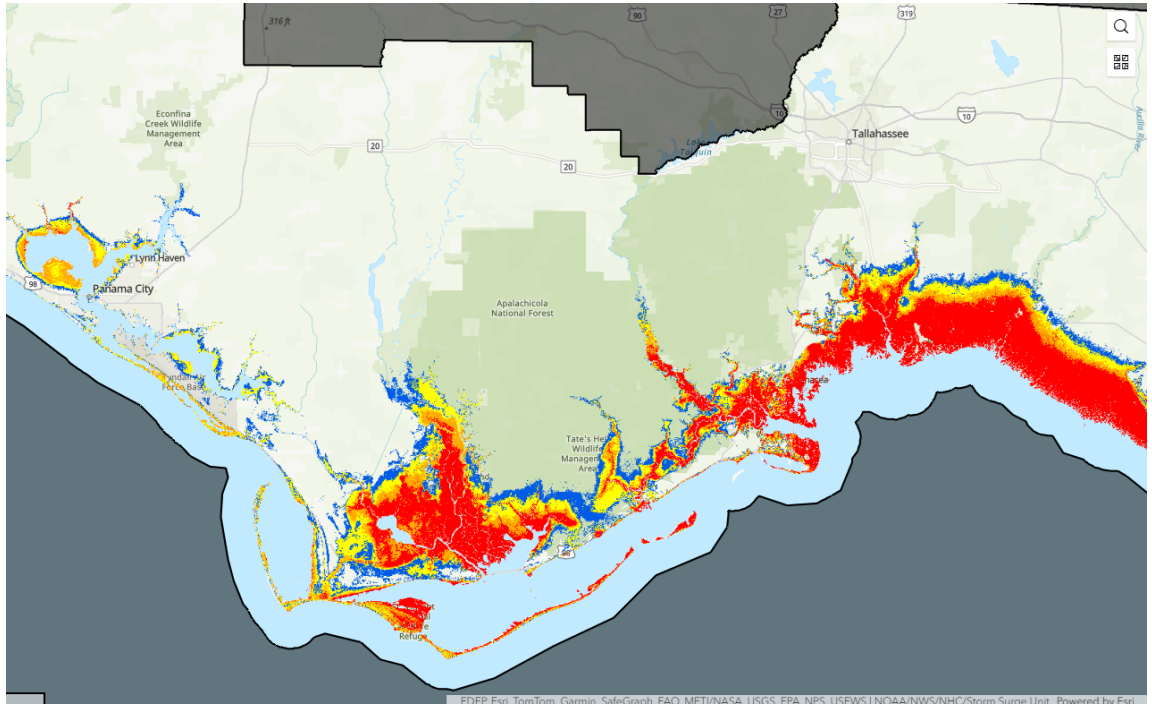


Storm Surge Planning Tools

Pre-Season	>2 days to 5 Days Out	Within 48 hours
National Storm Surge Risk Maps	National Storm Surge Risk Maps	Storm Surge Watch & Warning Graphic
Maximum of Maximums (MOMs)	Maximum Envelope of Water (MEOW)	Potential Storm Surge Flooding Map
		Peak Storm Surge Forecast Graphic

National Storm Surge Risk Maps

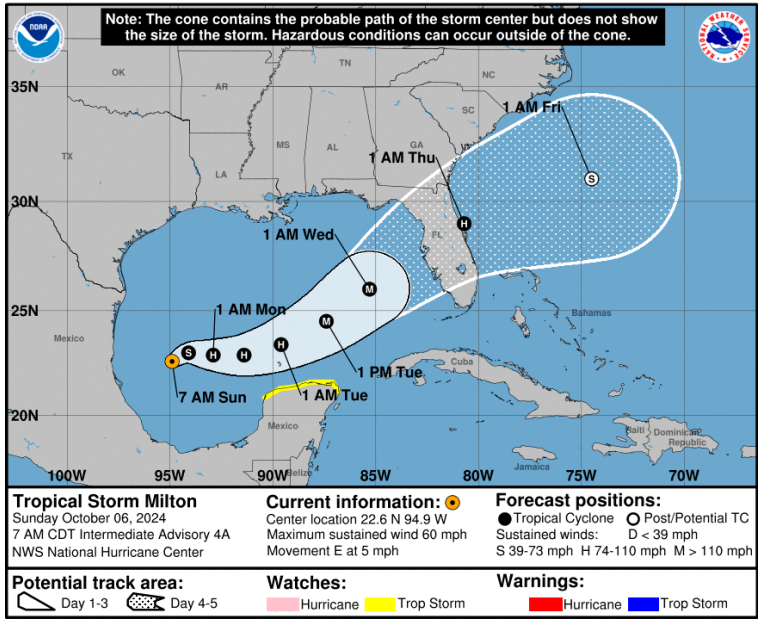
- Based on Maximum of Maximums by Saffir Simpson Wind Scale Category
- Accounts for most potential storm surge influencers
- Best used as a pre-season planning tool for evacuation zones and critical infrastructure design
- As it is continuous across the Gulf and Atlantic coastline, it will greatly exaggerate the extent of maximum surge in a realtime storm situation

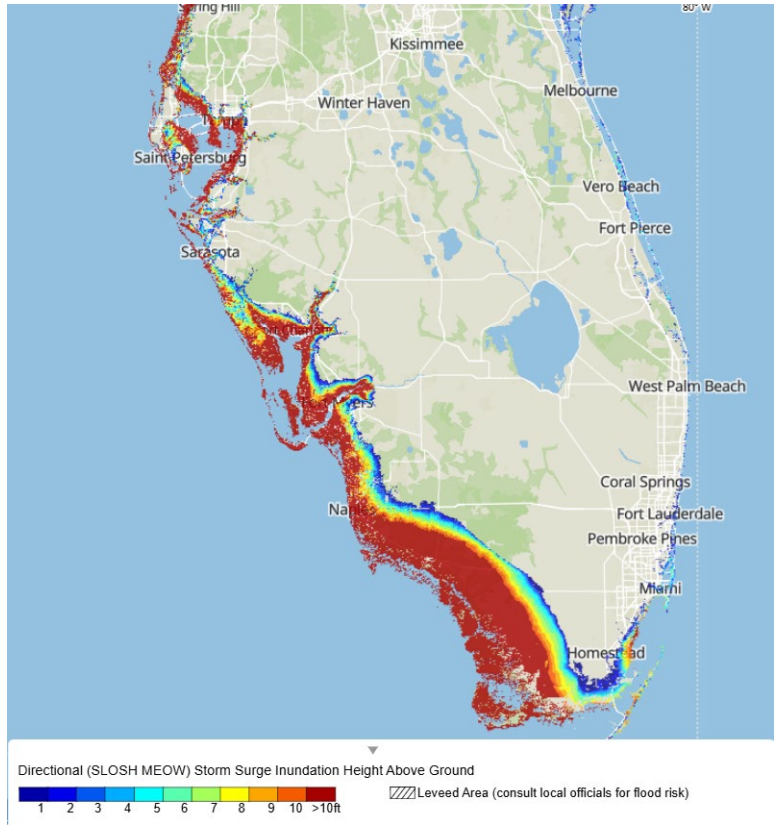


Category 2 National Storm Surge Risk Map

Maximum Envelope of Water

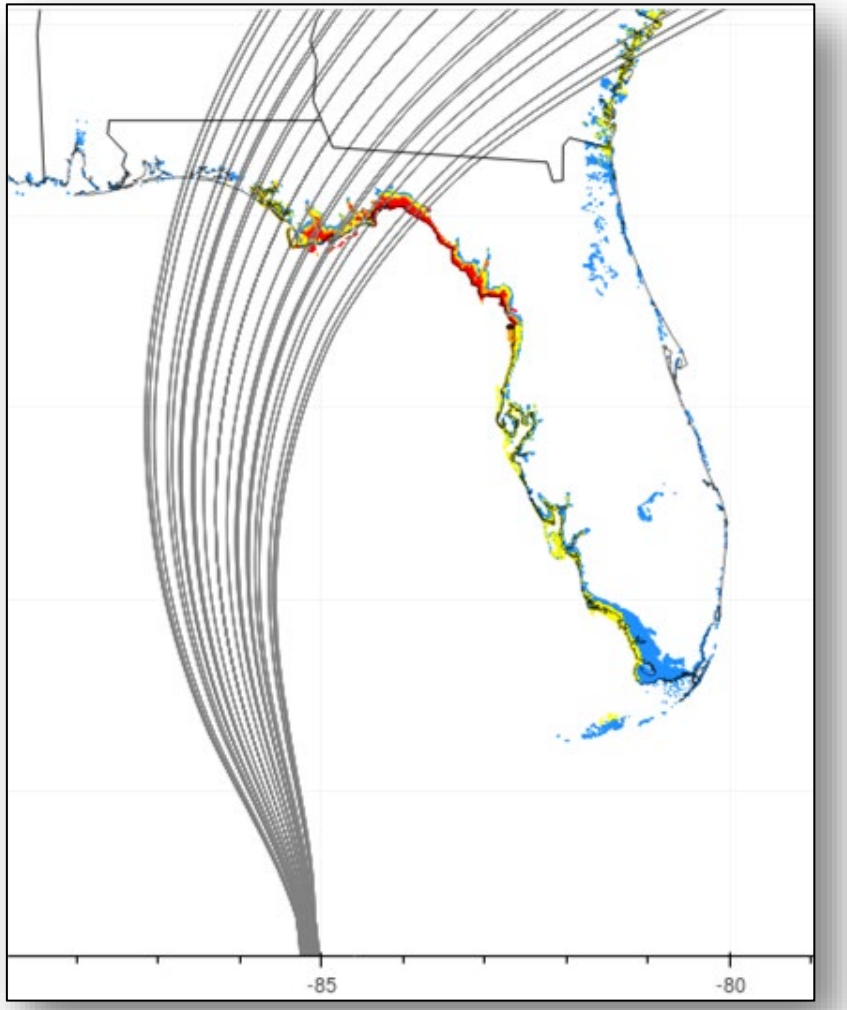
- Allows for limiting consideration to certain directions and speed of movement by a single Saffir Simpson Wind Scale Category.
- Tools like HurrEvac require a fixed forward speed and single category.
- Multiple MEOWs may need to be viewed to get a more comprehensive picture for potential storm surge.





