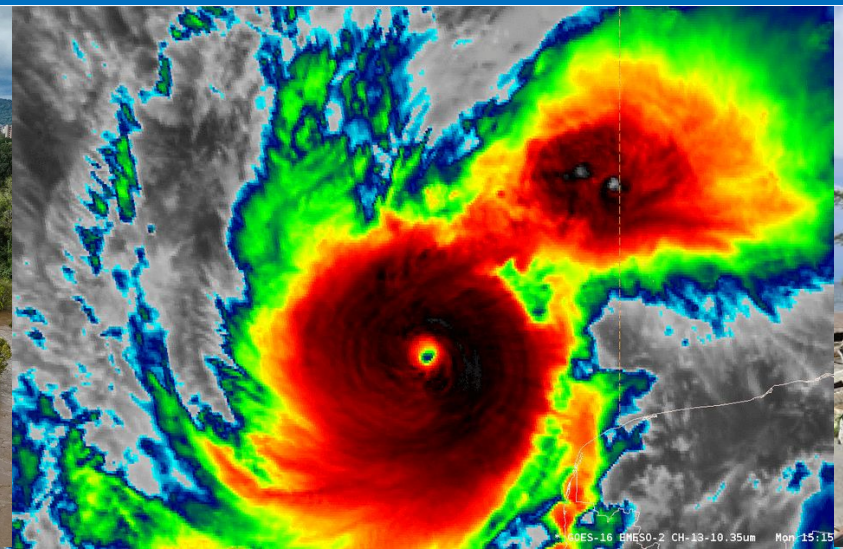
NOAA

National Weather Service

Lessons from the 2024 Hurricane Season and 2025 NHC Product and Service Updates

Robbie Berg
Warning Coordination Meteorologist
National Hurricane Center

NOAA Southeast and Caribbean Regional Team Webinar Series
April 22, 2024



NHC Needs Your Help!

Help Us Redirect the Focus Away from these Messages to What's Important

Hype

Hurricanes are getting so intense, scientists propose a Category 6

Hurried Critique

Where was Laura's storm surge?

Headlines

Hurricane Florence downgraded to Category 1 storm as it lashes North Carolina

Hazards(?)

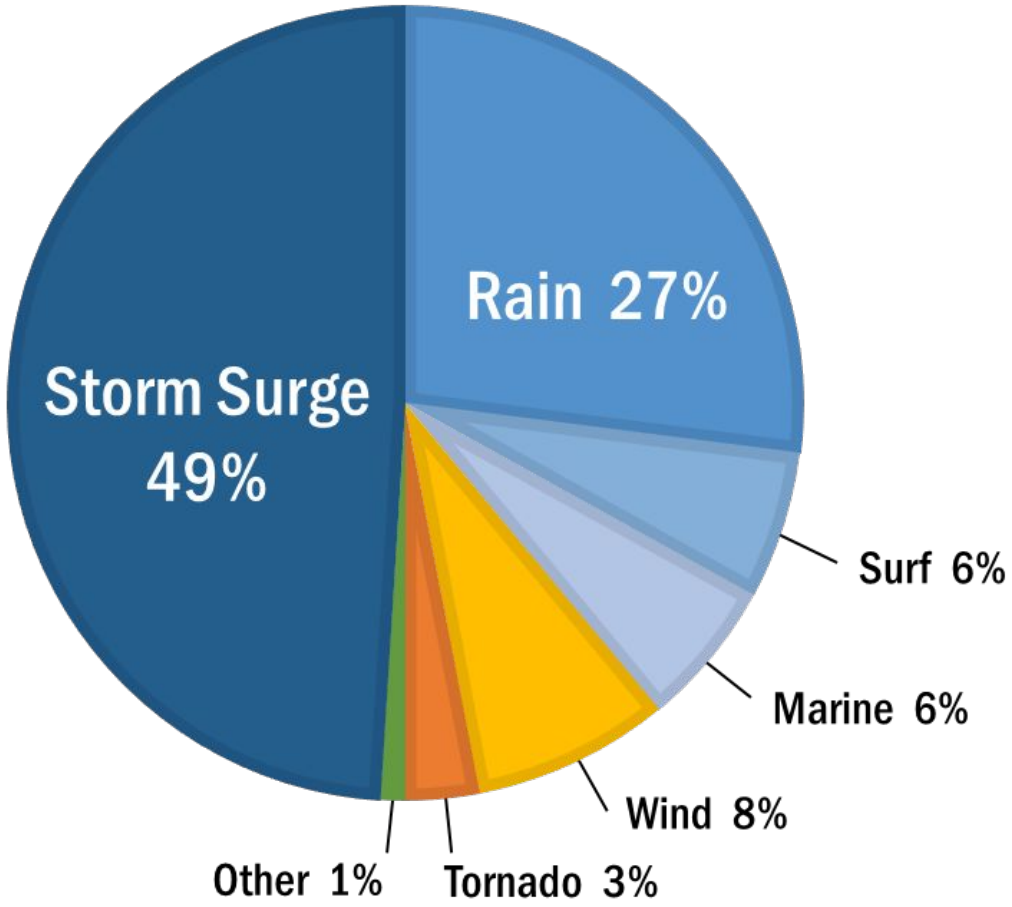
Hurricane Michael: Where is it going; what time will it make landfall?

(Model) Hugging

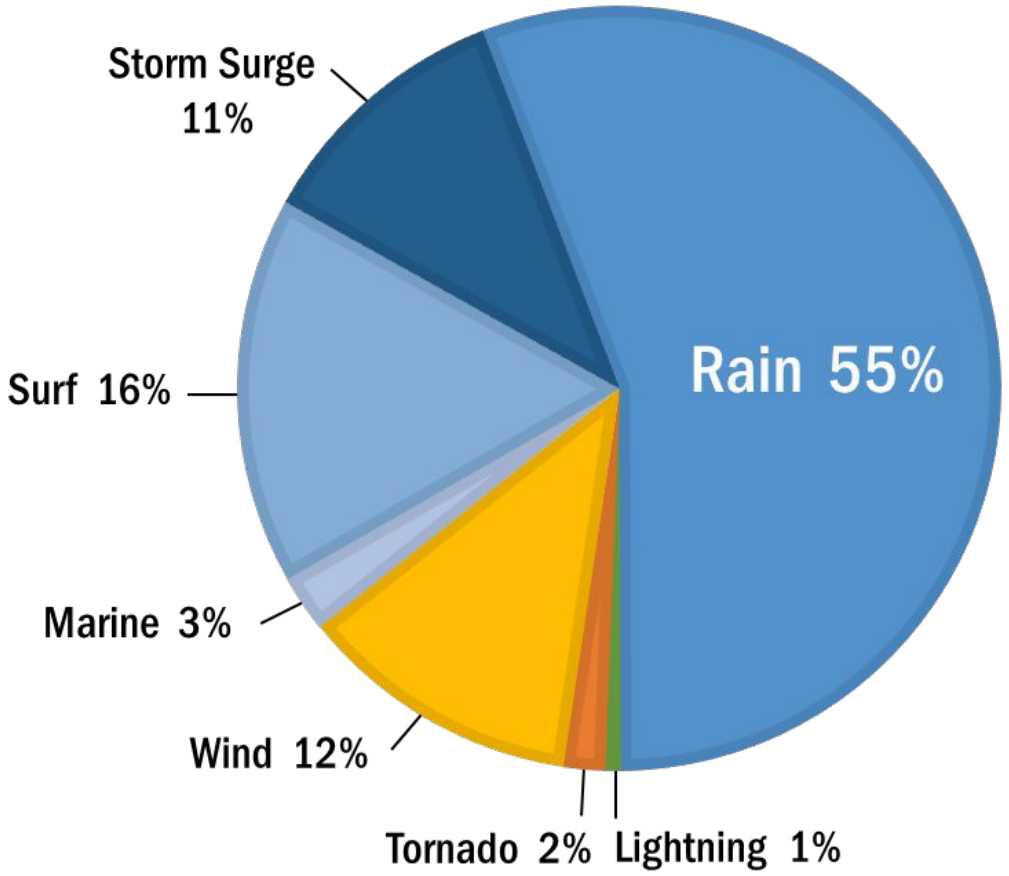
Which hurricane models should you trust in 2023?