Category 4 MEOW - NE/ENE/E - 20 mph

Storm Surge Probabilistic Power



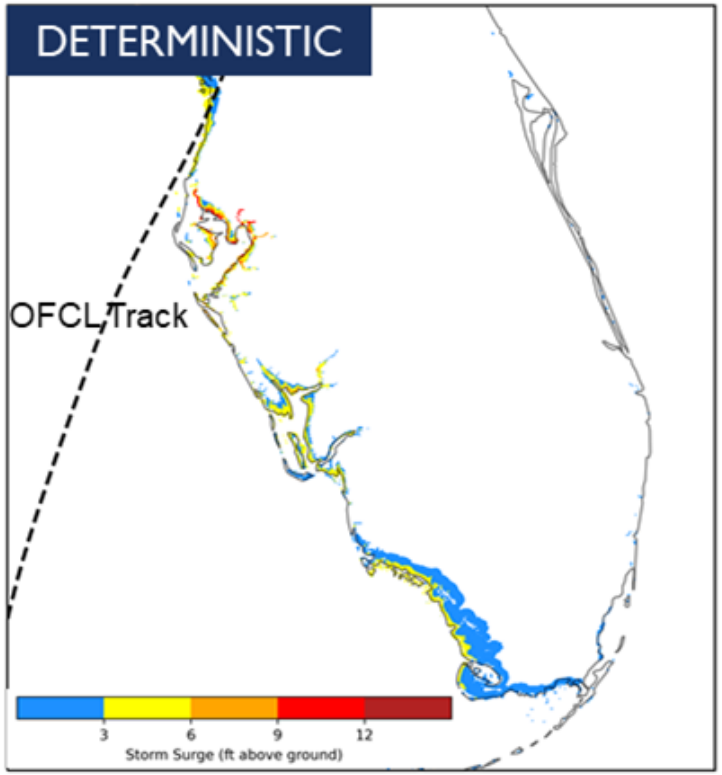
- 500 to 1000+ potential storm tracks are used to compile a distribution of storm surge values based on historic NHC track, intensity, forward speed and size forecast errors for each 6-hour forecast cycle.

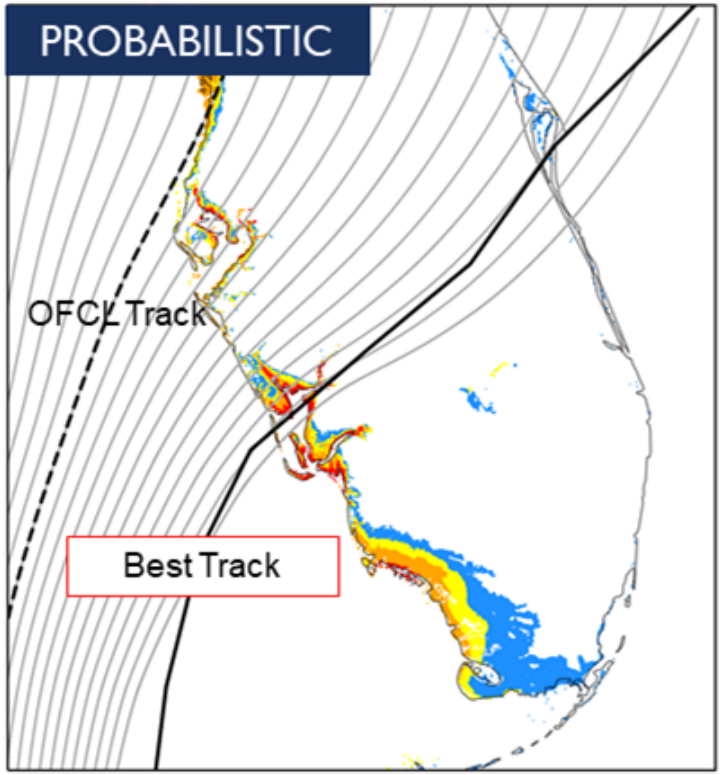
- From this database, a map showing a reasonable potential (highest 1 out of 10 chance) storm surge flood map can be created.

Storm Surge Probabilistic Power

Let's look at this within the context of Hurricane Ian…

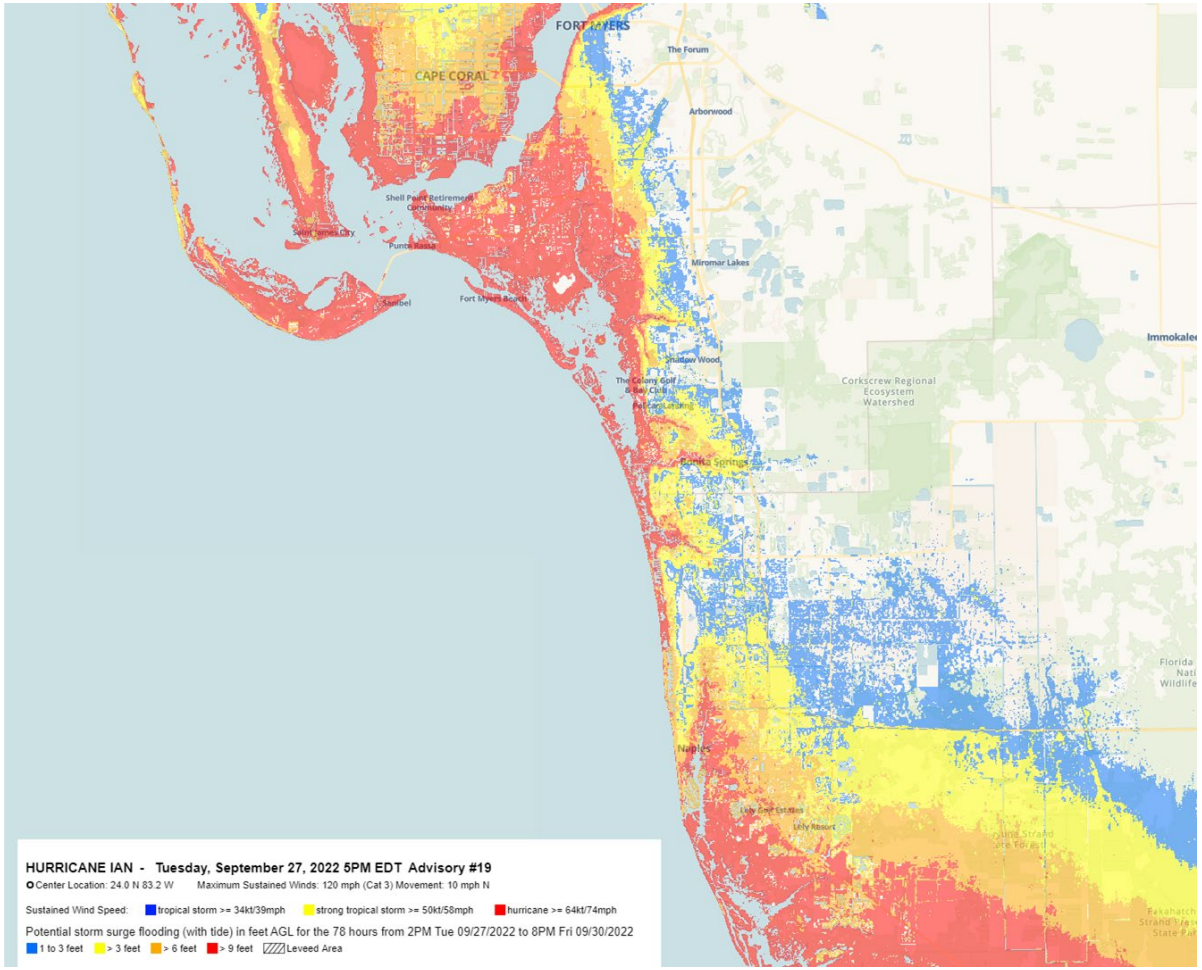
Deterministic vs. Probabilistic Guidance



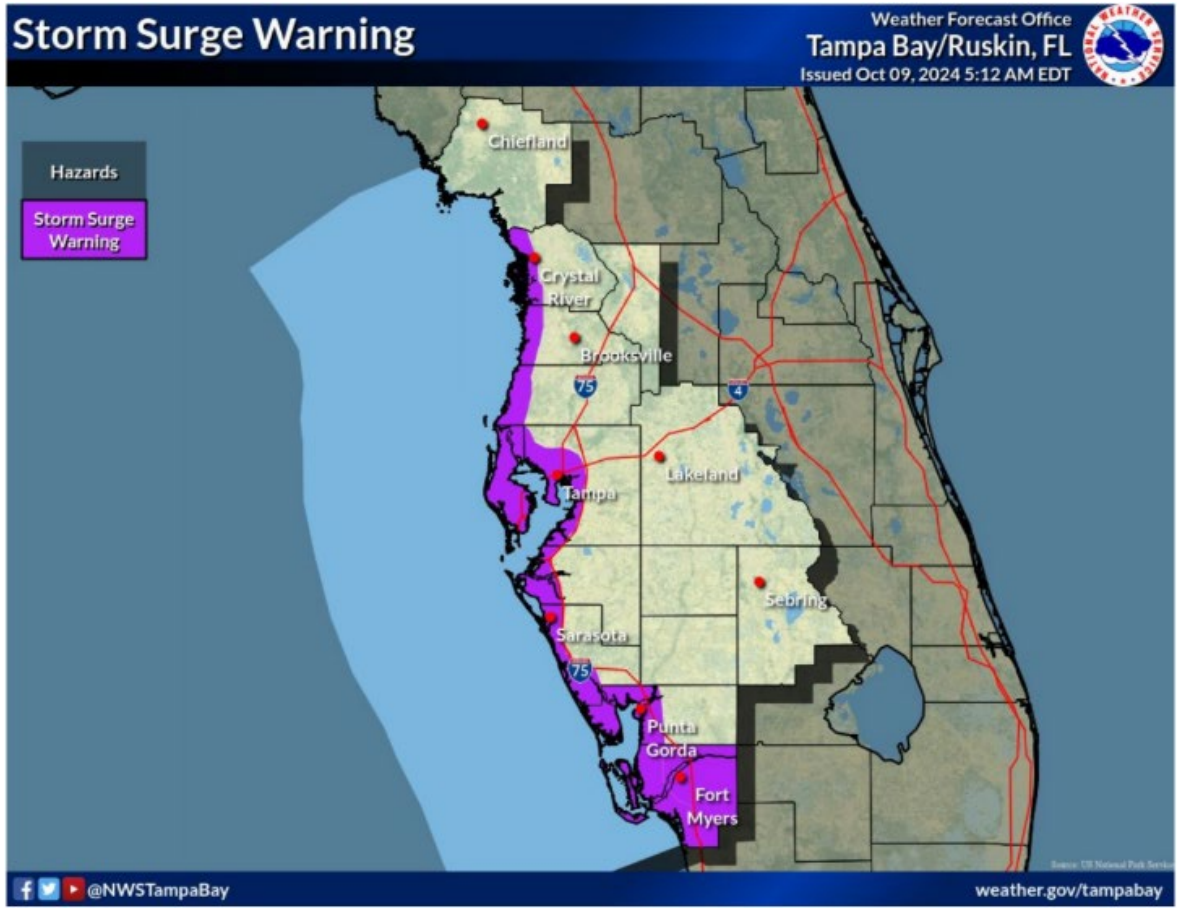


Potential Storm Surge Flooding Maps

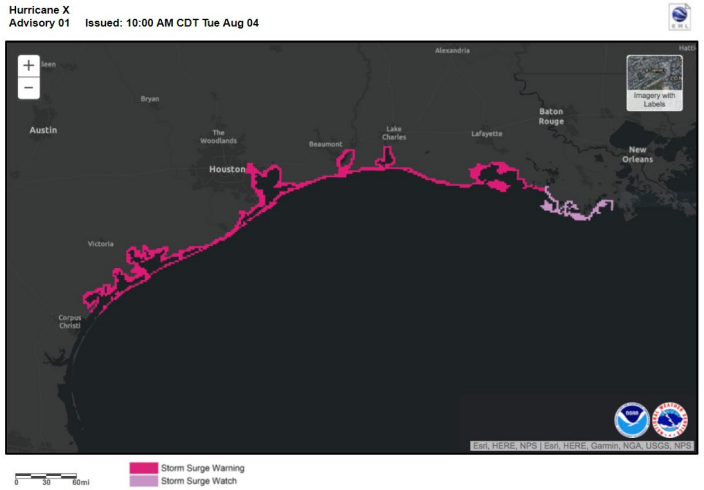
- Represent the reasonable worst case scenario of surge heights
- Takes into account forecast uncertainty, tides, and land elevation
- Not every point within a color range will see the peak value, but there is the potential for it - 1 in 10 chance it will be higher than depicted - this is what to prepare for
- Best for help with evacuation decisions and inland flooding penetration questions



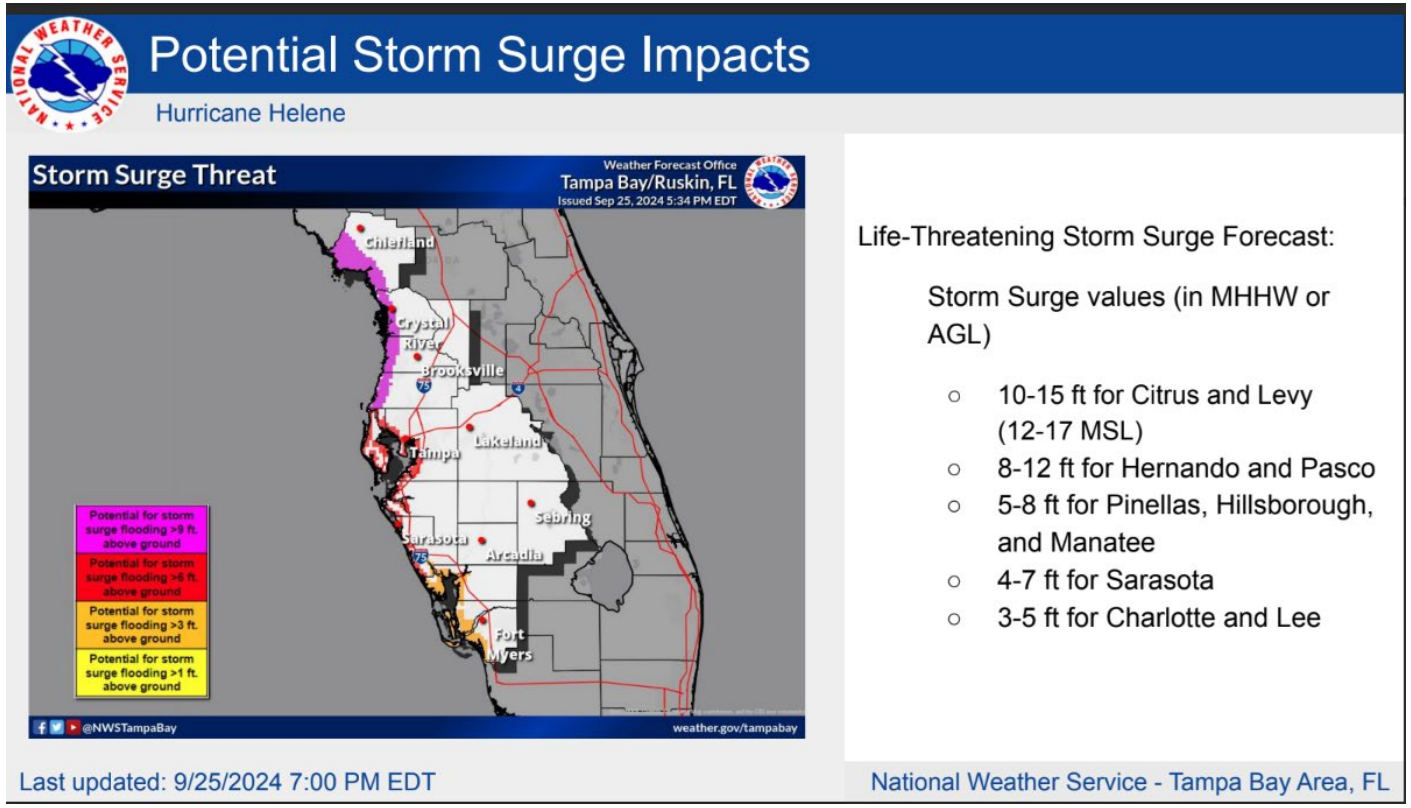
Storm Surge Watches & Warnings



- The Storm Surge Watch and Warning Graphic visualizes the areas most at risk from life-threatening surge
- Serves as a call-to-action



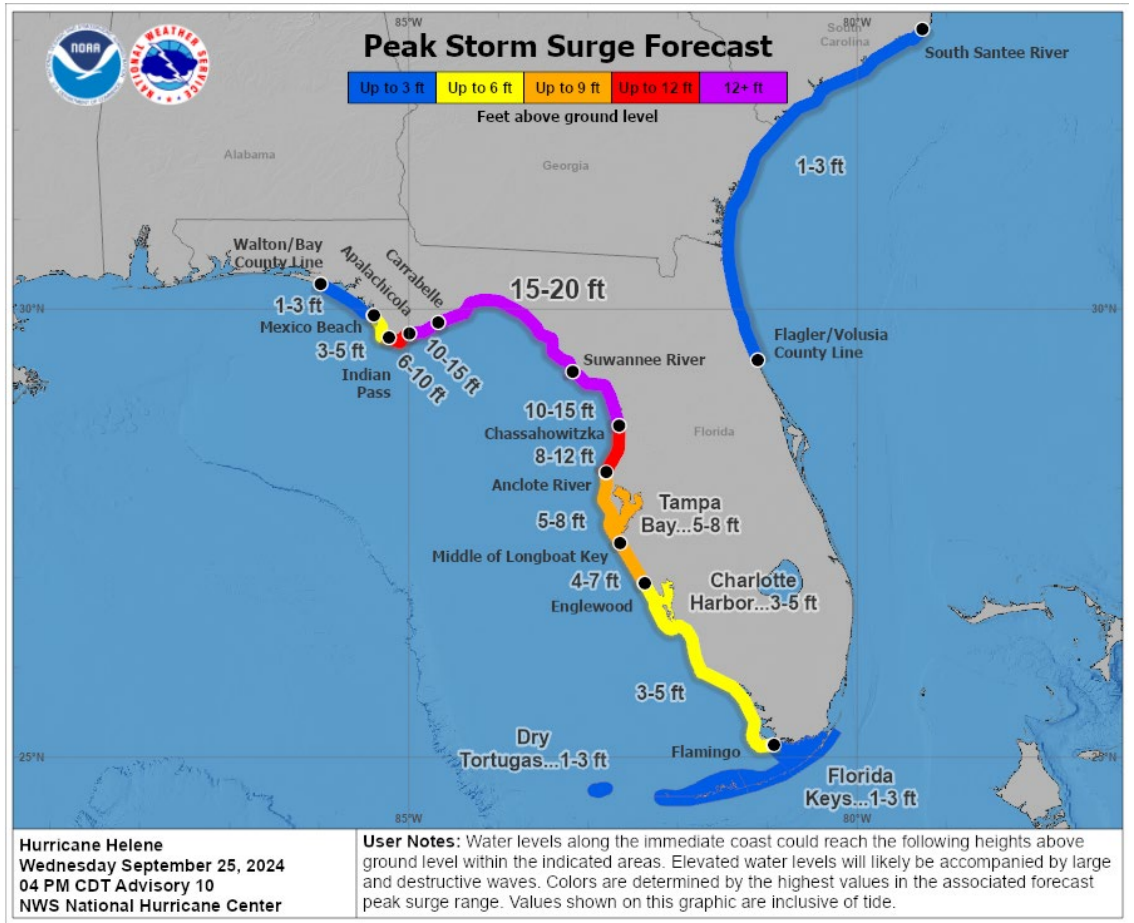
Storm Surge Threats & Impacts



- Potential Storm Surge Impacts become available as needed by your local NWS office.
- The graphics depict categorical reasonable worst-case (often highest 1-in-10) levels of potential impacts.
- Impact statements are customized for your portion of the state concerning infrastructure and what should be prepared for.
- Hazard-Based: Includes a “safety margin” relative to the forecast uncertainty.

Peak Storm Surge Forecast Graphic

- Issued whenever Storm Surge (and sometimes only when Hurricane or Tropical Storm Wind) Watches or Warnings are in effect.
- The values represent the height that water could reach above normally dry ground somewhere within the specified areas.
- The range expresses forecast uncertainty and to account for varying coastal geography.
- Caution: Do not *anchor* on the very first issuance; values can adjust upward/downward along the coastline as the storm and its forecasts evolve.



Recap…

What are some dangers with using just MOM and MEOW storm surge data for tropical cyclones?

Considers every possible angle of approach and landfall point, but may not account for historic tropical cyclone size, intensity, wind structure and forward motion situations

Provides a broad-brush depiction of risk

Could lead to degraded future public response

Recap…

What are some tools available to help you assess & communicate storm surge risk?

NHC Potential Storm Surge Flooding Map, the Peak Storm Surge Forecast Graphic, and the Storm Surge Watch and Warning Graphic

WFO Threat & Impact Graphics

HURREVAC MEOW Depictions (please consult with your local WFO!)