U.S. Direct Fatalities from Tropical Cyclones

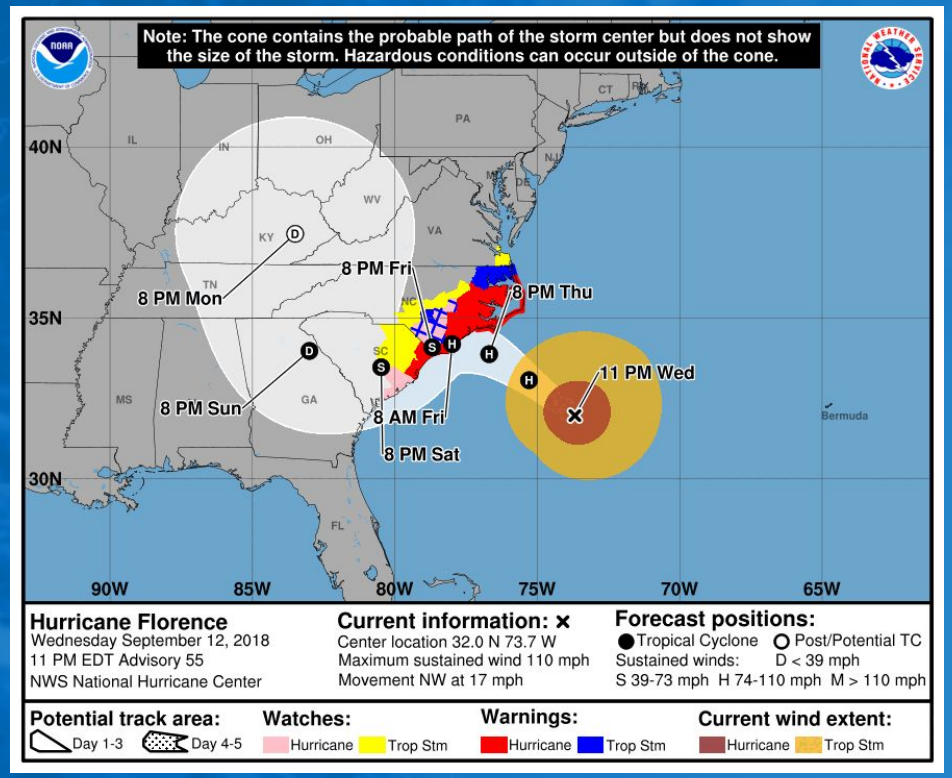
1963 to 2012

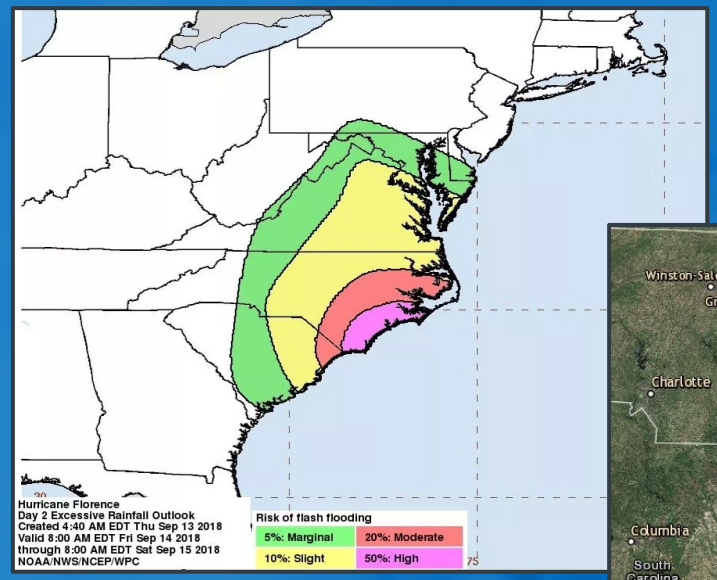


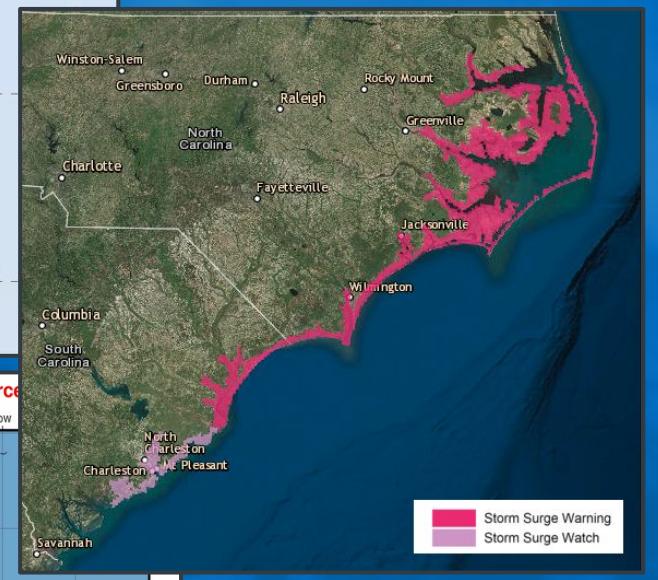
2013 to 2023

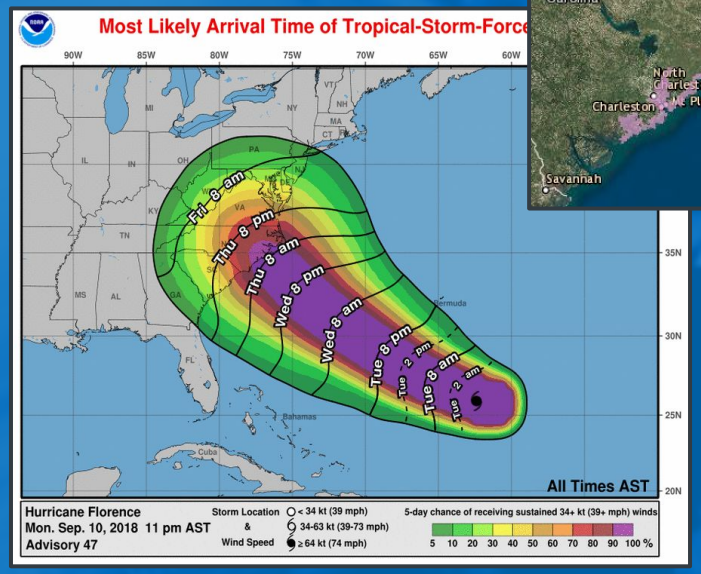


Focus Should Be on Watches/Warnings and the Risk of Individual Hazards





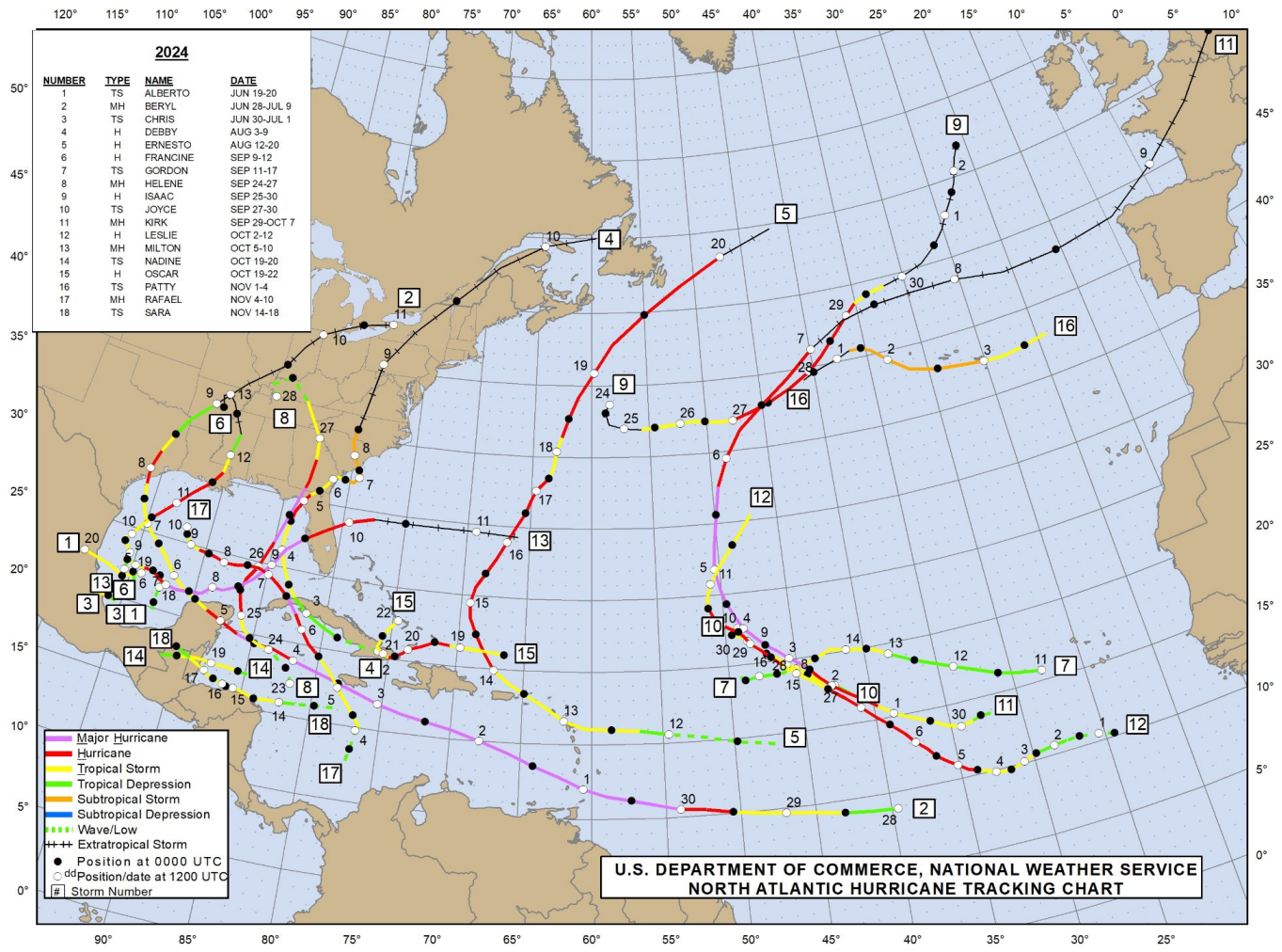




Experimental Cone with Inland Watches/Warnings

What Did We Learn from the 2024 Hurricane Season?

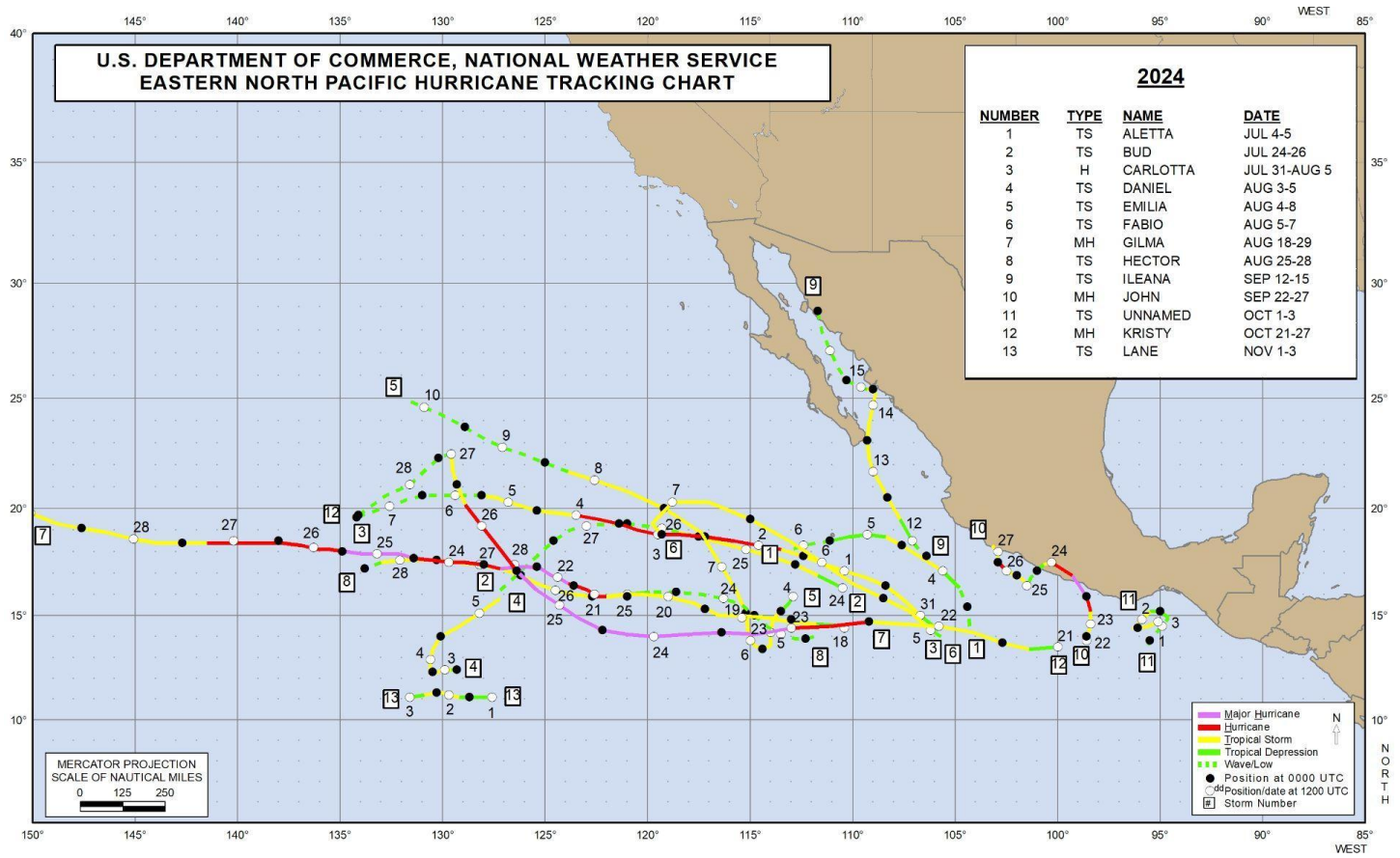
2024 Atlantic Season Summary



Track map for 2024 Atlantic hurricane season

- 18 named storms (14)
  11 hurricanes (7)
  5 major hurricanes (3)
- 10 hurricane landfalls
  - U.S.: 5
  - Cuba: 2
  - Grenada: 1
  - Bermuda: 1
  - Mexico: 1
- 5 U.S. Gulf Coast hurricane landfalls tied for the second most on record
- 425 total fatalities (274 direct, 151 indirect); 358 in U.S.

2024 East Pacific Season Summary



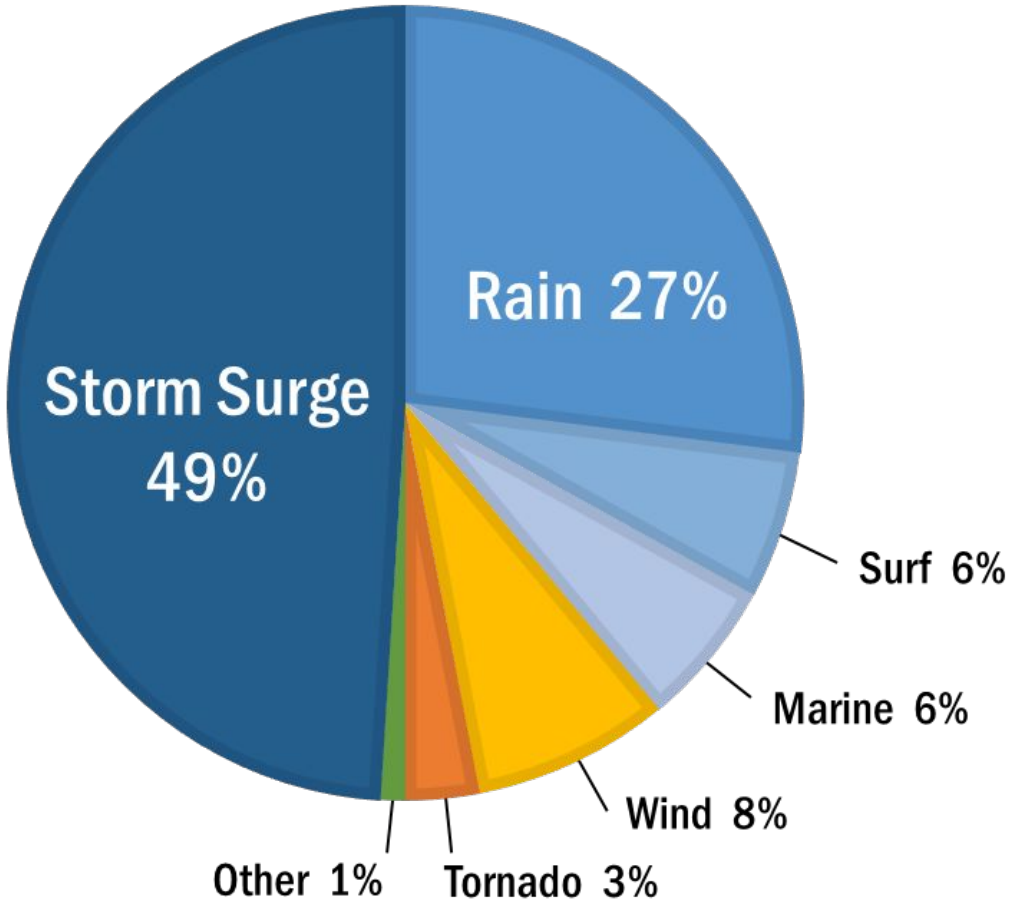
Track map for 2024 east Pacific hurricane season

- 13 named storms (15)
  - 4 hurricanes (8)
  - 3 major hurricanes (4)
- 1 hurricane landfall
  - Mexico: 1
- 31 direct fatalities, all from freshwater flooding
  - 29 – Hurricane John
  - 2 – unnamed tropical storm (formerly Tropical Depression Eleven-E)

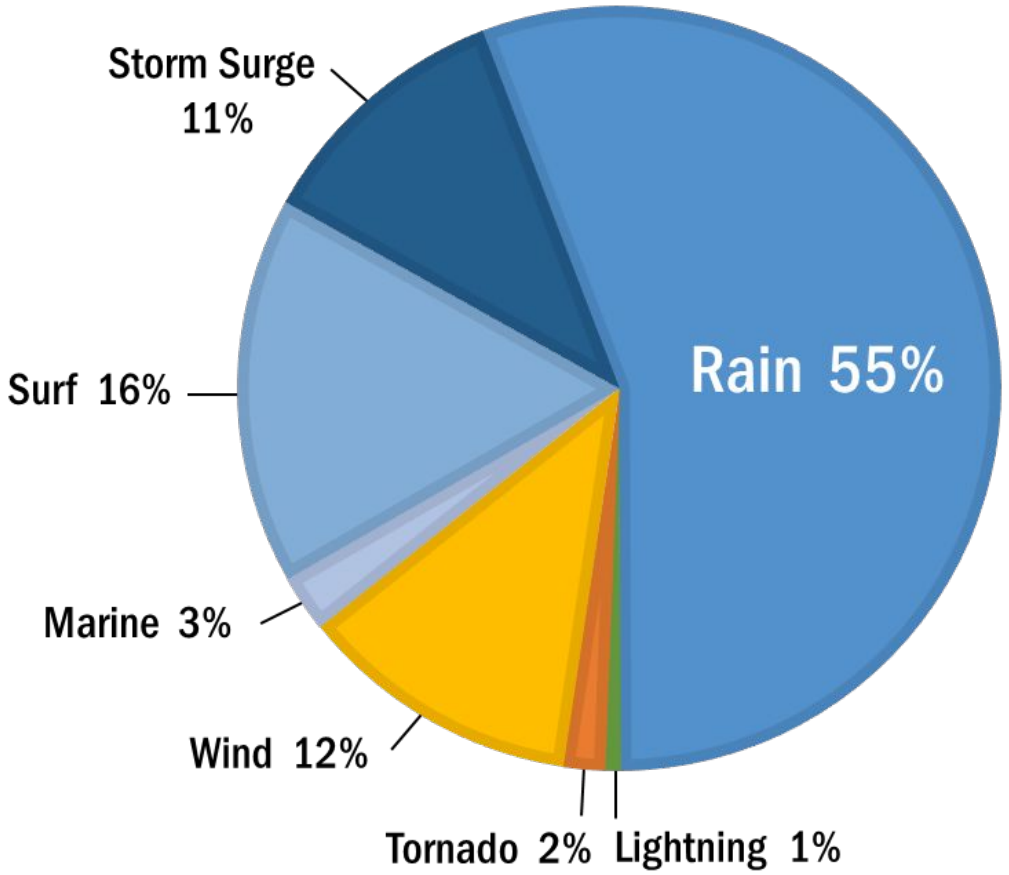
Lesson #1:
Water is Still the Main Villain

U.S. Direct Fatalities from Tropical Cyclones

1963 to 2012



2013 to 2023



In 2024…

- Water (freshwater flooding, storm surge, rip currents/surf, marine incidents) was responsible for
  - 59% of direct deaths from tropical cyclones in the United States (127)
  - 83% of direct deaths from tropical cyclones in other countries across the region (73)

- Freshwater flooding accounted for the most direct deaths
  - Hurricane Helene: 95
  - Hurricane John: 29

- 12 of the 13 storms that caused direct deaths had at least 1 fatality attributed to freshwater flooding