GOVERNOR'S HURRICANE CONFERENCE®

Tropical Cyclone Rainfall

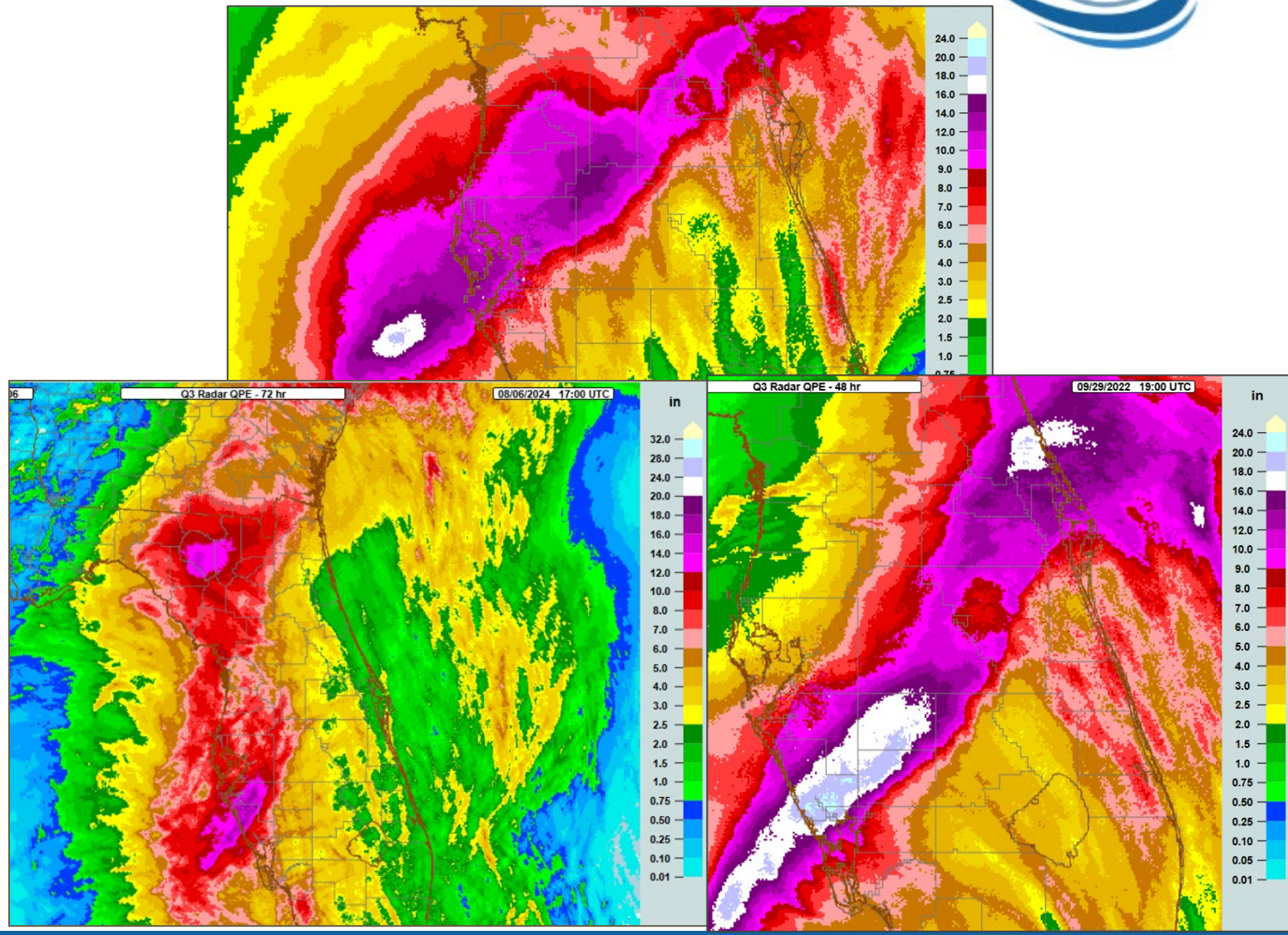
Kelly Godsey, NWS Tallahassee
kelly.godsey@noaa.gov

Training Session 17

Tropical Cyclone Rainfall

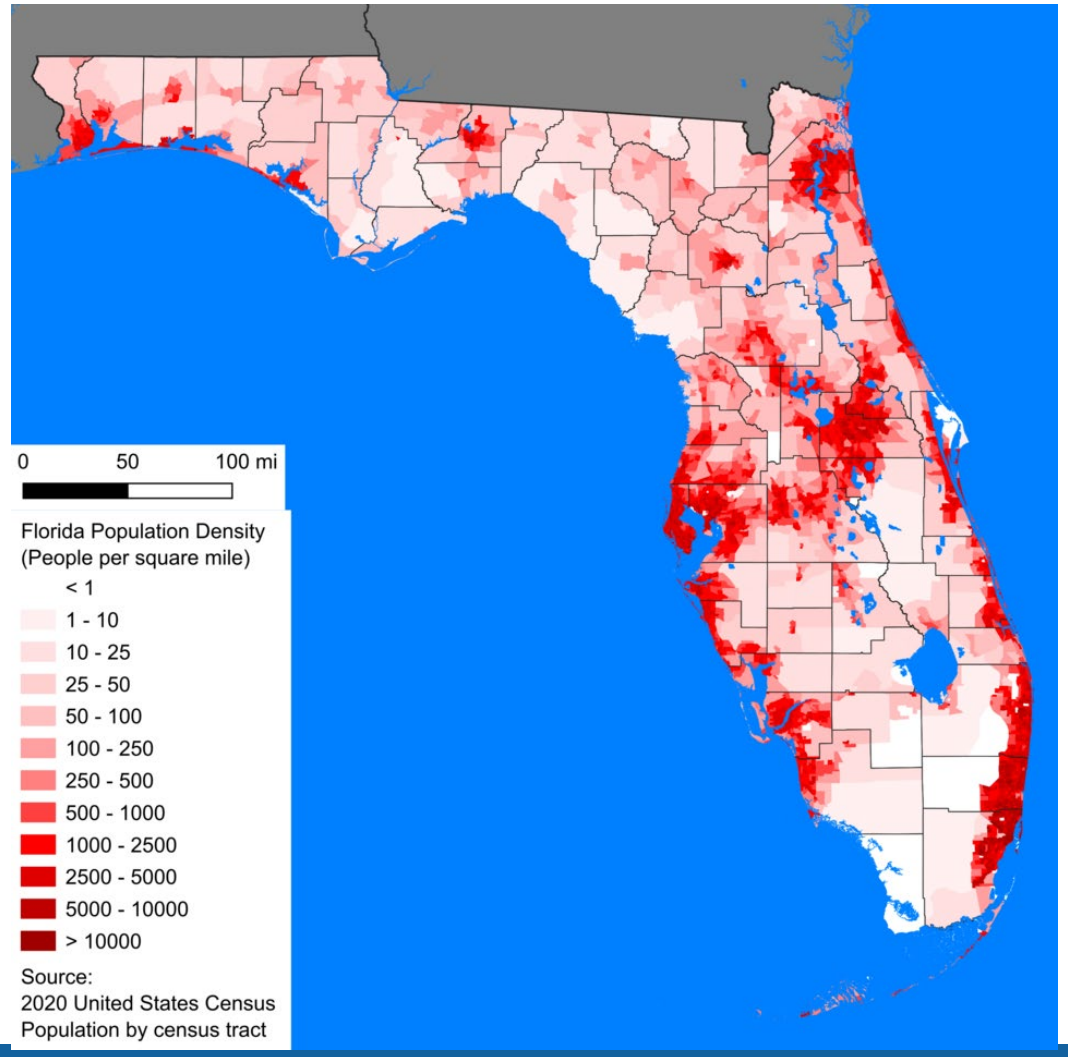
- Do these rainfall footprints look familiar?
- They should!

  They are 3 of 6 of recent FL hurricane landfalls
- Each produced destructive flash flooding.



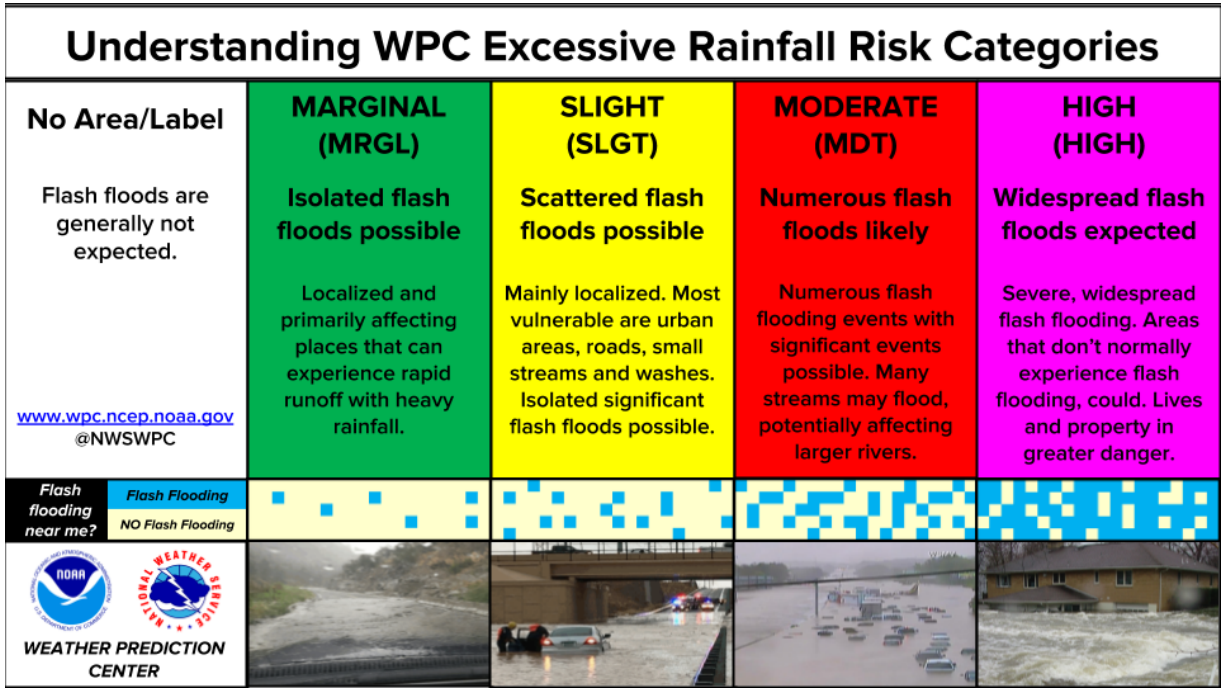
Why is extreme rainfall a FL concern?

- Florida's population boom large factor in flood vulnerability:
  - Rapid growth across inland areas
  - Growth & associated development has covered natural drainage areas
  - "Concrete jungles" across the state
  - Limited urban area drainage
- Tropical system heavy rain related to storm size & forward speed, ***not intensity***.