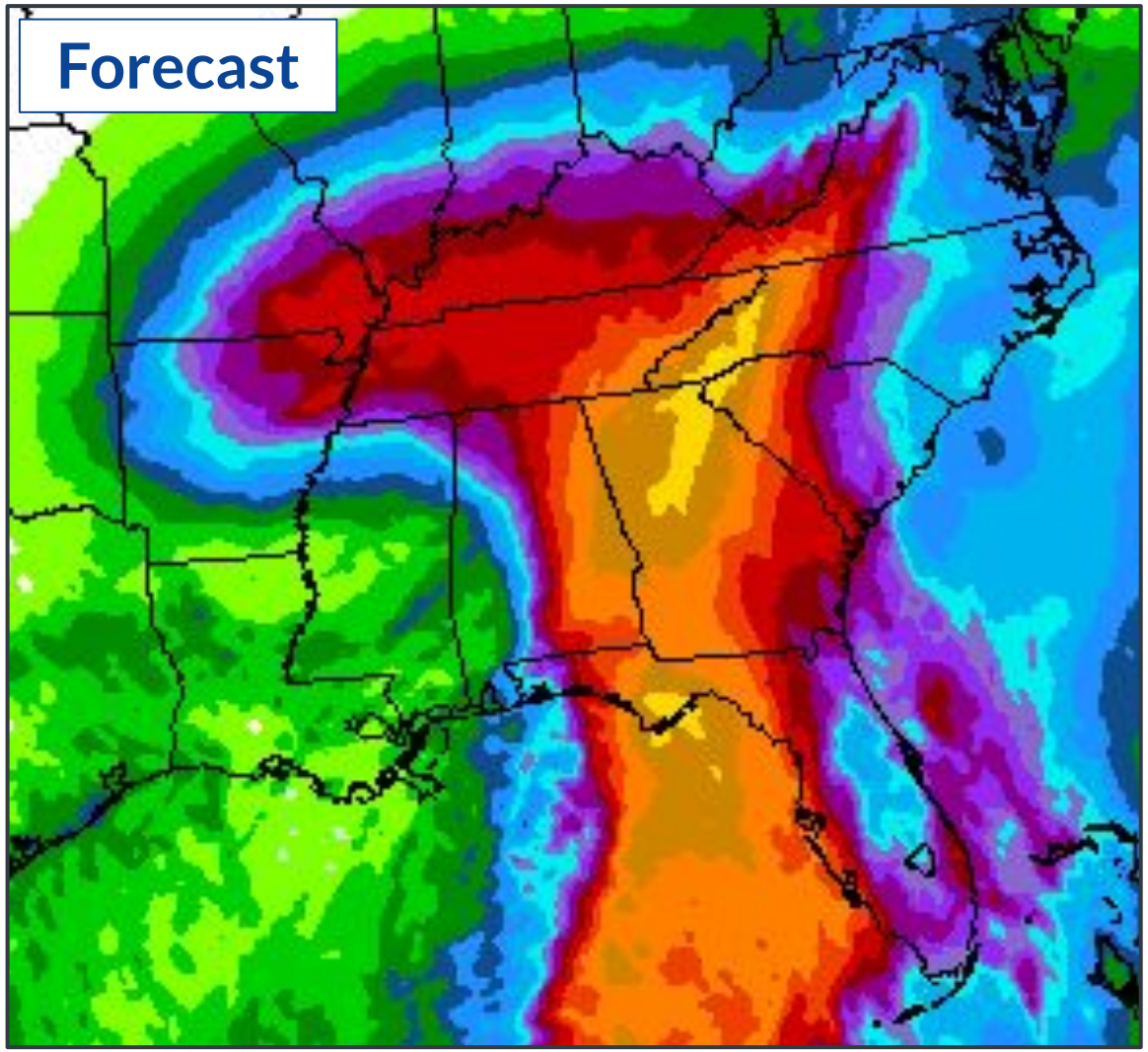

Asheville, NC (Helene)

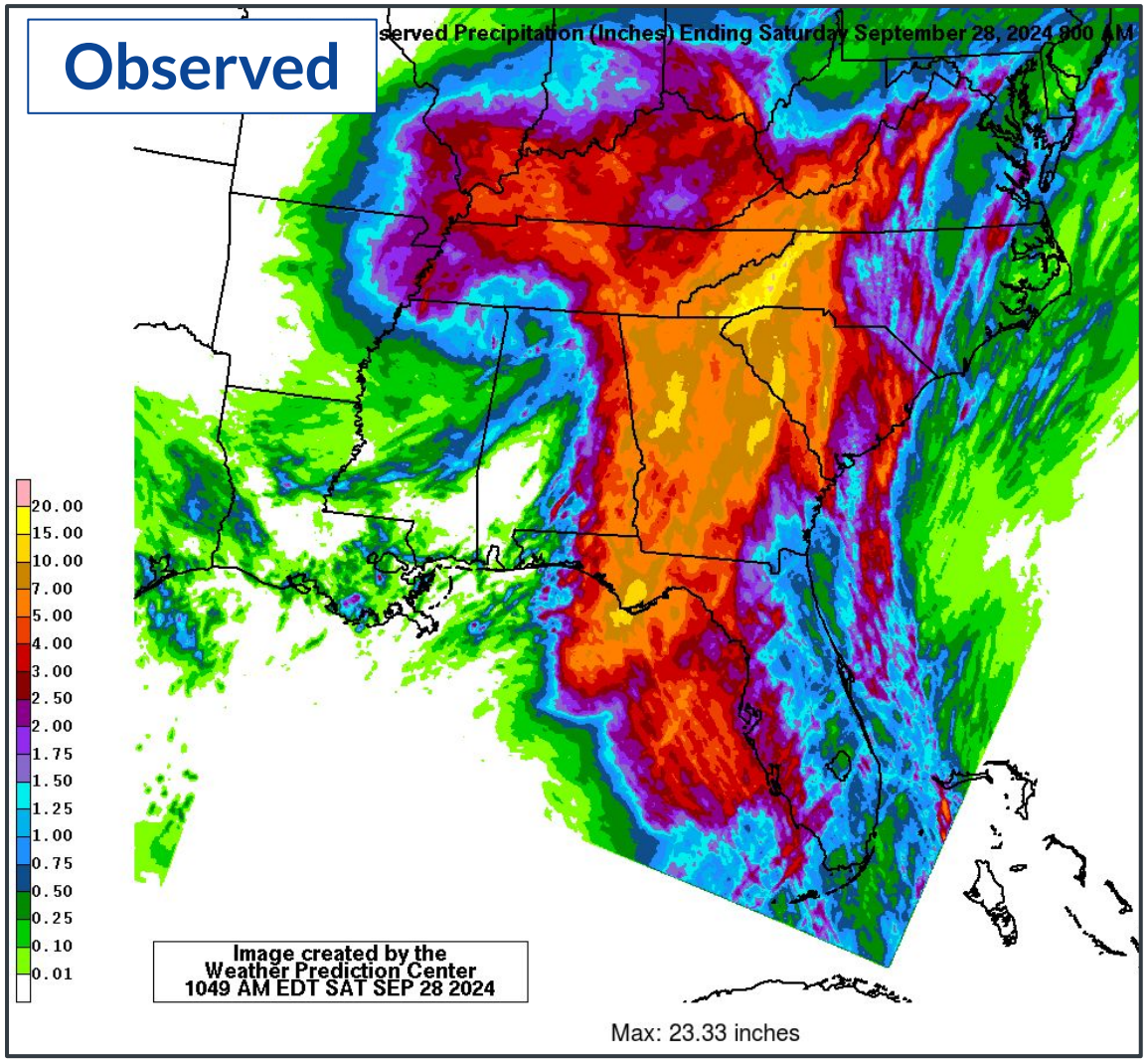

Acapulco, MX (John)


Pinellas Co., FL (Helene)

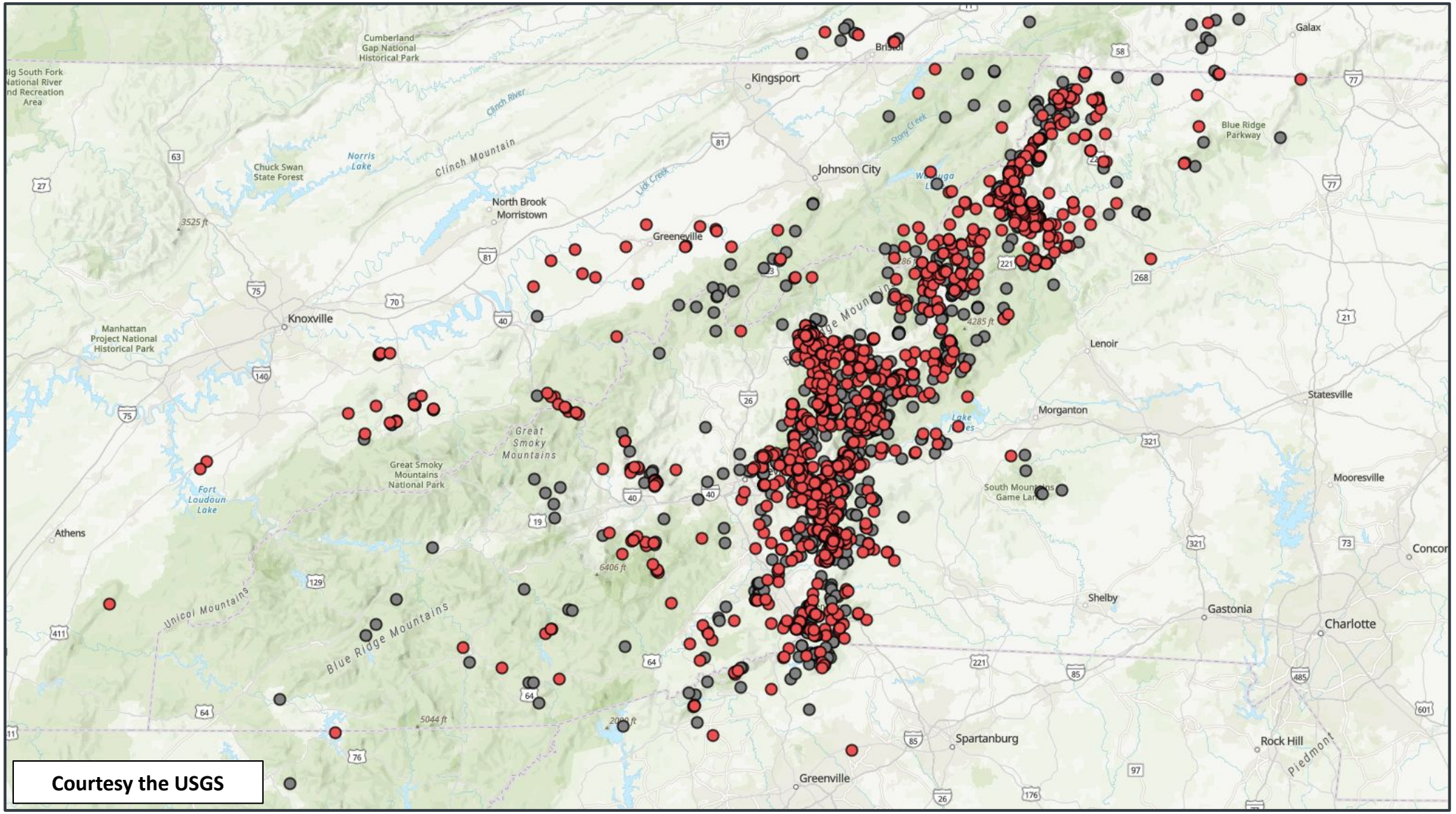
WPC Helene 3-Day "Storm Total" Forecast

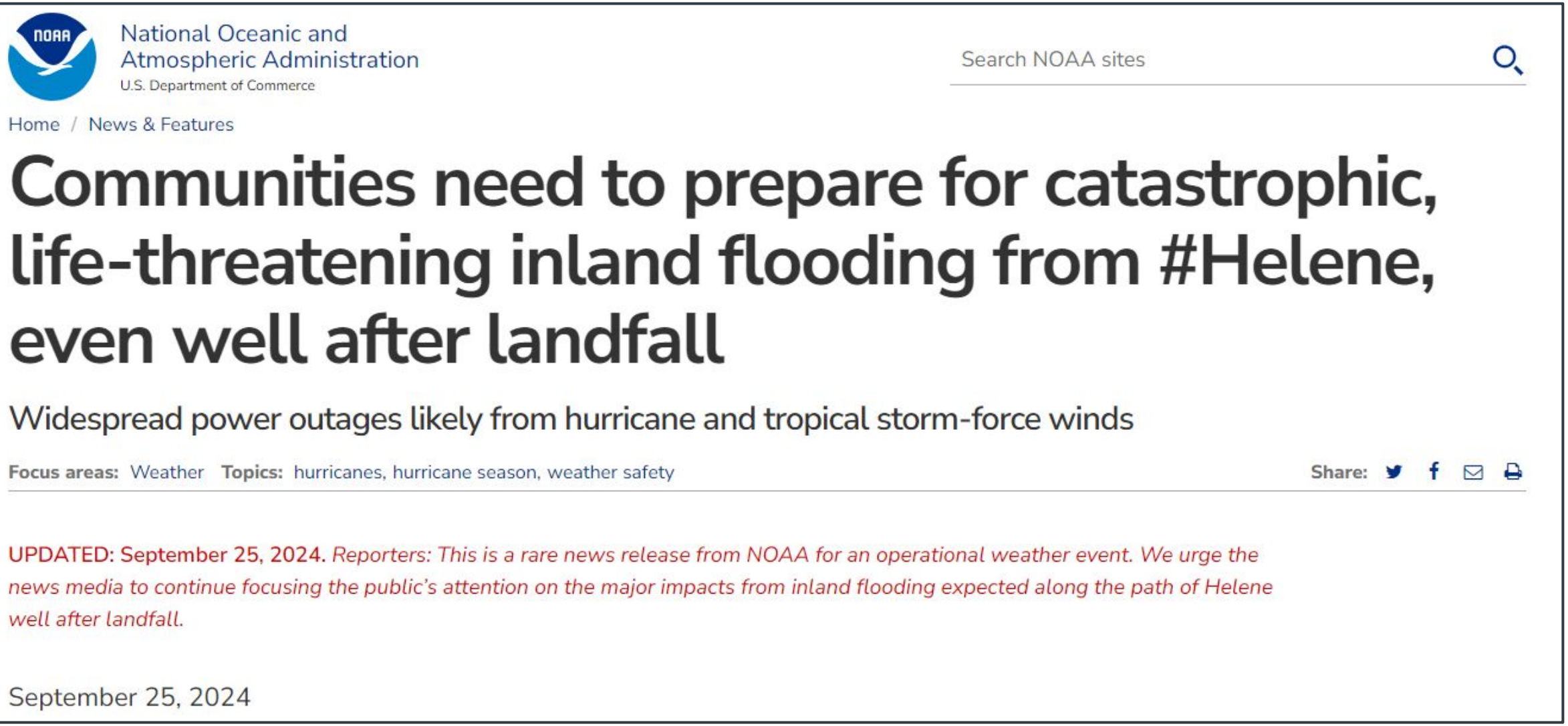
Issued 5 am Wednesday Sep 25





Helene Landslides





National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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Communities need to prepare for catastrophic, life-threatening inland flooding from #Helene, even well after landfall

Widespread power outages likely from hurricane and tropical storm-force winds

Focus areas: Weather **Topics:** hurricanes, hurricane season, weather safety **Share:**