Let's Set a Plan for Flash Flooding

- Starts with outlook phase when a system is five days away
- Don't focus on storm intensity to assess flood risk (wind threat only!)
- Focus on flash flooding threat in addition to wind, surge & tornado impacts

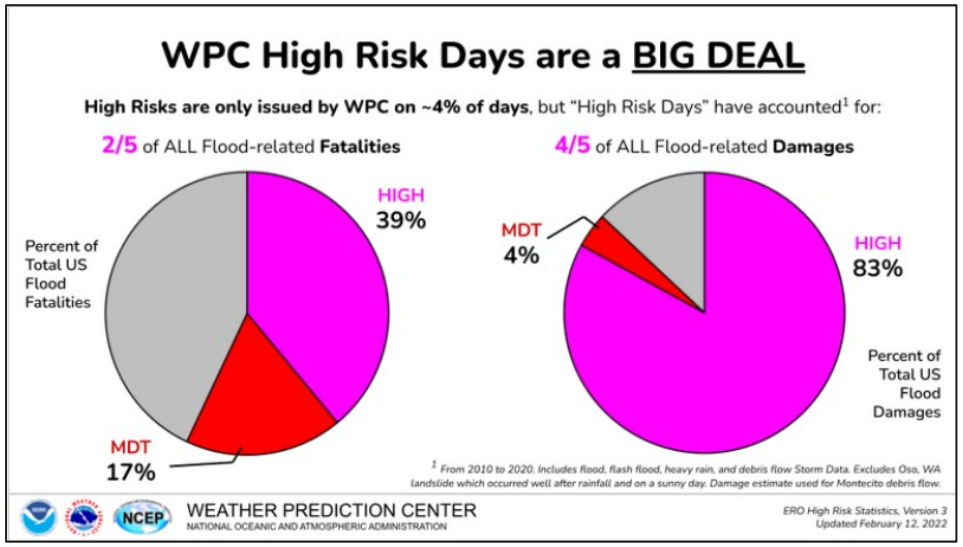


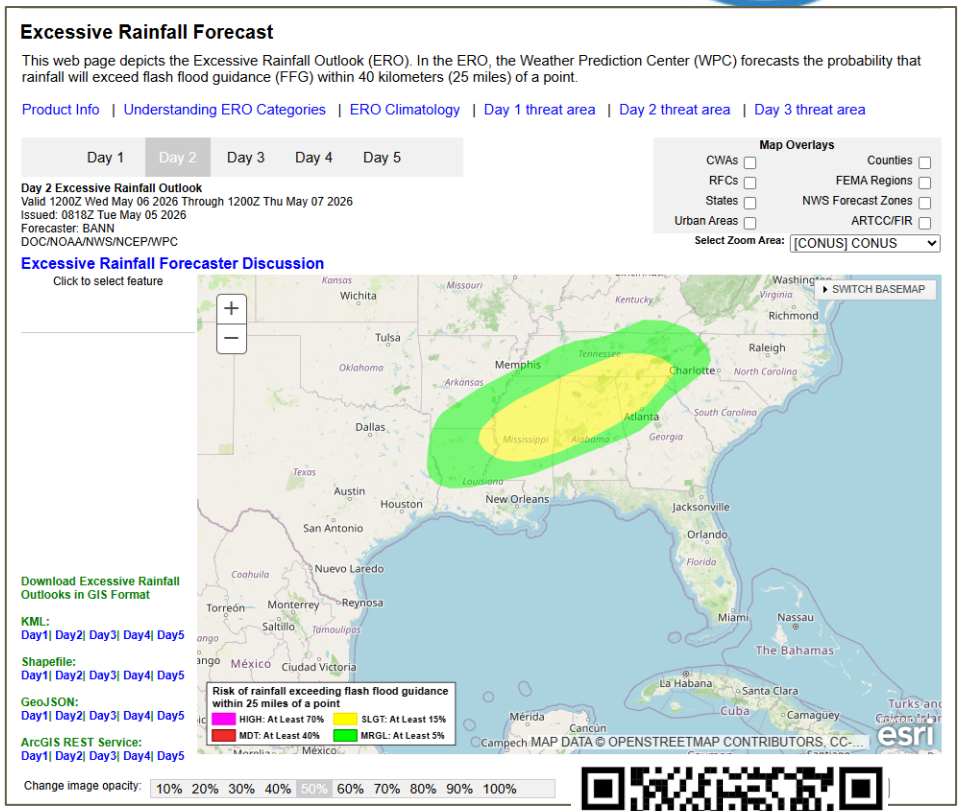
Some of Florida's most prolific flooding came from tropical storms - Tropical Storm Easy (1950) with

38.7 inches of rain in Yankeetown.

Excessive Rainfall Outlooks

- The Weather Prediction Center (WPC) issues excessive rainfall outlooks out to five days.
- These outlooks define the potential that your community could see enough rainfall to produce flash flooding.
- Consider it as a 4 tiered scale - but the low end of the scale doesn't mean there's no risk.



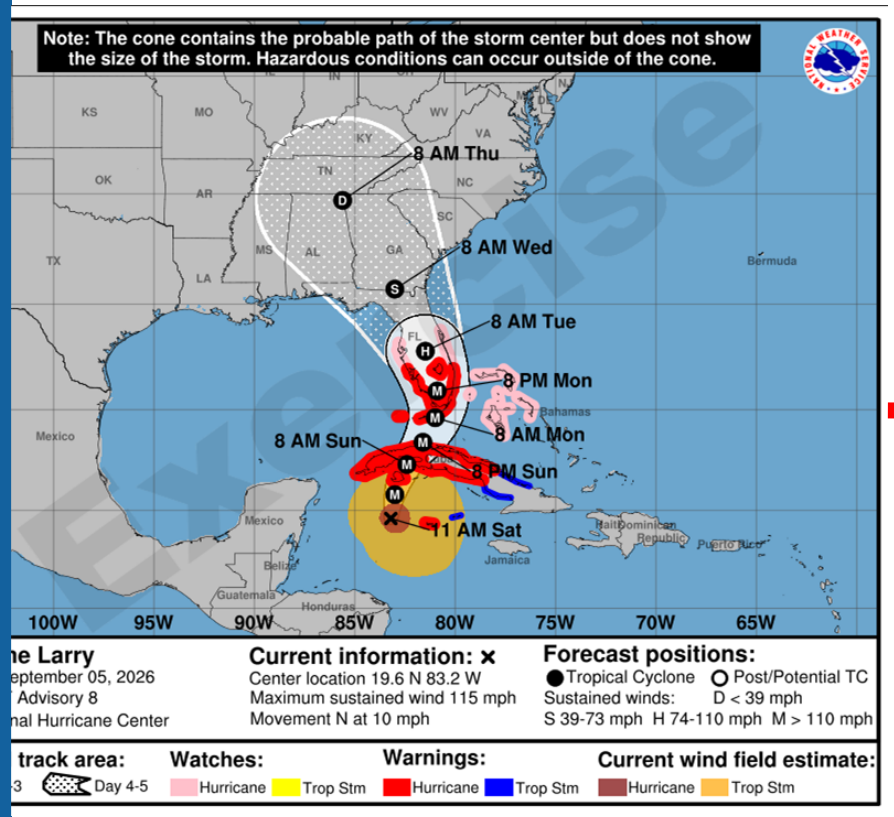


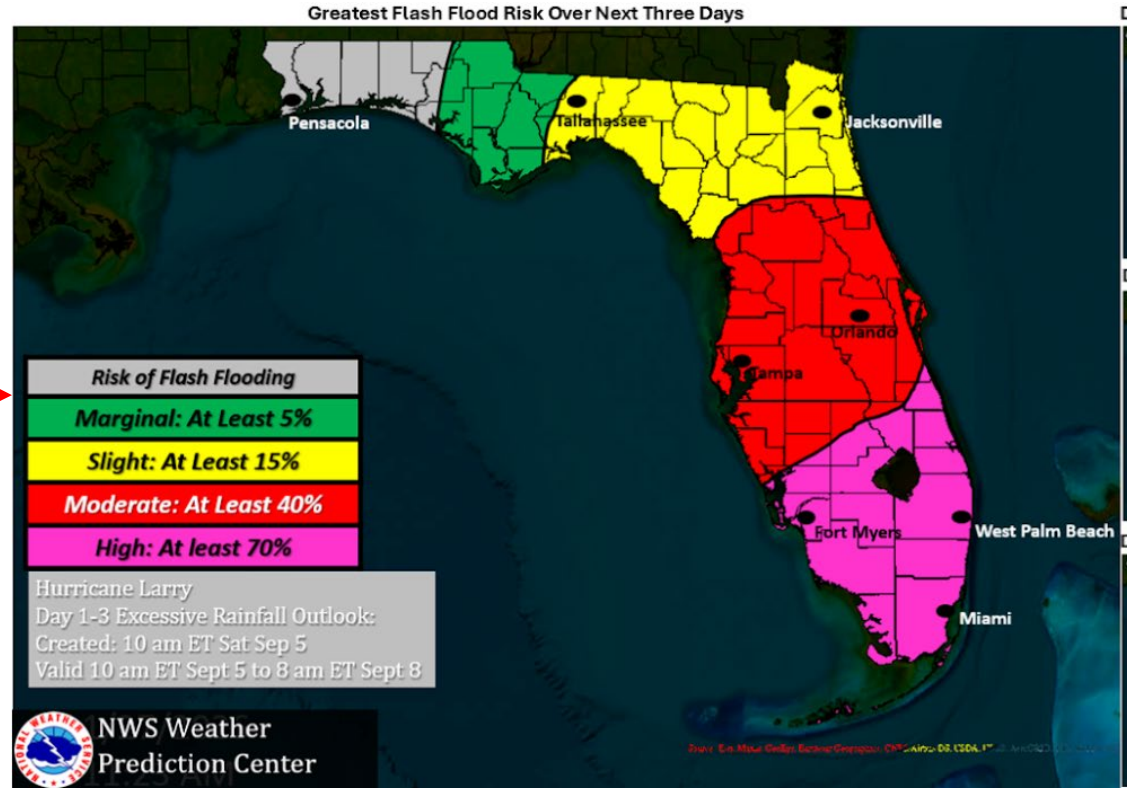
Risk of rainfall exceeding flash flood guidance within 25 miles of a point

- HIGH: At least 70%
- SLGT: At least 15%
- MDT: At least 40%
- MRGL: At least 5%