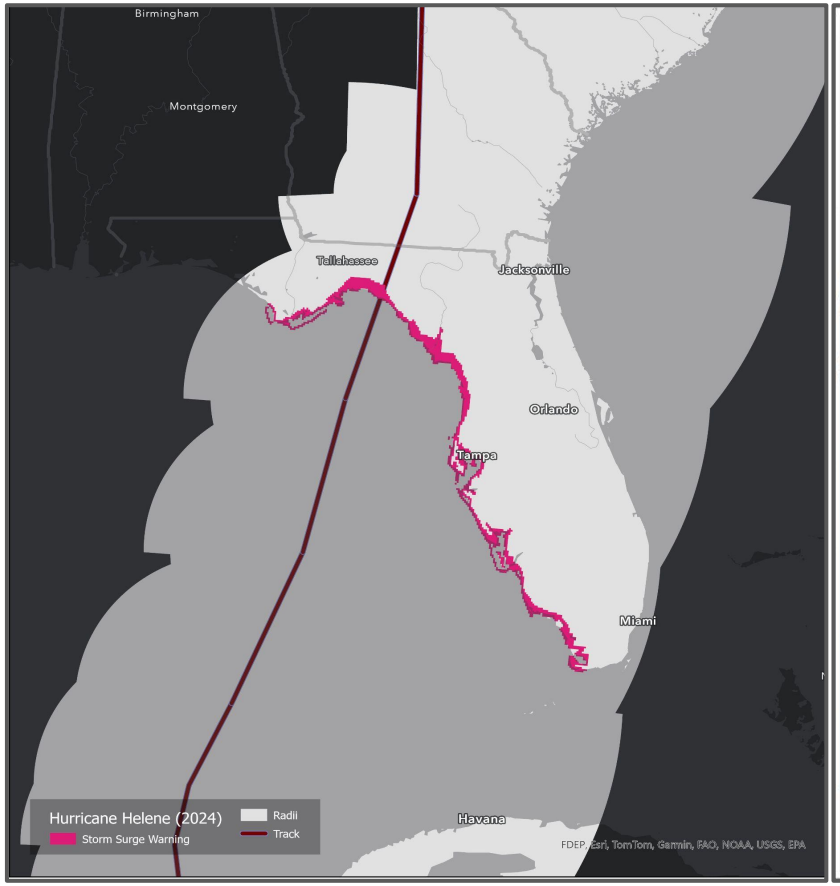
UPDATED: September 25, 2024. *Reporters: This is a rare news release from NOAA for an operational weather event. We urge the news media to continue focusing the public's attention on the major impacts from inland flooding expected along the path of Helene well after landfall.*

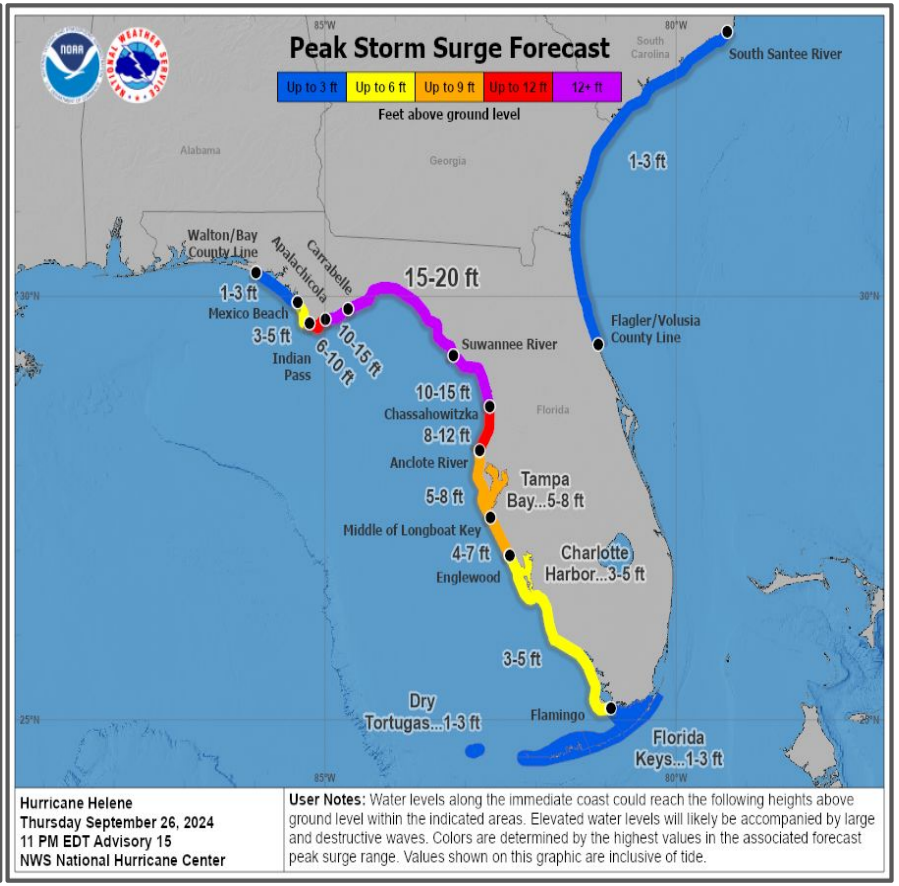
September 25, 2024

NOAA Press Release
https://www.noaa.gov/news-release/communities-need-to-prepare-for-catastrophic-life-threatening-inland-flooding-from-helene-even-well

Hurricane Helene - Storm Surge

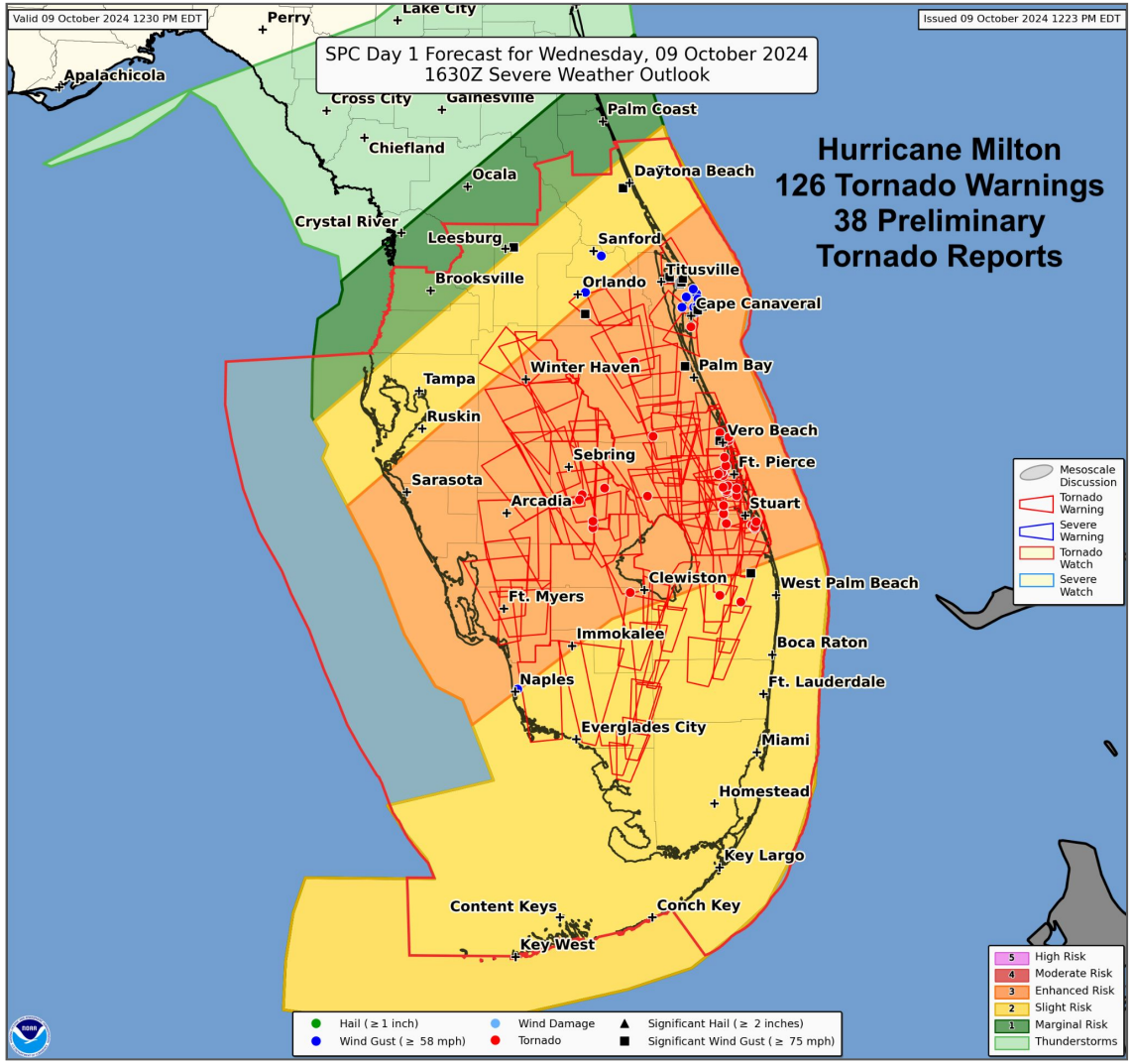
- Storm Surge Warning for much of the FL West Coast about 40 hours prior to water levels rising
- More than 15 feet AGL of storm surge predicted for Florida Big Bend and verified by HWM team
- Record breaking storm surge in Tampa Bay, with maximum inundation of 7 ft AGL observed
- 9 known storm surge fatalities, all in Pinellas County, FL





Lesson #2:
Yes, Hurricanes Can Spawn Significant Tornadoes

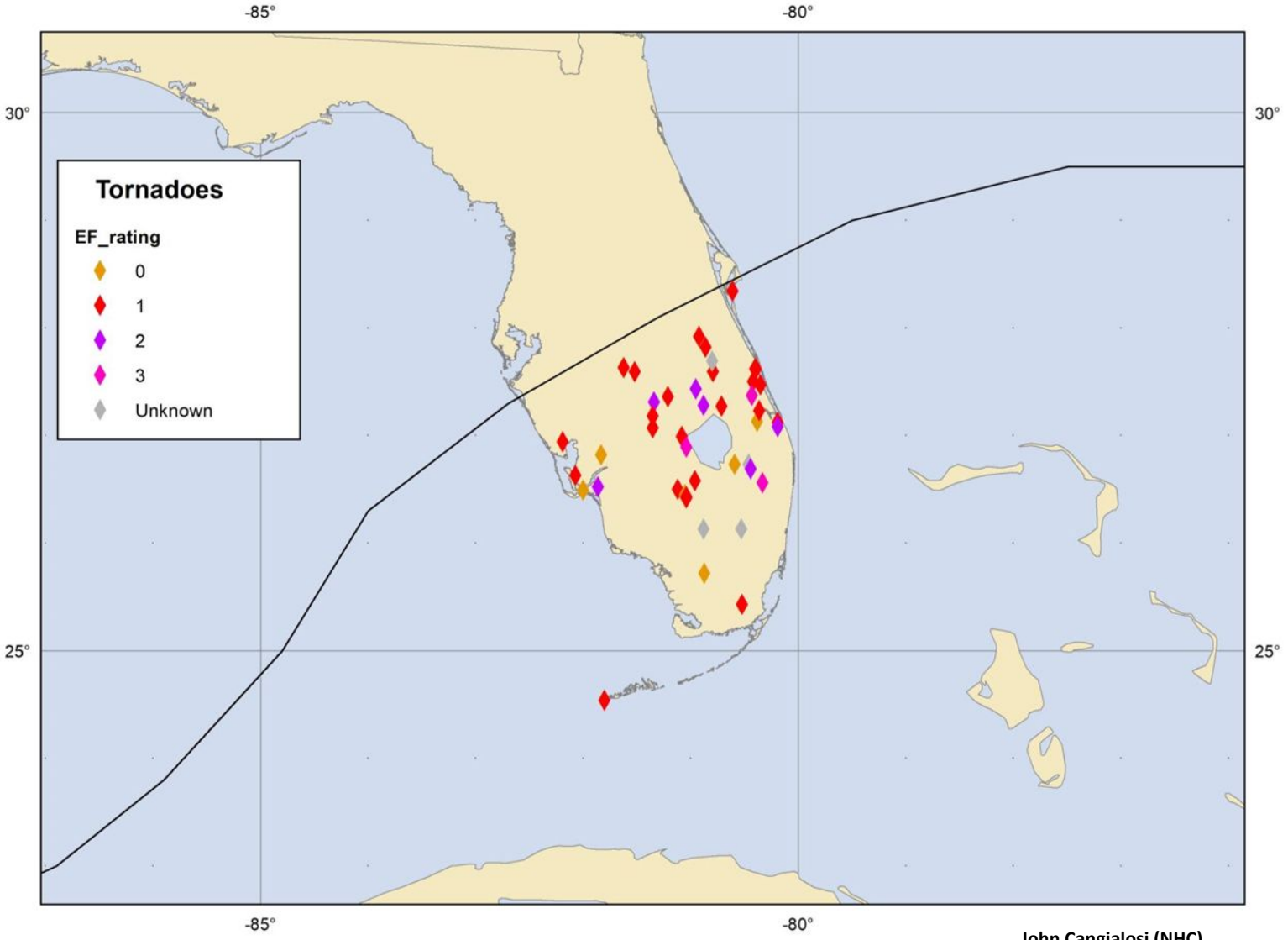
Hurricane Milton Tornadoes



Tornado Warnings for Milton:

- NWS offices issued 126 tornado warnings
- 2nd largest number for a single state on a single day
- 1st is 134 in Alabama on April 27, 2011

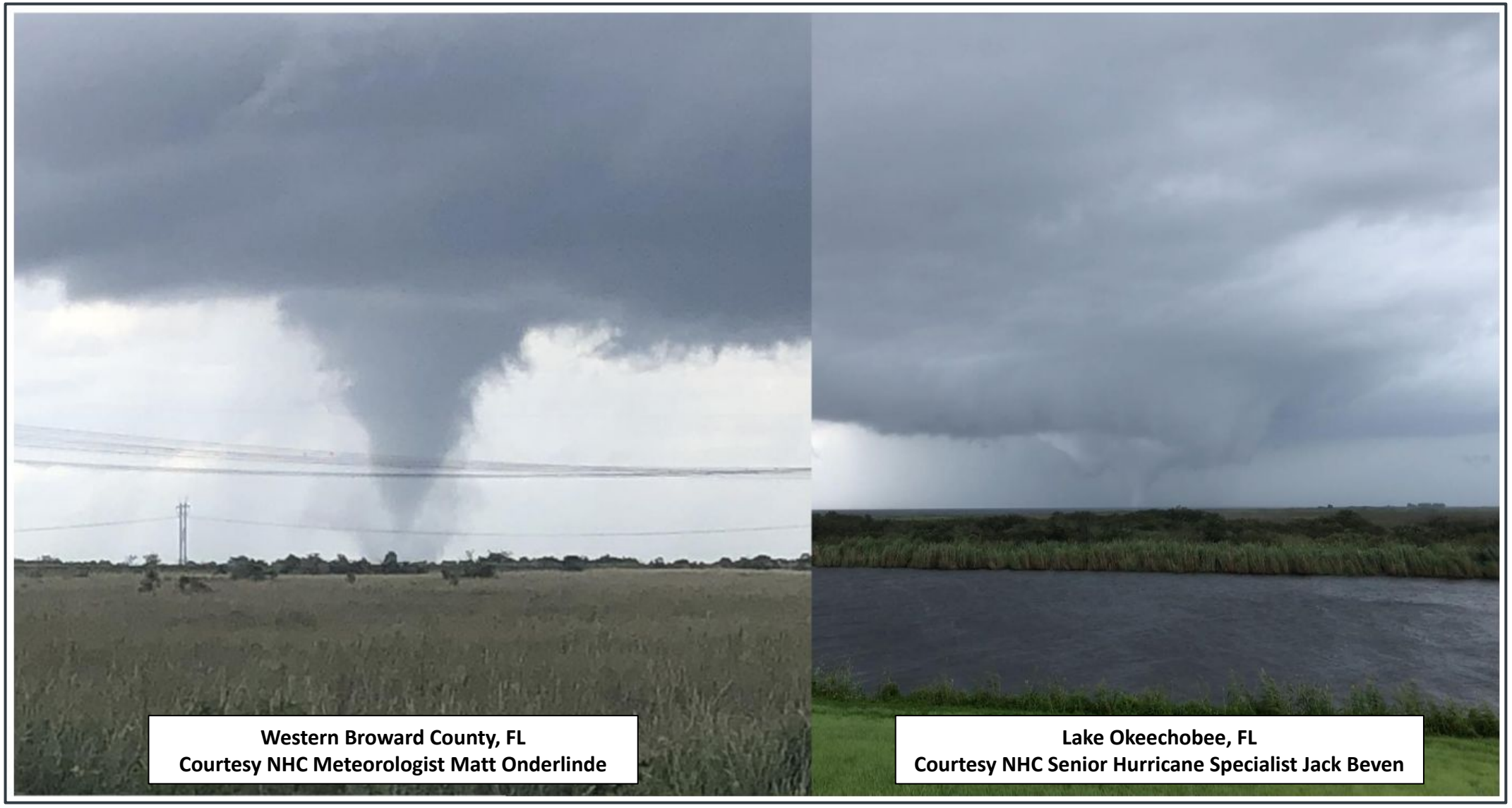
Hurricane Milton Tornadoes



John Cangialosi (NHC)

- 45 known tornadoes, 1 tornadic waterspout
- 3 EF3 tornadoes
  - First tropical cyclone in SPC's database (since 1995) to produce more than 1 EF3
- 6 fatalities due to tornadoes

Hurricane Milton Tornadoes



Western Broward County, FL
Courtesy NHC Meteorologist Matt Onderlinde

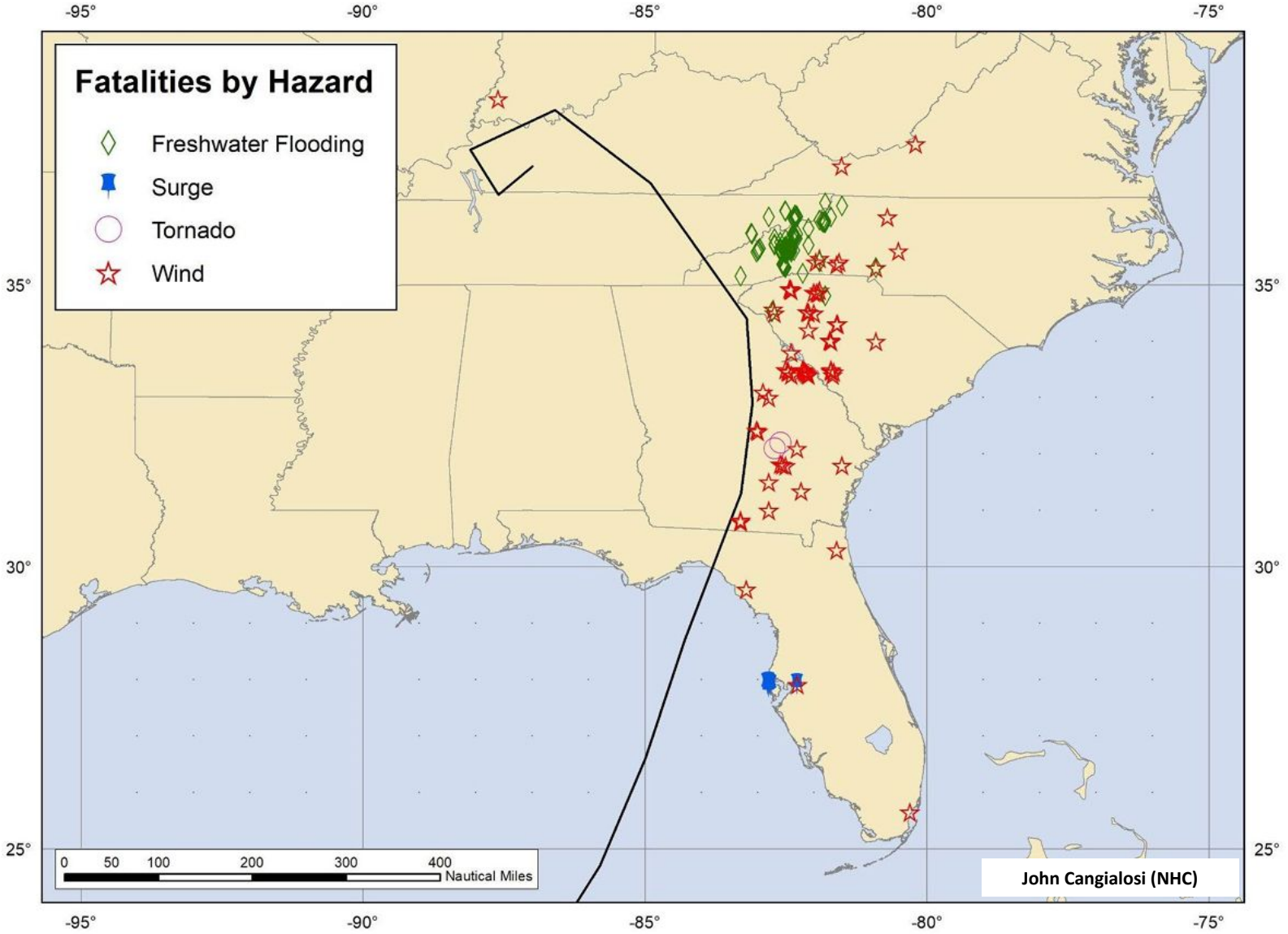
Lake Okeechobee, FL
Courtesy NHC Senior Hurricane Specialist Jack Beven

Hurricane Milton Tornadoes

EF3 tornado near Lakeport, Florida

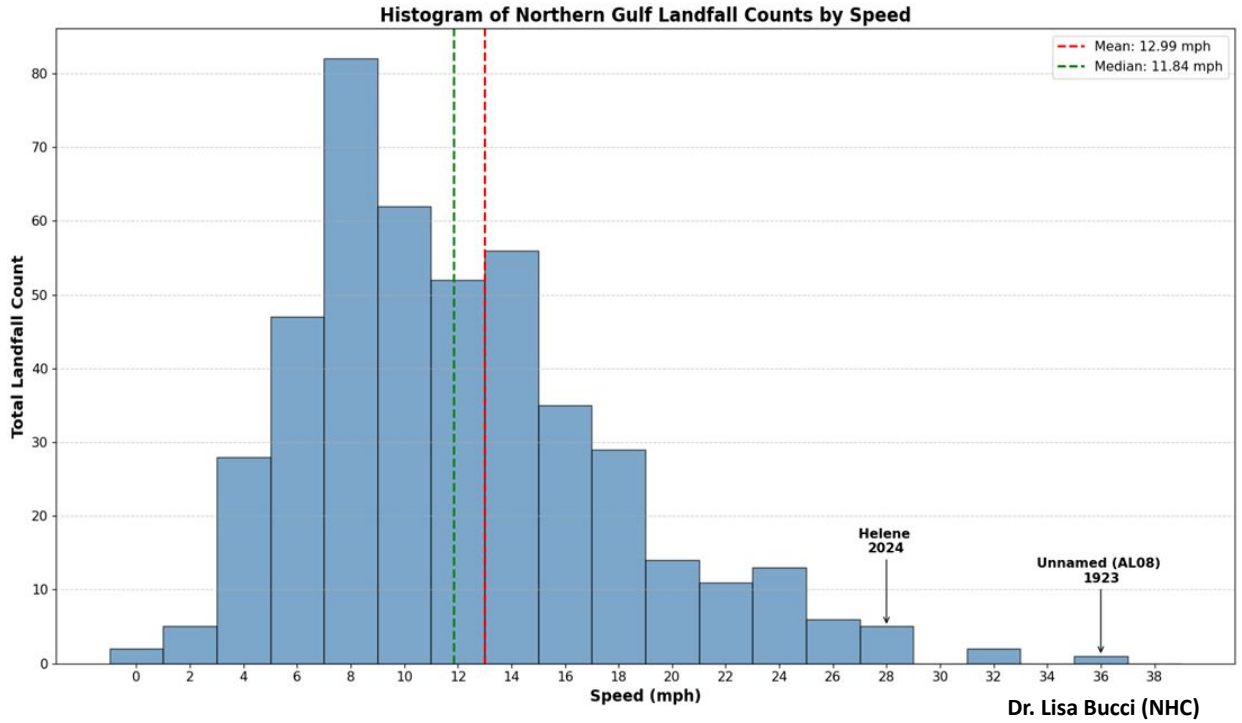
Lesson #3:
Wind Gusts Matter

Hurricane Helene Fatalities

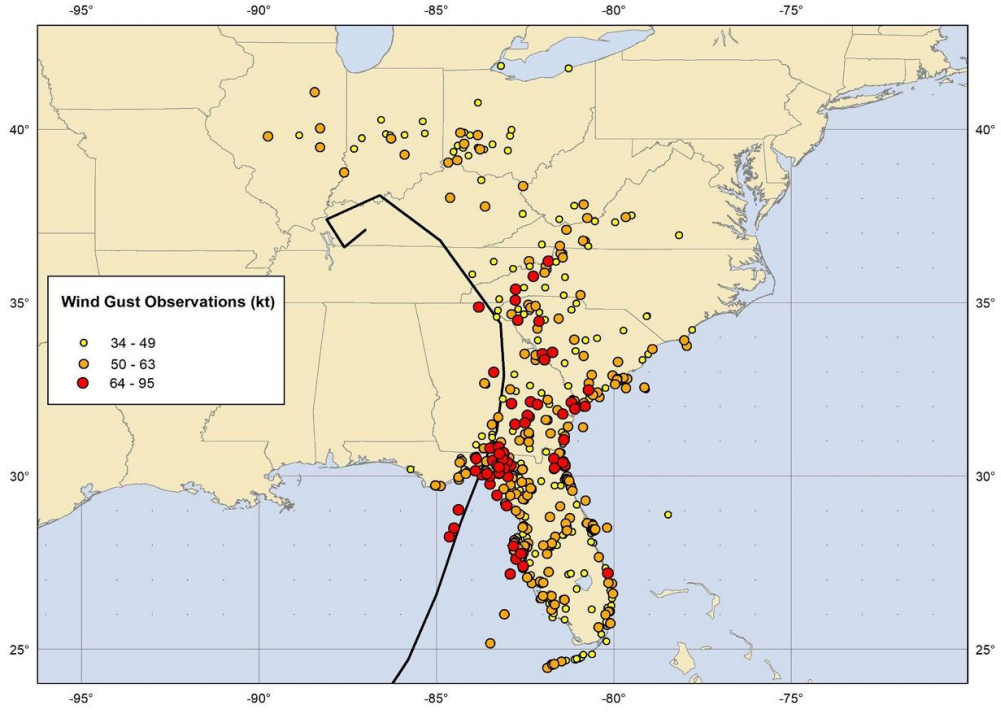


- 79 U.S. wind fatalities from Beryl, Debby, Helene, and Milton
  - Most in a year since at least 1963
- 10 U.S. tornado fatalities from same storms
  - Second most in one year (behind 2004)

Hurricane Helene



Dr. Lisa Bucci (NHC)



John Cangialosi (NHC)

- Strong winds occurred well inland due to
  - Helene's fast forward speed (twice what is normal)
  - Mountainous terrain

- Notable wind gusts
  - Mt. Mitchell, NC: 106 mph
  - Banner Elk, NC: 101 mph
  - Alma, GA: 100 mph
  - Augusta, GA: 82 mph

Hurricane Helene

August, Georgia

Pictures courtesy of NWS Columbia

Hurricane Helene

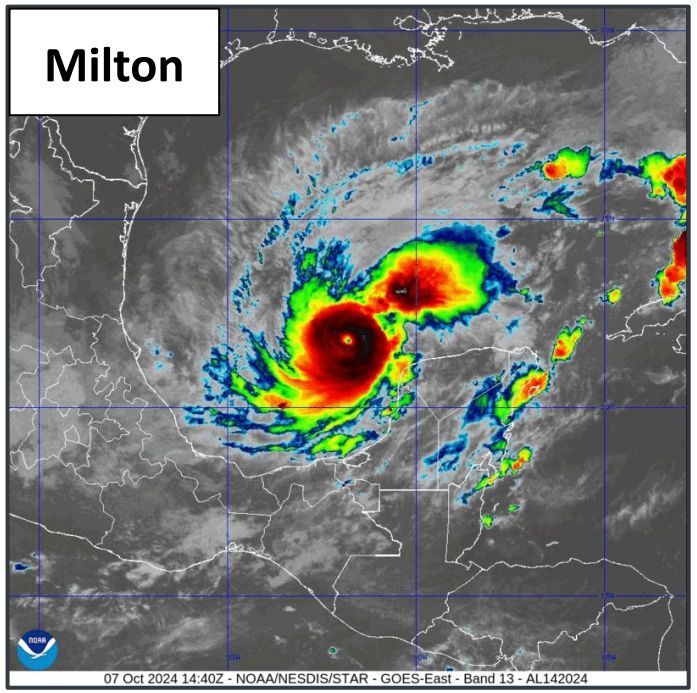
North Carolina Mountains

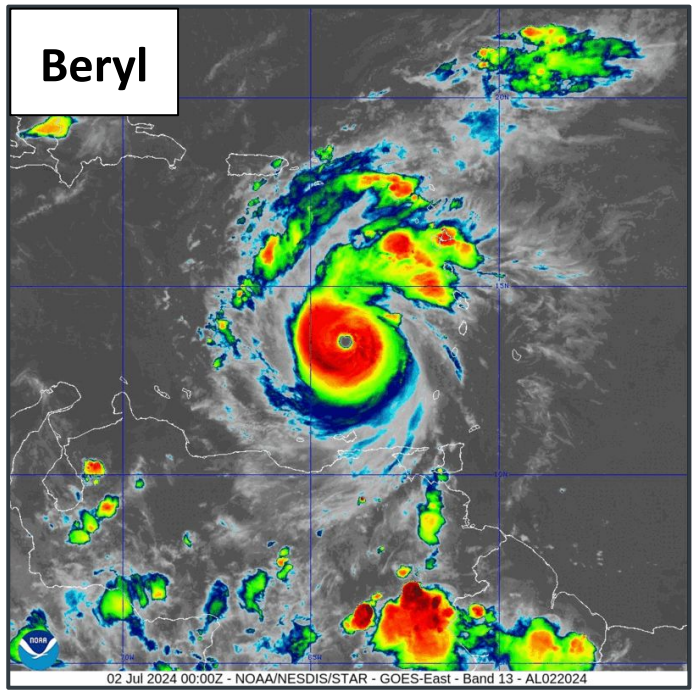
Lesson #4:
Rapid Intensification Is (And Will Likely Continue to Be) a Problem…But There's Hope

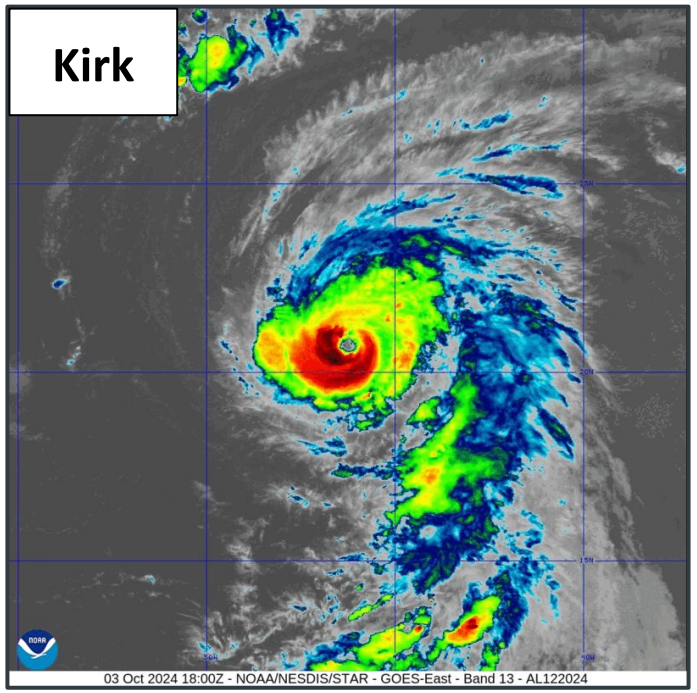
2024 Rapid Intensification

- There were **34** cases of rapid intensification (RI) in the Atlantic in 2024
  - Each case is defined as a separate 24-hour period of at least a 35 mph (30 knot) increase in winds
  - Nearly double the mean number of RI cases in a typical year [18 (2014-2023)]