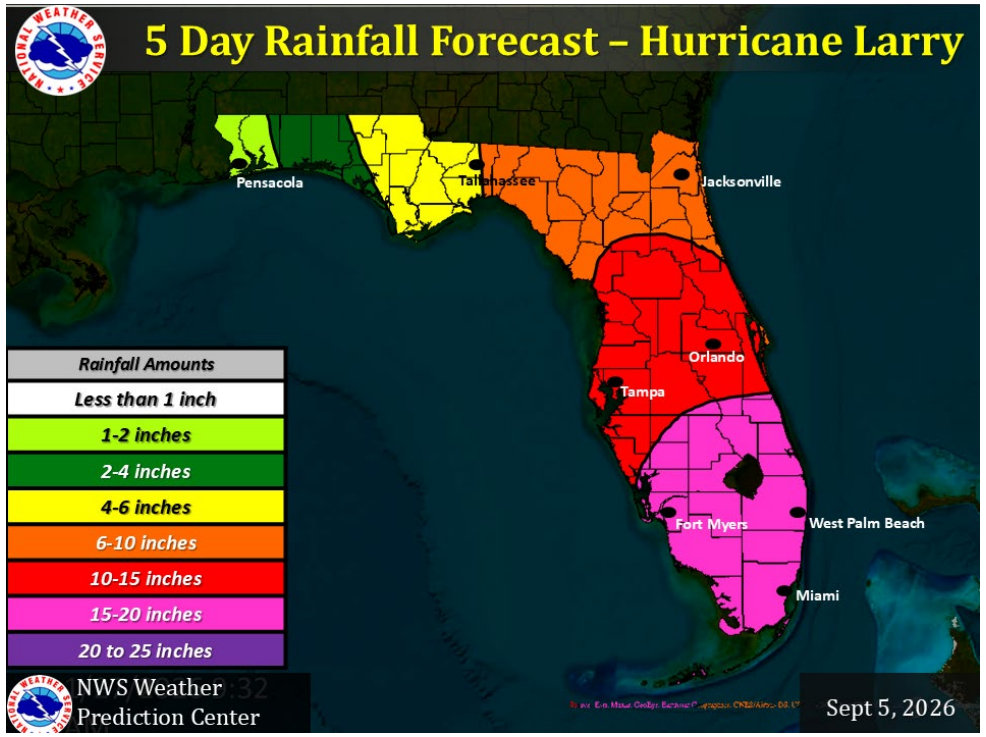
How does this work with an active storm?

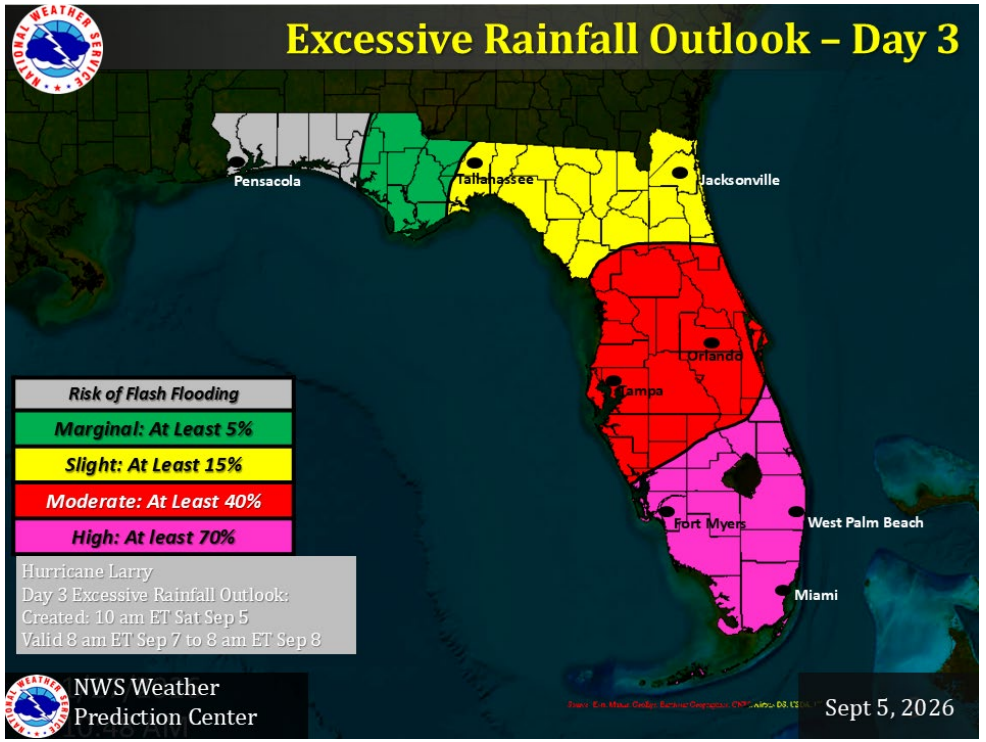
- WPC creates the excessive rainfall outlooks
- They also appear on the NHC webpage in a composite graphic like this one.





Amounts vs Impacts





- As a decision maker, how are amounts interpreted?
- How are they communicated?
- Could this cause confusion?

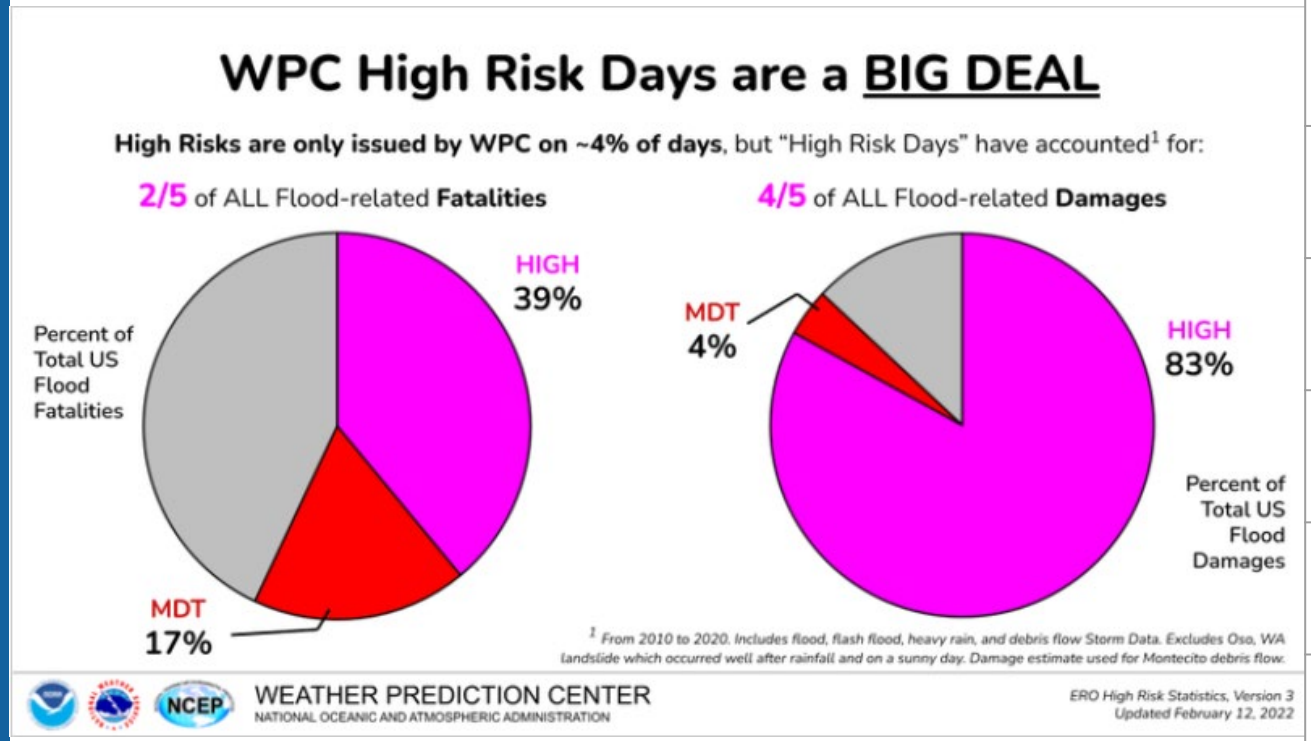
- Outlooks identify risk and uncertainty
- Using a 4 tiered scale you can explain **impacts** without specific amounts.
- Trends in EROs matter too!

I want to know how much rain.

Why should I use the outlooks instead?

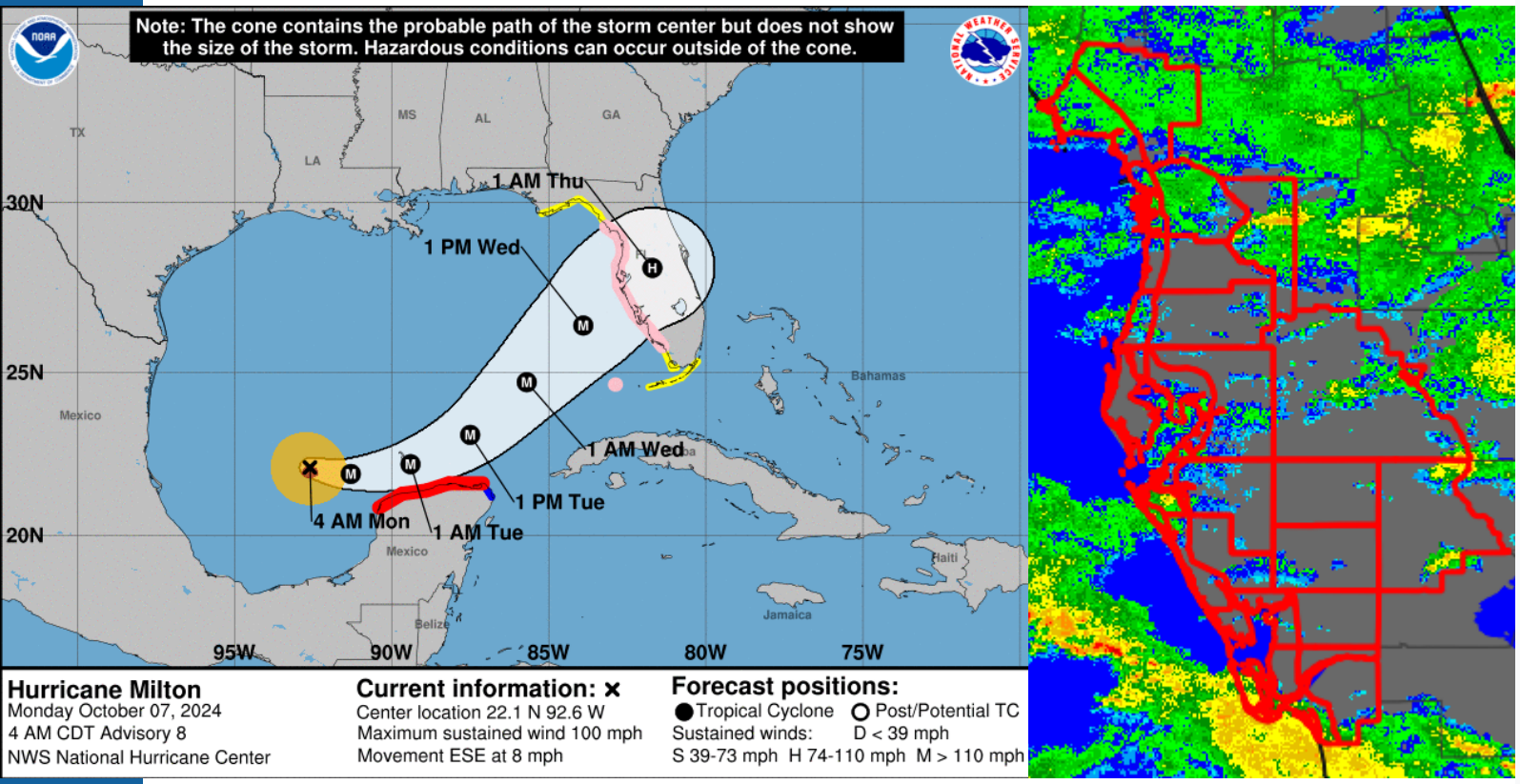
Amounts Tell Us…	Risk Levels Tell Us…
A static number or most likely range	The threat level using the range of possible outcomes
Most likely accumulation or range at a location, without regard to terrain	Threat level with terrain & considers past conditions
Most likely accumulation or range over the event	A specific 24 hr risk interval for five days, also looking at rates
A numeric range whose impact is poorly understood	A risk level is easier to quantify & see trends
A numeric range is tough to communicate impacts	A risk level communicates potential impacts

Let's revisit the critical days again…



2016 to Present	Slight	Moderate	High
Mobile	317	70	11
Tallahassee	257	37	8
Jacksonville	182	25	9
Tampa Bay	119	18	5
Melbourne	102	18	5
Miami	90	20	4
Key West	49	11	2

In the watch phase



...FLOOD WATCH IN EFFECT FROM SUNDAY MORNING THROUGH THURSDAY MORNING...