- Hurricane Milton strengthened by 90 mph (80 kt) over 24 hours on from Oct. 6 to 7
  - Pressure dropped by 82 mb in about 16 ½ hours to 895 mb





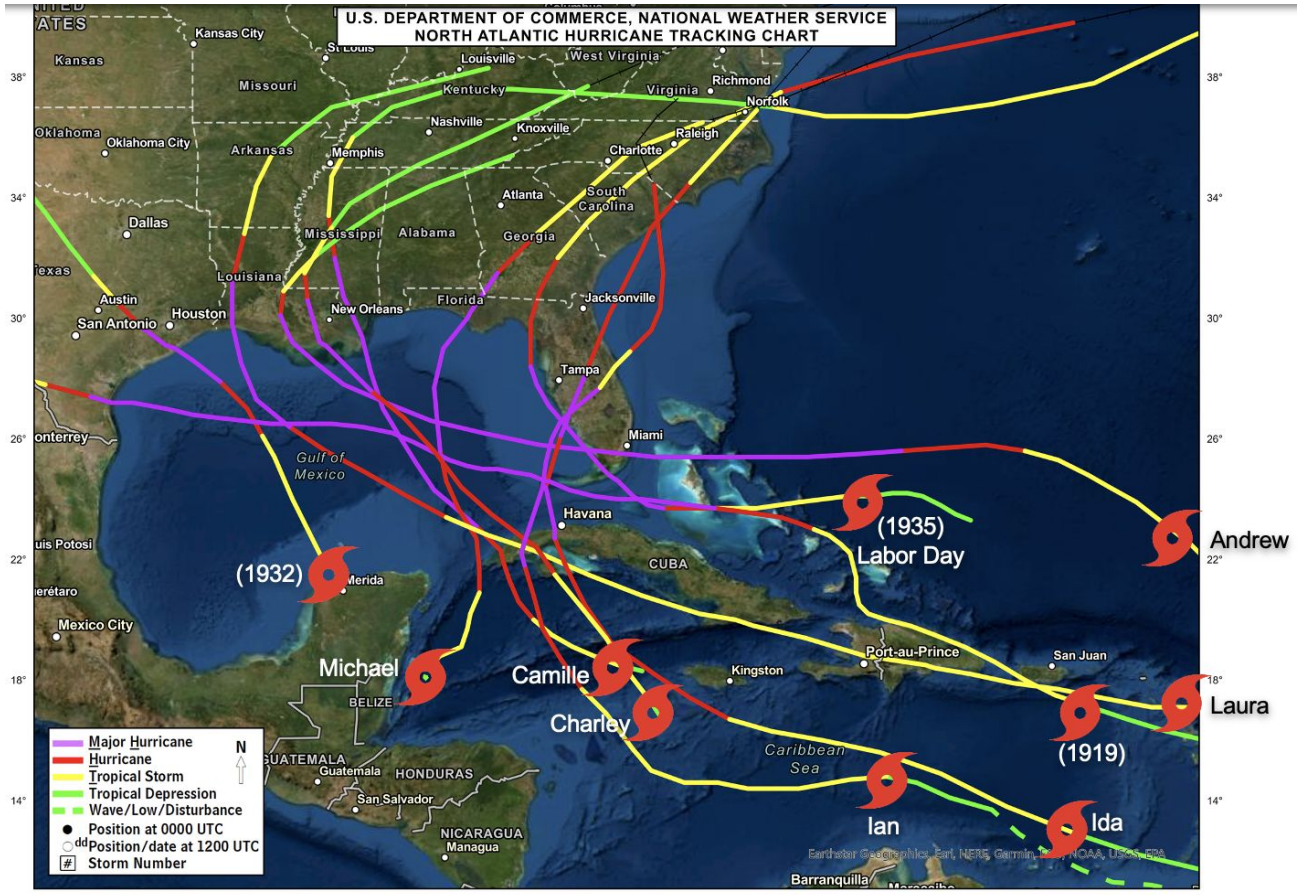


RI Near Land Means Short Prep Times

The Nation's strongest hurricanes (150+ mph) in the last 100 years were **all tropical storms 3 days before landfall**

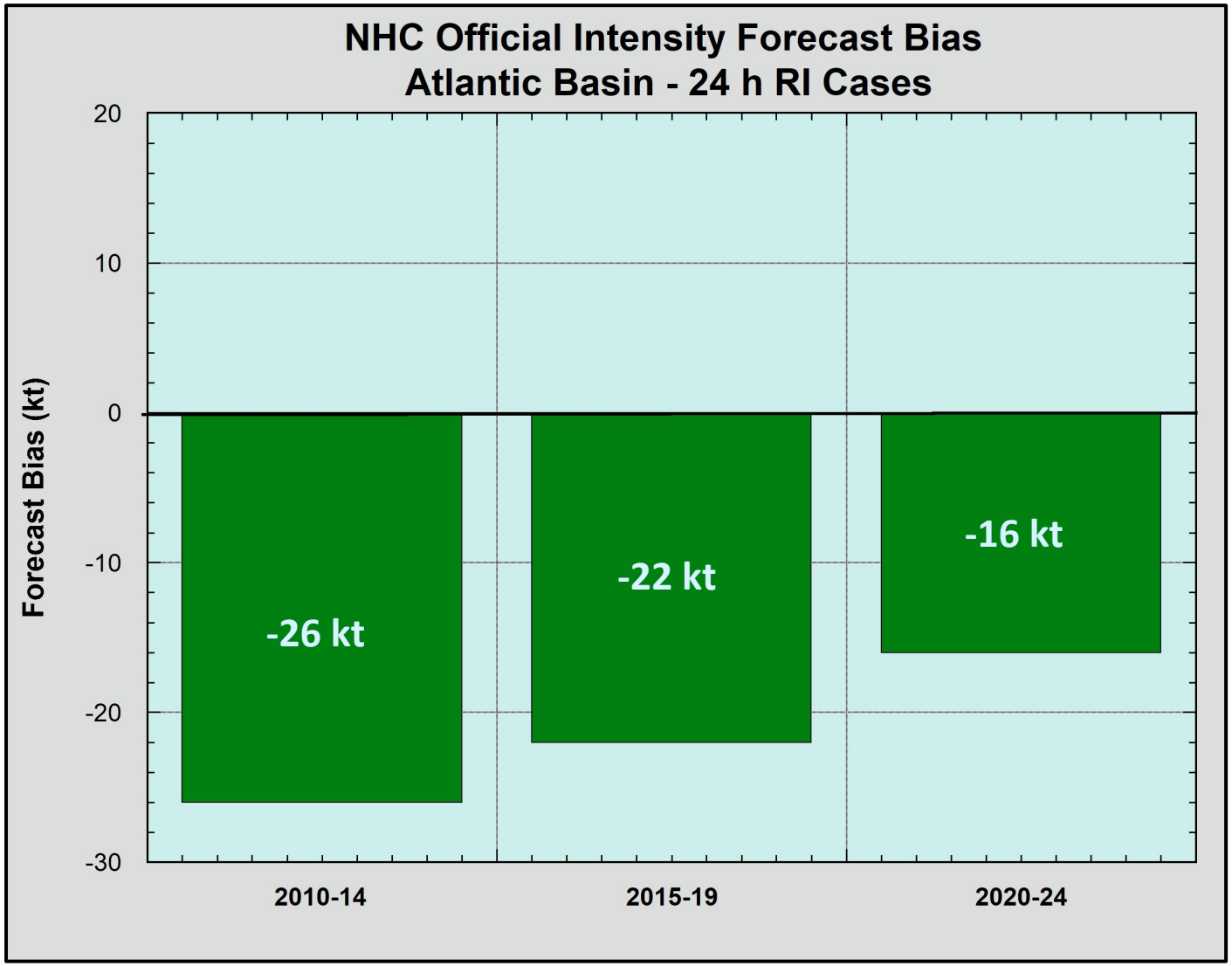
U.S. 150 mph+

1919 – Storm 2
1932 – Storm 2
1935 – Labor Day
1969 – Camille
1992 – Andrew
2004 – Charley
2018 – Michael
2020 – Laura
2021 – Ida
2022 – Ian



Average time to become a hurricane is **50 h before landfall**

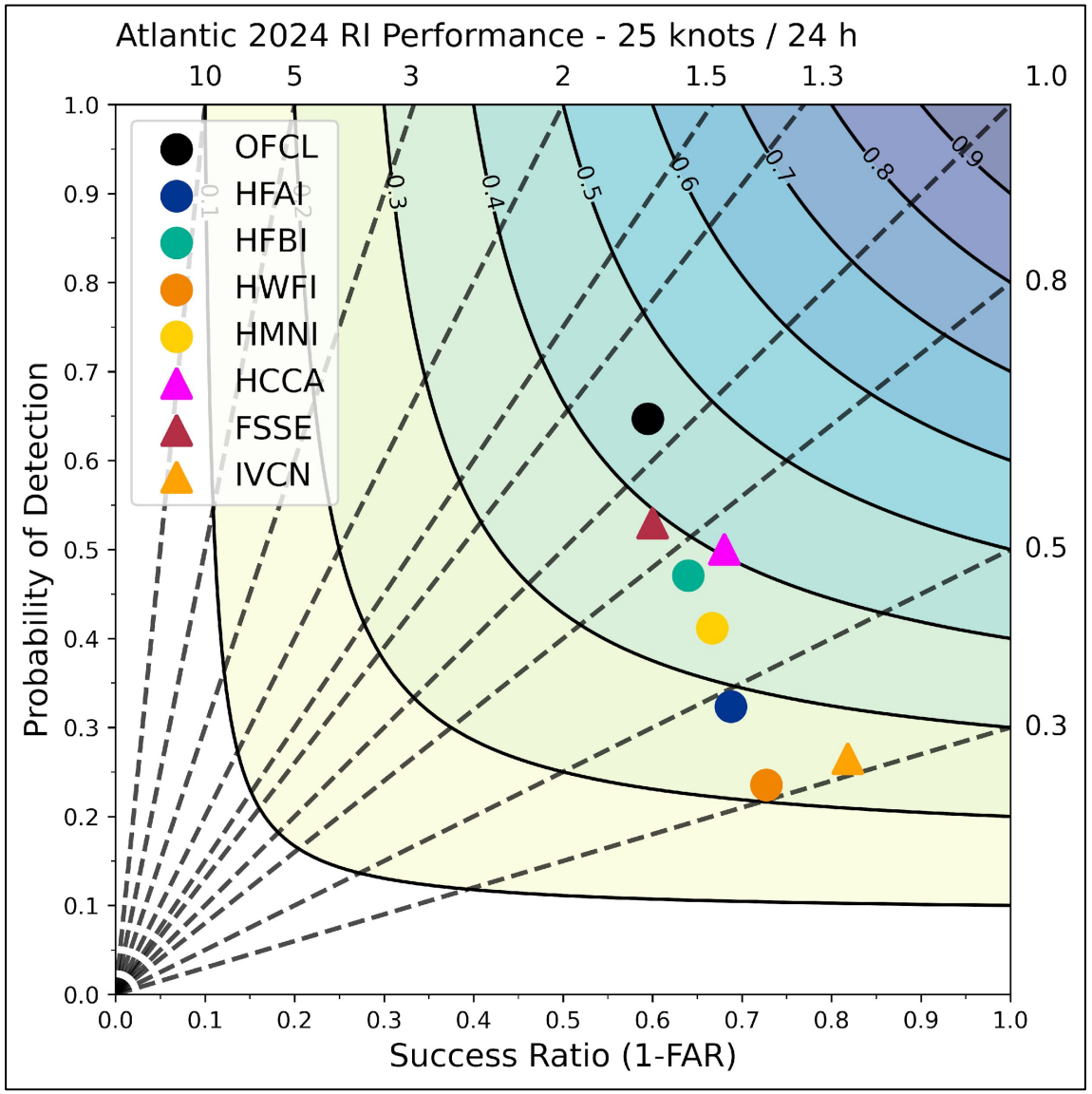
Progress in Forecasting Rapid Intensification



There are encouraging trends that NHC forecasters are gradually getting better at forecasting RI

Our intensity forecast biases for RI cases has decreased from 26 kt (30 mph) too low to 16 kt (18 mph) too low over the past 10-15 years

There's Even Some Skill over the Models…



Critical Success Index (CSI)

Goal: You want to be as far in the upper right (purple shading) as possible.

- High in detection
- Low in false alarms

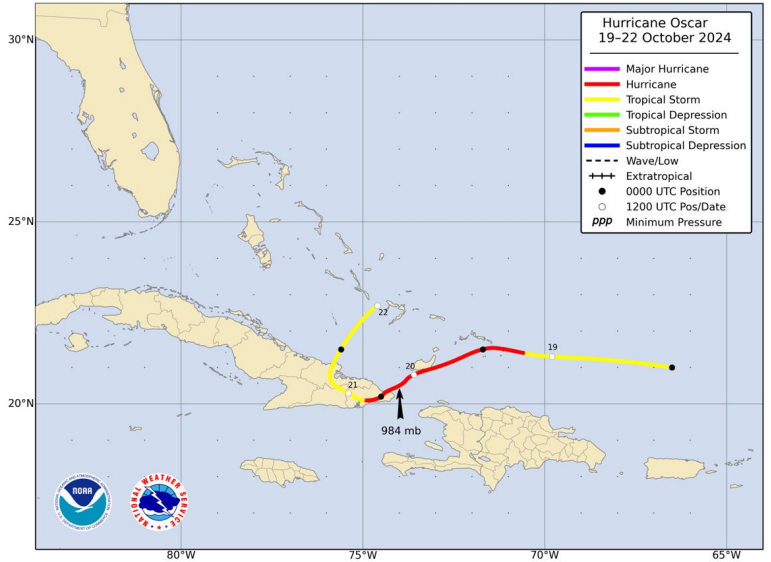
Note that NHC's 2024 RI forecasts (🟧) have a higher CSI than the intensity models used to make the forecasts

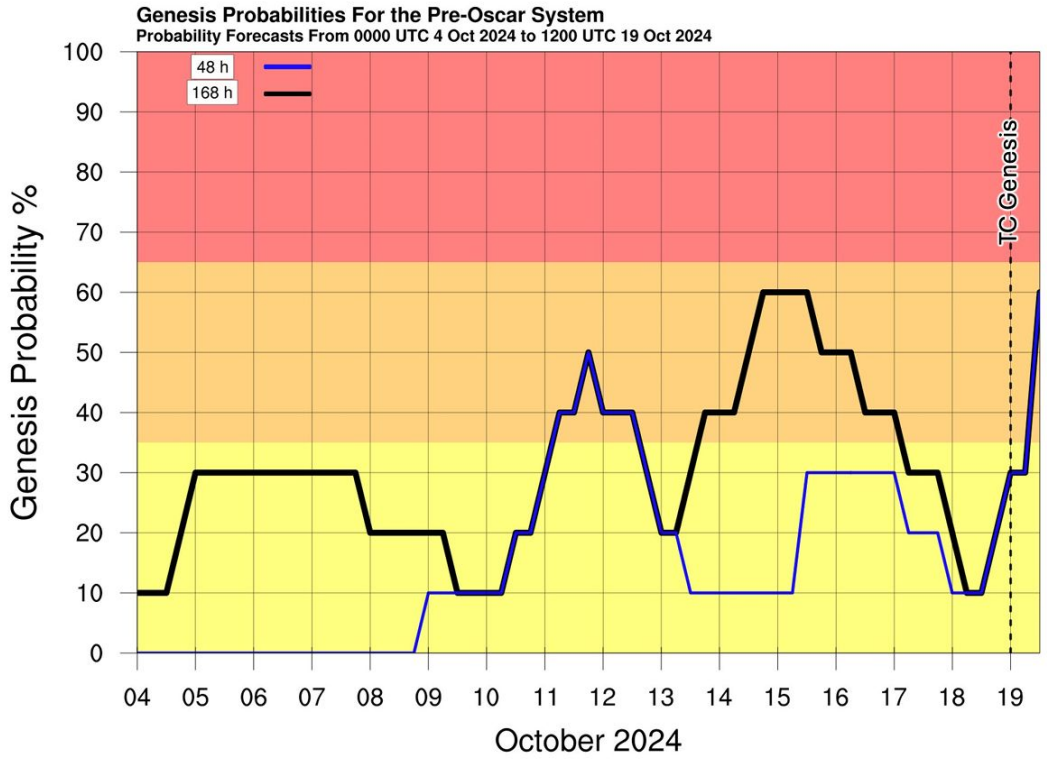
- Mostly driven by a higher rate of detection than the models

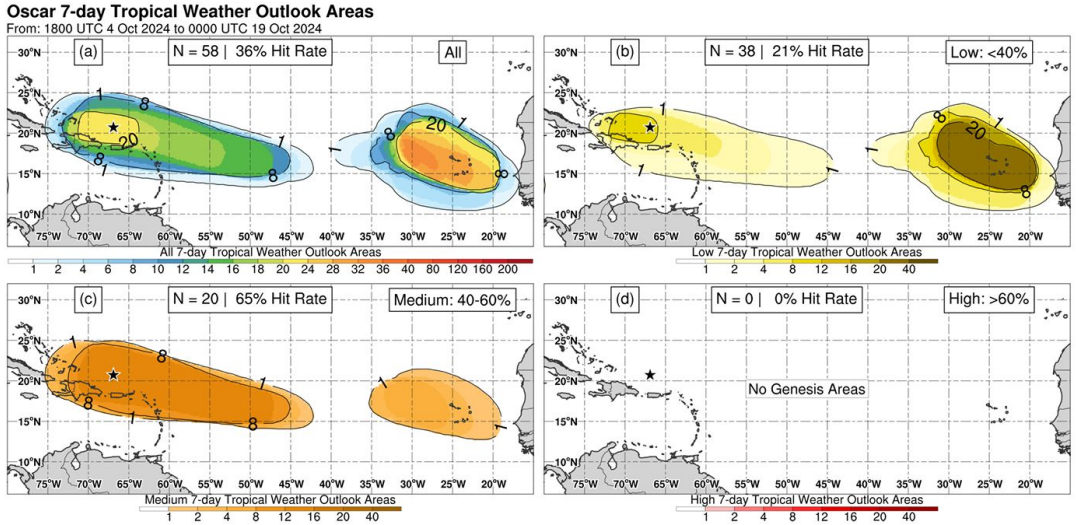
Lesson #5: Storm Formation Can Still Sometimes Be Unexpected

Hurricane Oscar

- Genesis probabilities for Oscar never got in the high category before formation
- Oscar's tiny size may have played a role



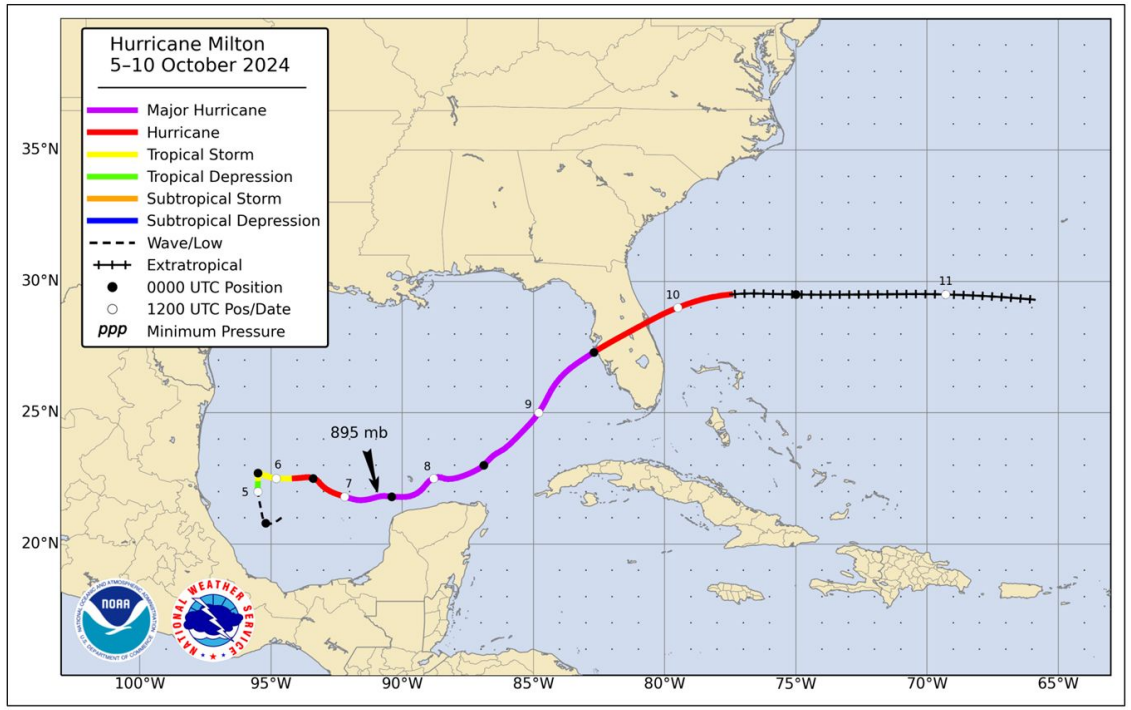


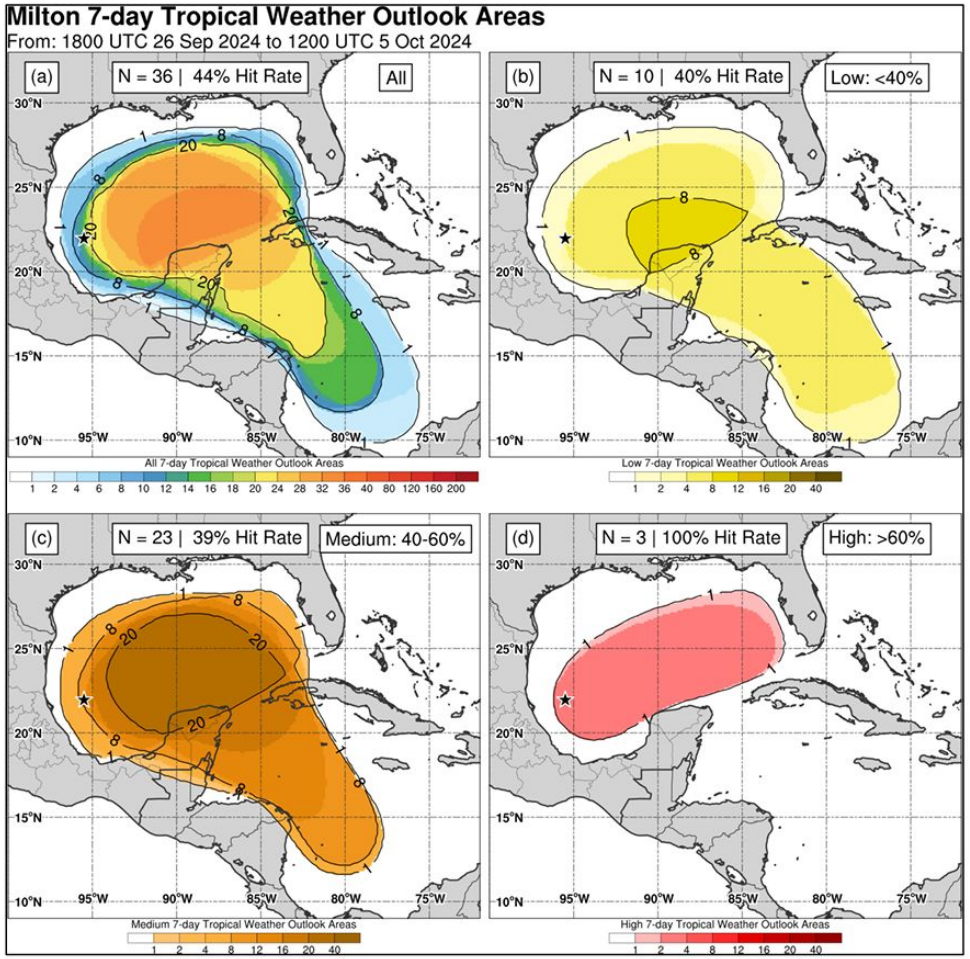


Hurricane Milton

- Short-term genesis chances were 0% at the time Milton formed (although long-term chances were high)

- The forecast for genesis location was poor

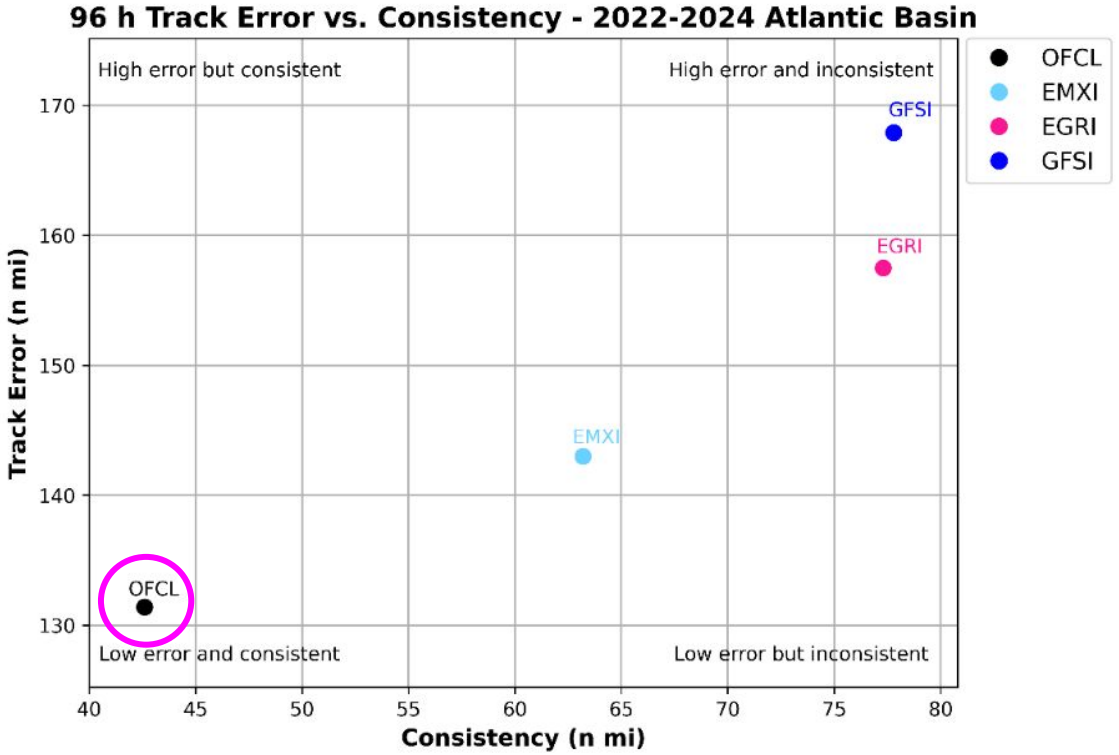




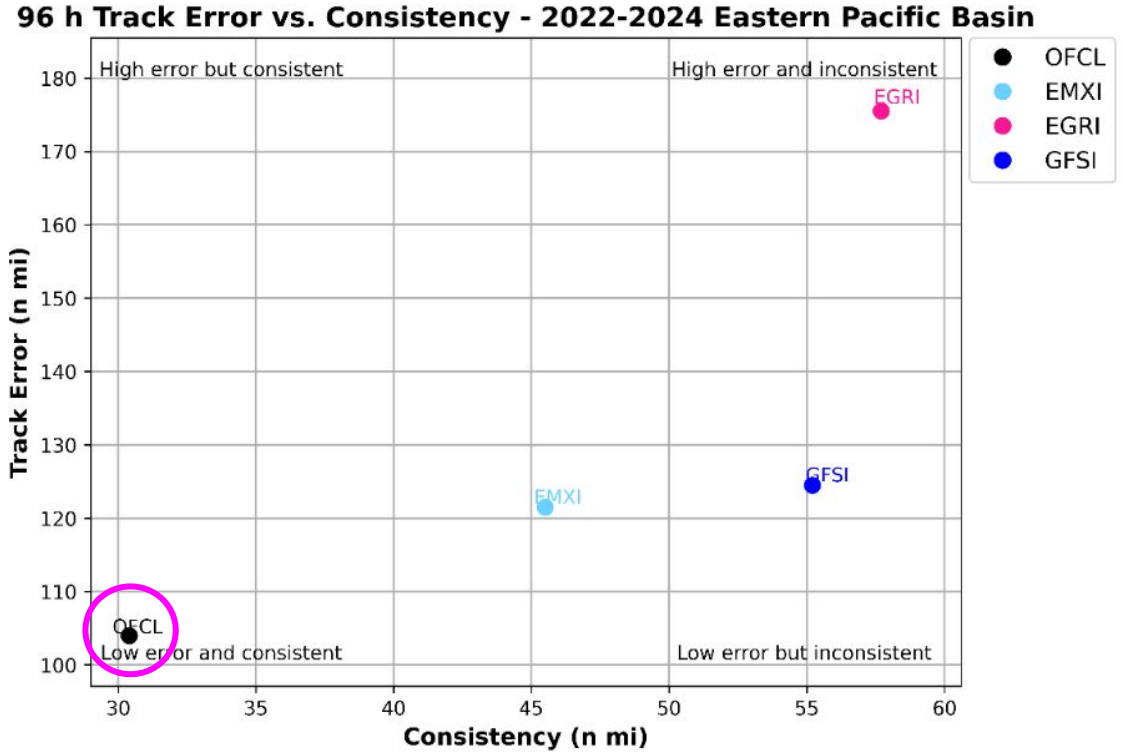
Lesson #6:
Consistency is Key

Consistency: Avoiding the Windshield Wiper

Atlantic



Eastern Pacific



- On the whole, NHC's forecasts are more accurate and more consistent than the models we use to make the forecasts