* WHAT...Flooding caused by excessive rainfall is possible.

* WHERE...Portions of southwest and west central Florida, including the following areas, in southwest Florida, Coastal Charlotte, Coastal Lee, Inland Charlotte and Inland Lee. In west central Florida, Coastal Citrus, Coastal Hernando, Coastal Hillsborough, Coastal Levy, Coastal Manatee, Coastal Pasco, Coastal Sarasota, DeSoto, Hardee, Highlands, Inland Citrus, Inland Hernando, Inland Hillsborough, Inland Levy, Inland Manatee, Inland Pasco, Inland Sarasota, Pinellas, Polk and Sumter.

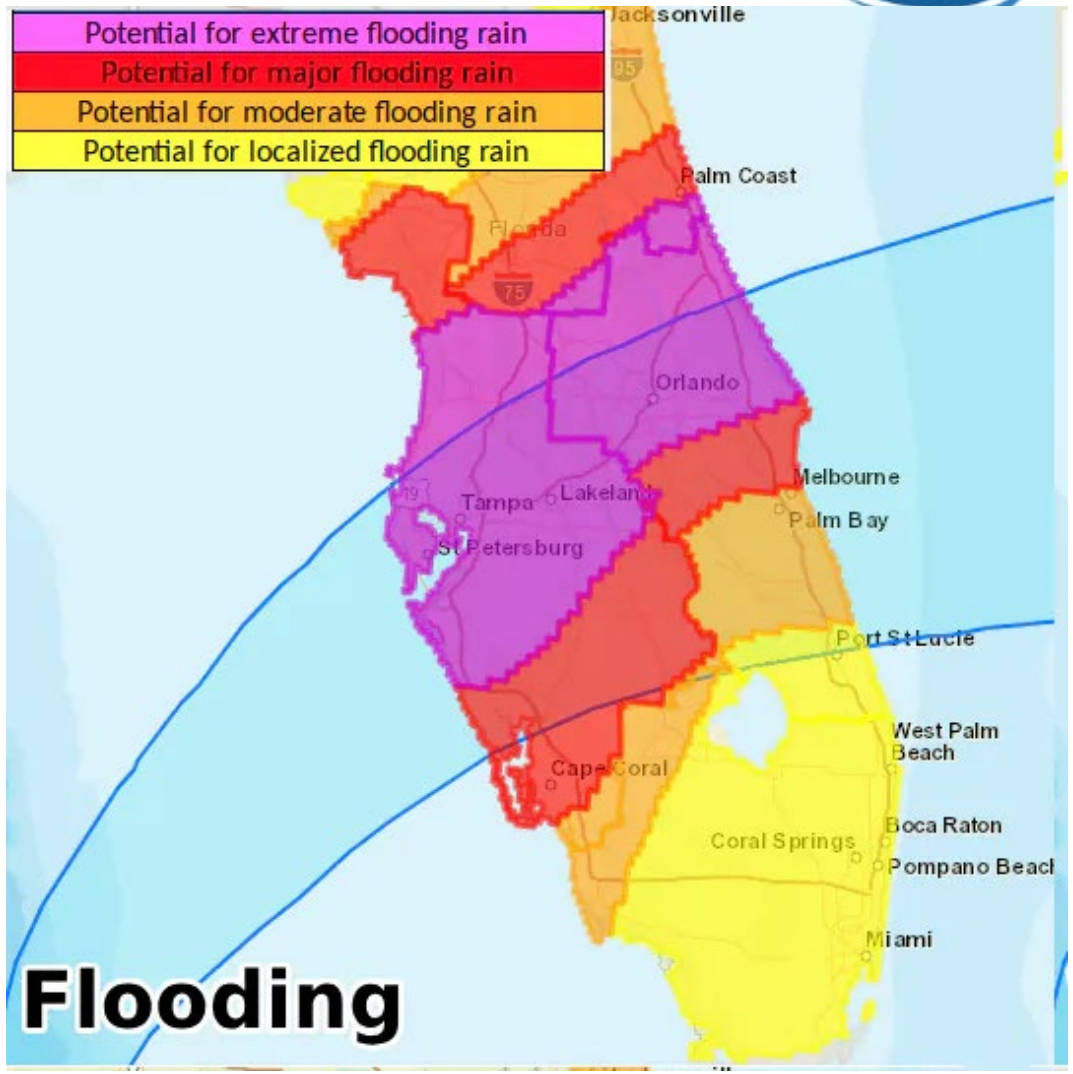
* WHEN...From Sunday morning through Thursday morning.

* IMPACTS...Excessive runoff may result in flooding of rivers, creeks, streams, and other low-lying and flood-prone locations. Storm drains and ditches may become clogged with debris.

* ADDITIONAL DETAILS...
  - Heavy rainfall is forecast this week as deep moisture streams across the area. Then, as a tropical system approaches late Tuesday into Wednesday, the threat for heavy rainfall will increase even further. Rainfall totals of 5 to 8 inches, with isolated totals up to 12 inches will be possible.
  - https://www.weather.gov/safety/flood

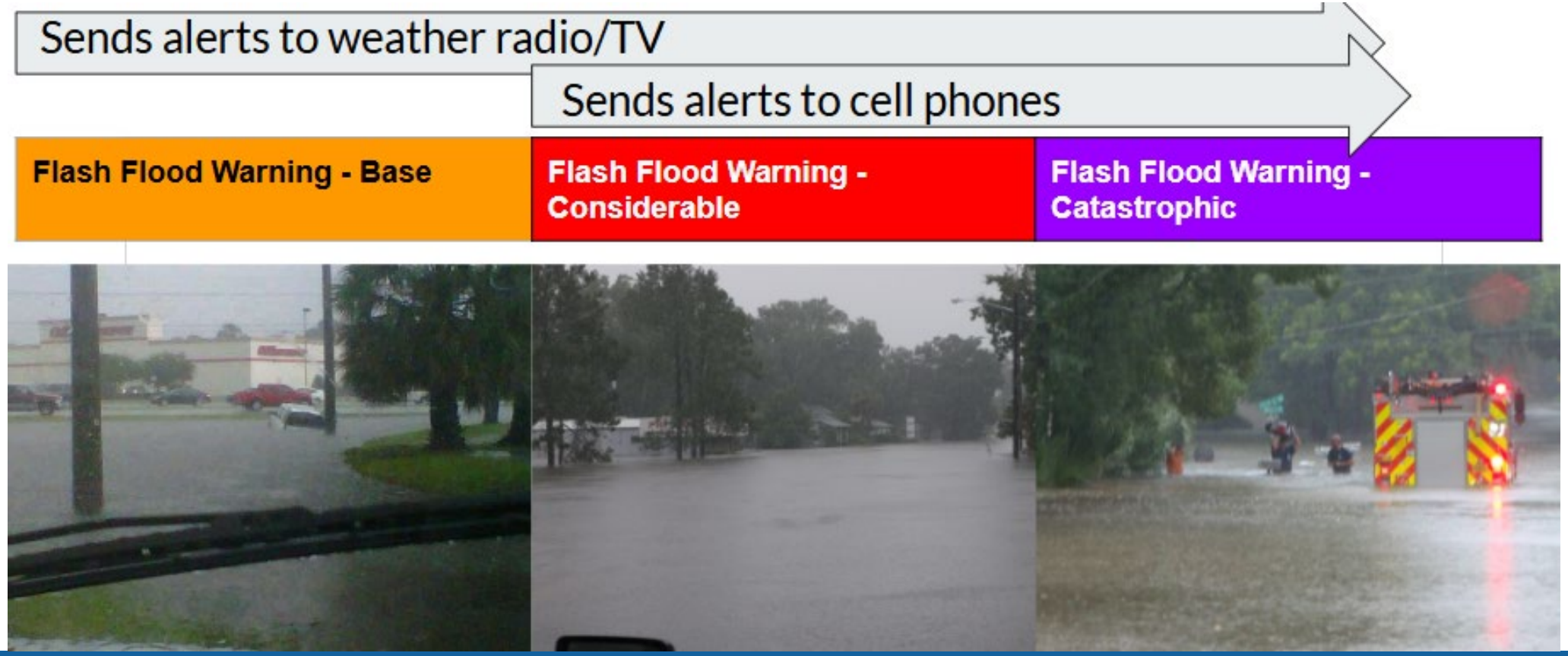
Flood Threat Graphic

- Just with the other hurricane hazards, a flood threat graphic is produced during the watch phase.
- This depicts the level of impact, similar to the excessive rainfall outlook.
- This impact graphic is created by your local weather office.
- As with everything else, watch trends.
- Treat the red (high) and purple (extreme) colors as catastrophic events!

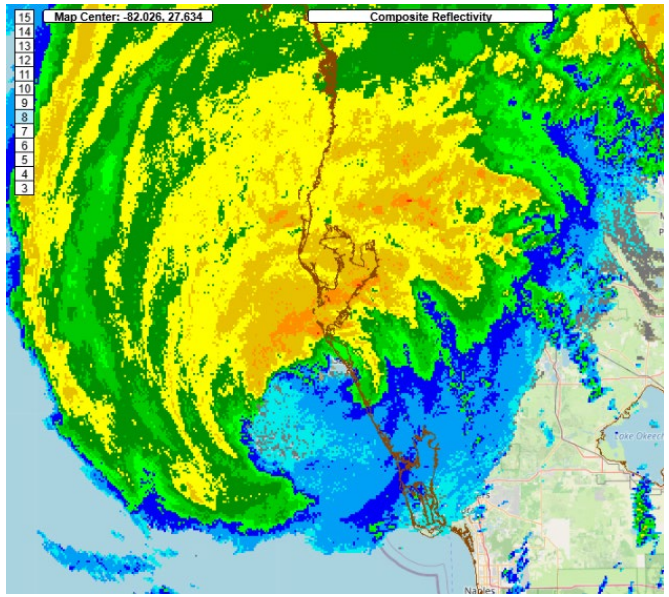


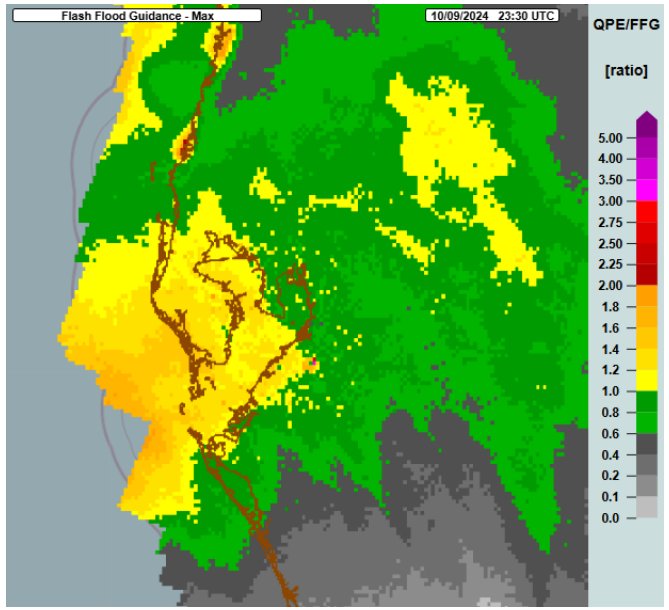
When it starts to rain…Warnings

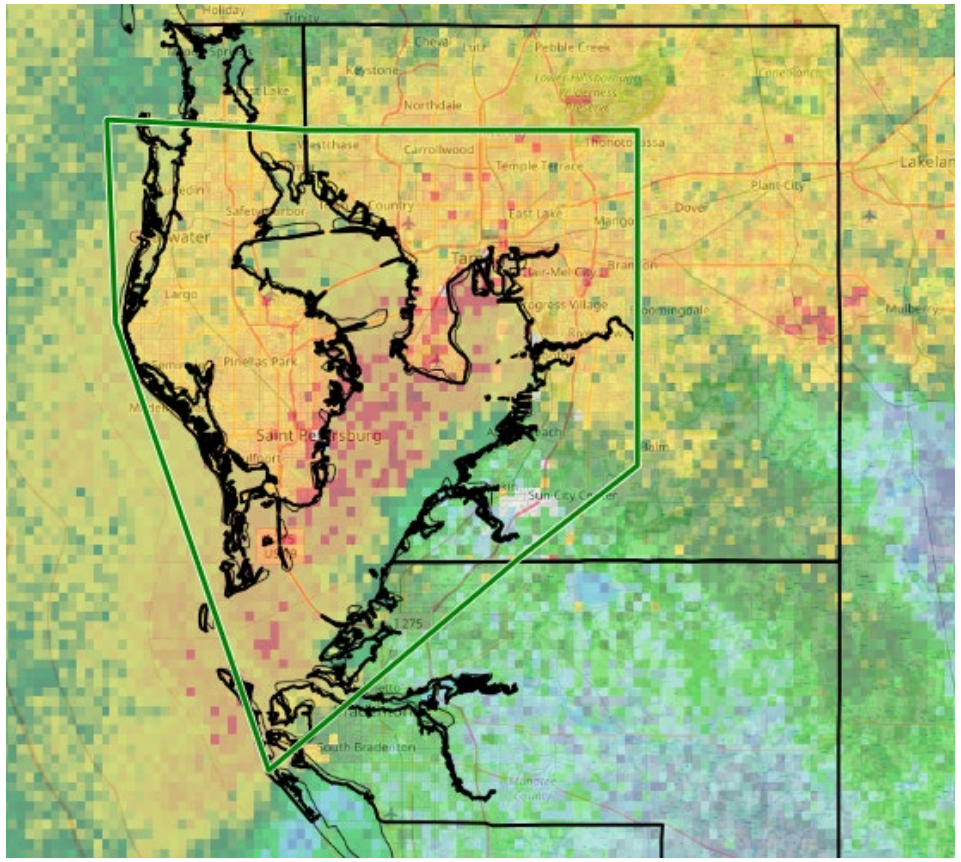
- Flash flood warnings identify where life threatening flooding from heavy rainfall is expected or occurring
- Flash flood warnings are impact-based.



Warning Phase - And What it Means







NWS Meteorologists analyze radar data to identify areas likely to flood when rain begins.

Warning polygons define the area at risk of life-threatening flooding.

And What You See from us…

BULLETIN - EAS ACTIVATION REQUESTED
Flash Flood Warning
National Weather Service Tampa Bay Ruskin FL
926 PM EDT Wed Oct 9 2024

...FLASH FLOOD EMERGENCY FOR ST. PETERSBURG, TAMPA, RIVERVIEW, AND PALMETTO...

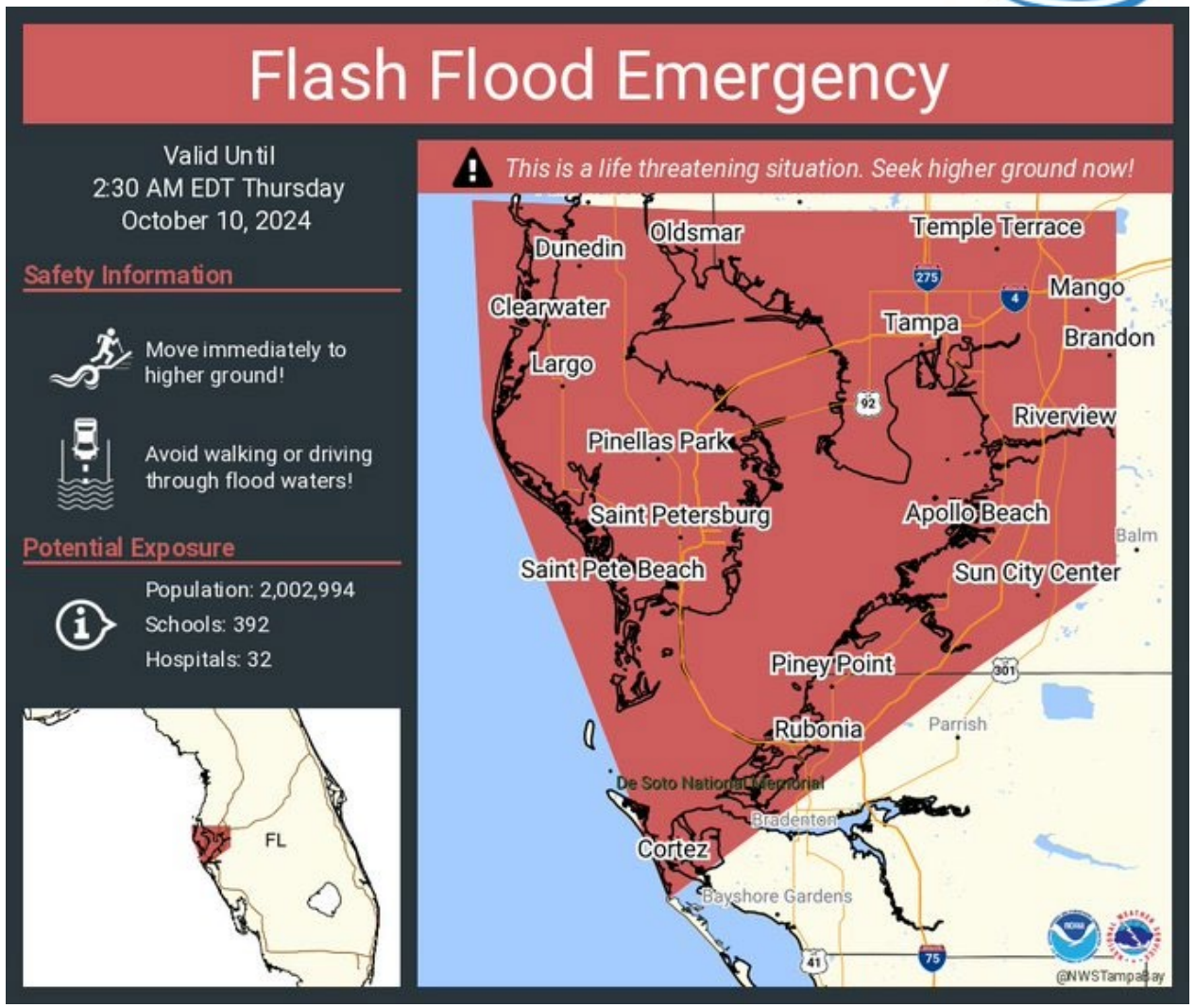
The National Weather Service in Tampa Bay Ruskin has extended the

* Flash Flood Warning for...
  Central Hillsborough County in west central Florida...
  Northern Manatee County in west central Florida...
  Southeastern Pinellas County in west central Florida...

* Until 230 AM EDT.

* At 926 PM EDT, Doppler radar indicated thunderstorms producing heavy rain across the warned area. Between 10 and 14 inches of rain have fallen. Flash flooding is already occurring.

  This is a FLASH FLOOD EMERGENCY for St. Petersburg, Tampa, Riverview, and Palmetto. This is a PARTICULARLY DANGEROUS SITUATION. SEEK HIGHER GROUND NOW!



Warnings are the last “heads up” to seek safe shelter

- Pinellas County Hurricane Milton example:
  > 1.5 ft of rain fell in a short period of time - Rapid water rise & significant impacts

- How do we support? Three tiered system - **Outlook - Watch - Warning**
  Key in your preparations

- Identify your flood prone areas before event & take protective action as risk increases.

Waiting until the first drops of rain may be too late.

Recap -
Flooding Rain Doesn't Have to be a Surprise!

- Follow a process when approaching any heavy rainfall event.
- Know your vulnerable flood locations
- Check outlooks & monitor trends.
- If a watch is issued, the threat is increasing. Put your plan into action.
- Warnings mean flooding is imminent. Responding may be challenging if not impossible, especially if a tropical system is already making landfall.
- **Flooding can happen in a flash. But it doesn't have to be a surprise!**

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Questions?

NWS JAX Tropical

NHC Education

https://www.nhc.noaa.gov/outreach/