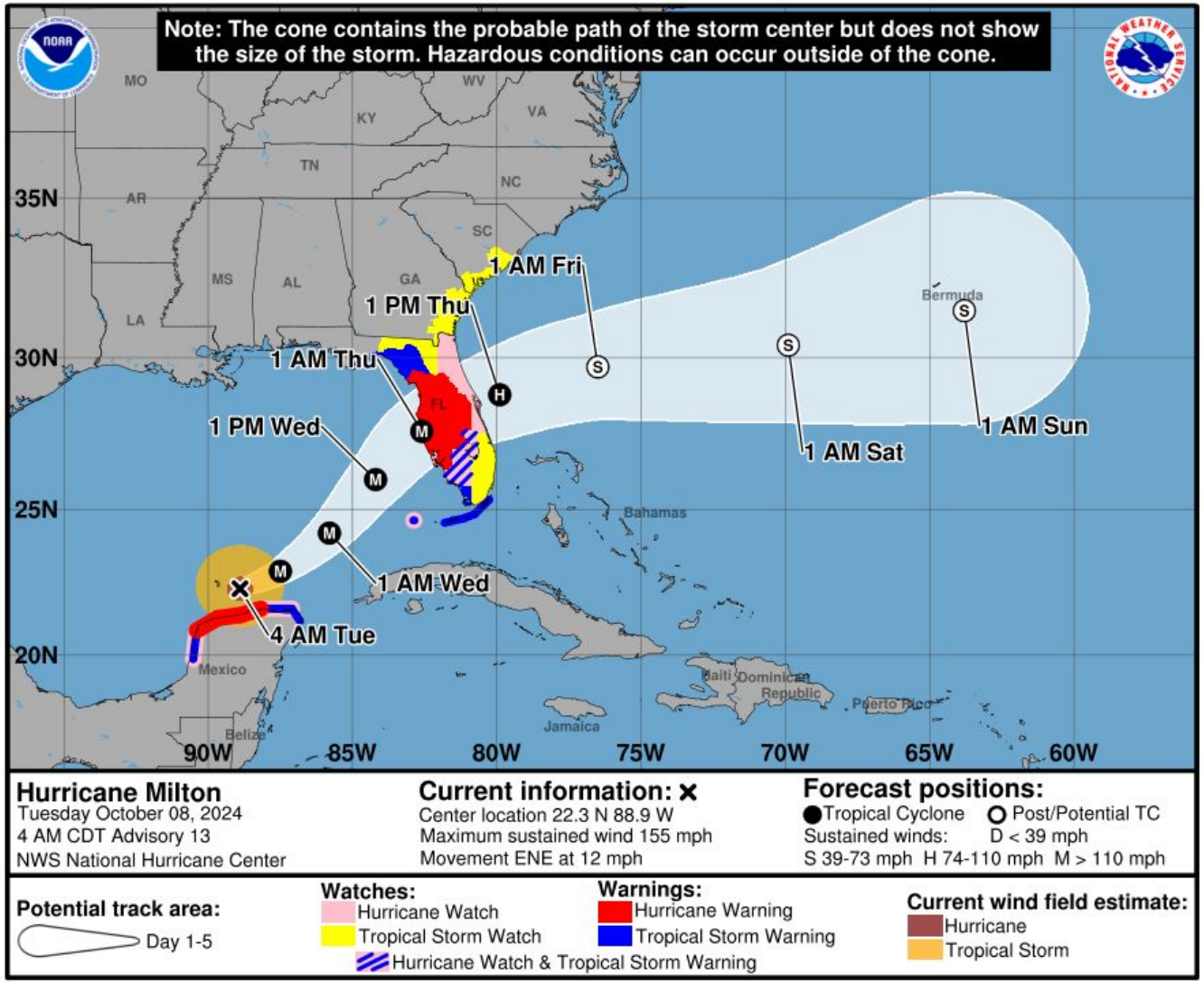
New NHC Products and Services for 2025

2025 Product/Service Updates

- Inland U.S. watches/warnings on cone graphic
  (second experimental year)
- Updated issuance criteria for Potential Tropical Cyclone products
- U.S. rip current risk map
- 60- and 72-hour hurricane-force wind radii forecasts
- Post-storm heat risk
- Cone size slightly smaller for 2025

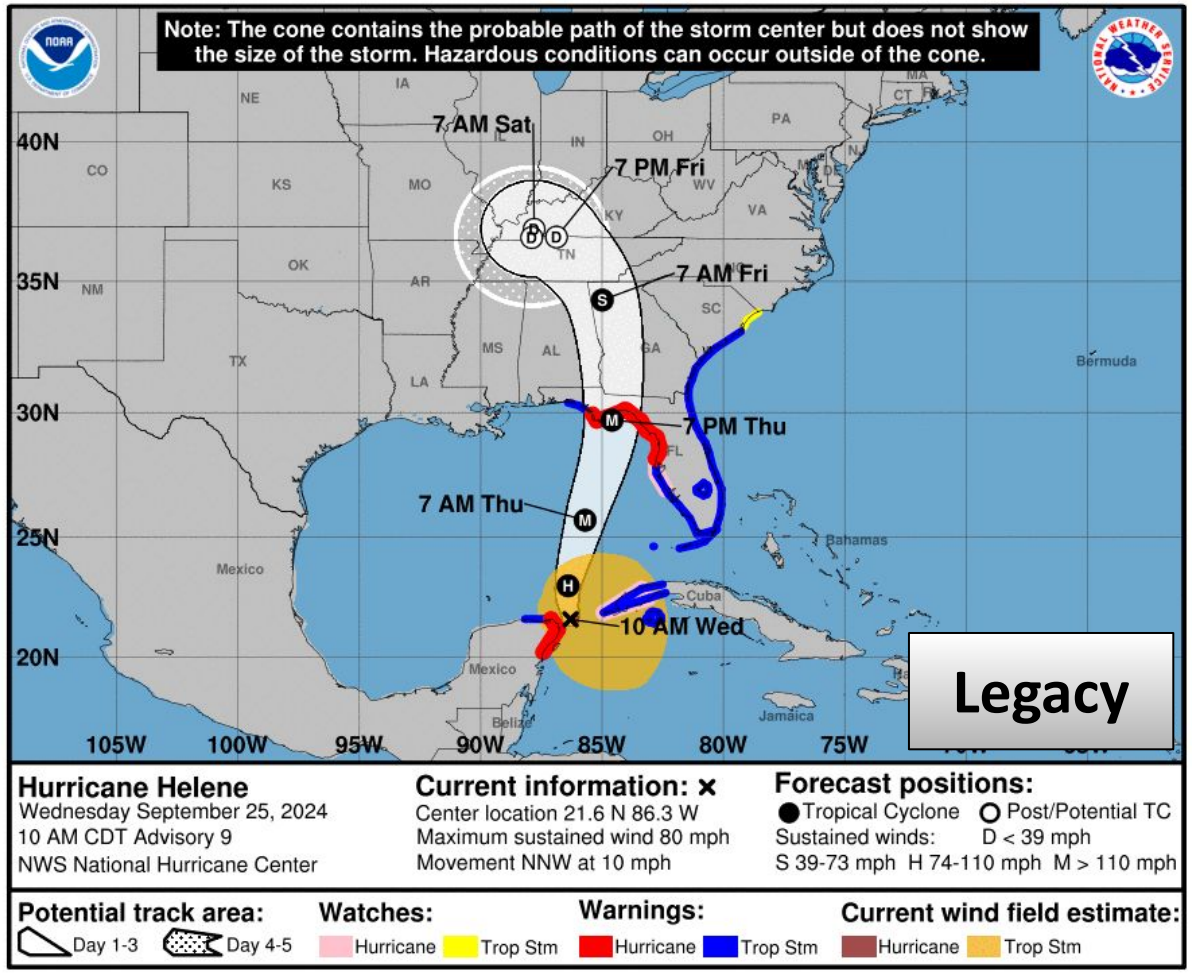
Depiction of Inland Warnings and Watches on the Cone

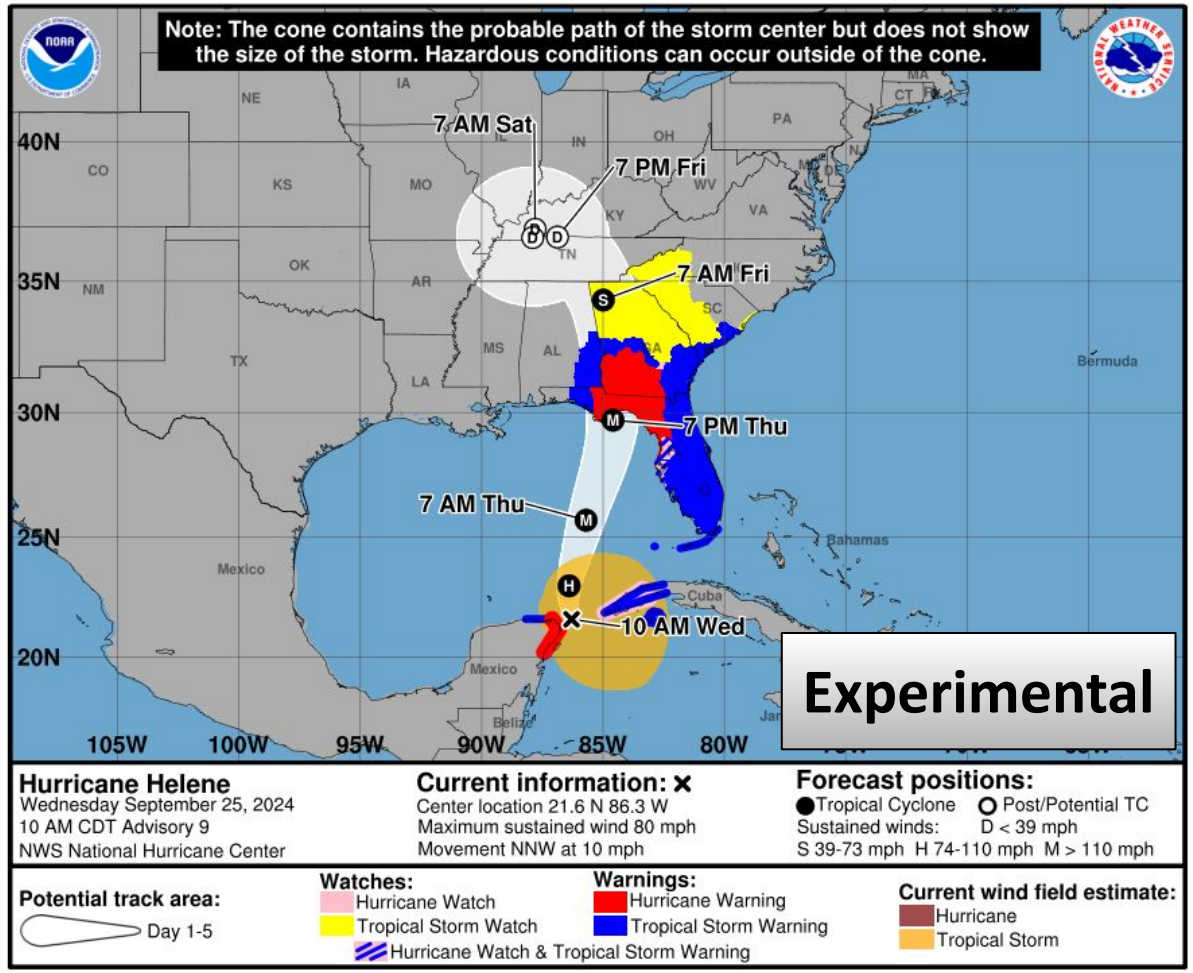
- In 2024, NHC debuted an experimental cone that included a depiction of inland U.S. hurricane and tropical storm watches and warnings
- This better highlighted the risk of coastal and inland wind impacts
- The experimental cone will be available again during the 2025 hurricane season
  - **Only change from 2024**: the legend will include an entry for simultaneous Hurricane Watch and Tropical Storm Warning (pink/blue stripes)



Inland U.S. Watches/Warnings on Cone Graphic (Experimental)

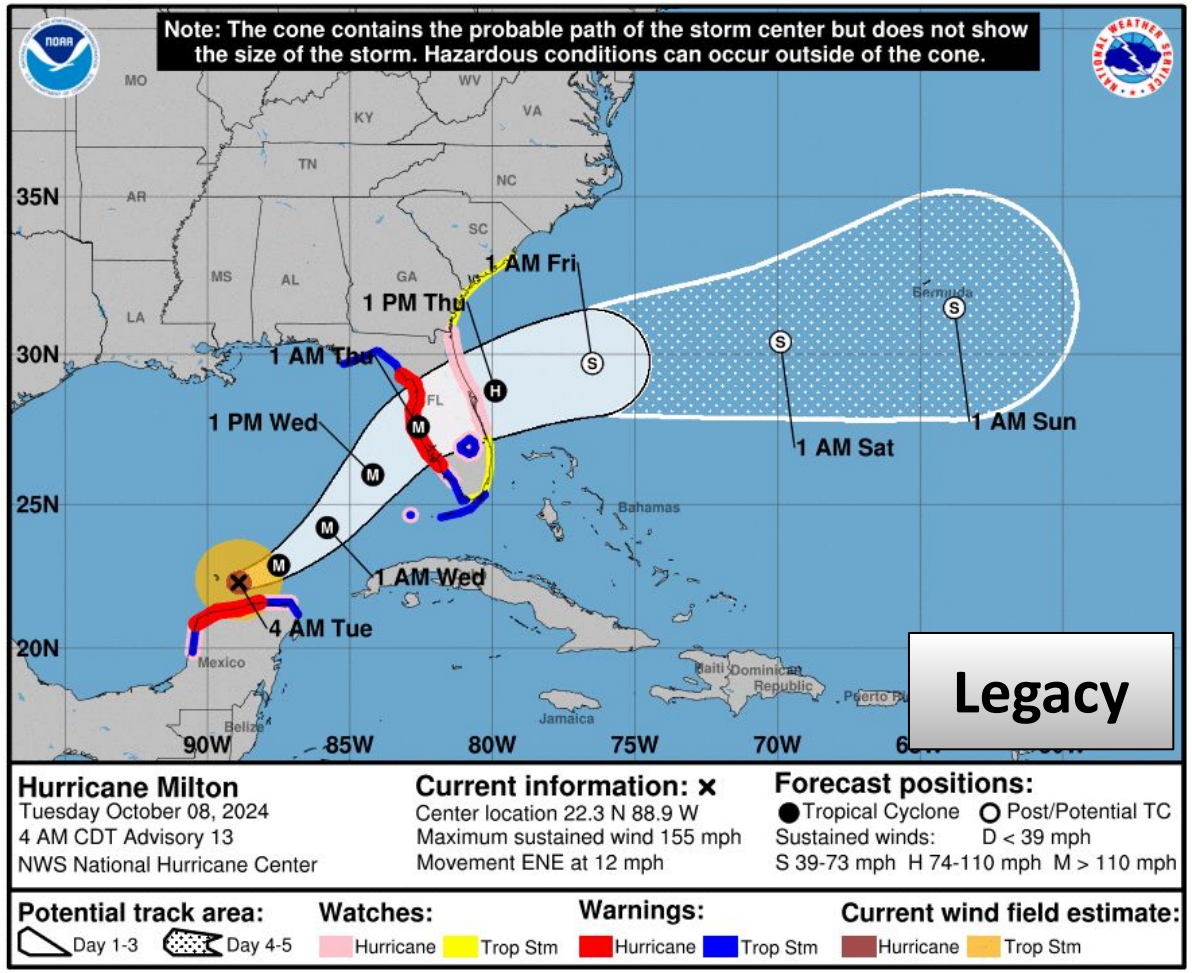
New cone provided better depiction of the inland wind risk from Helene in the southeast United States

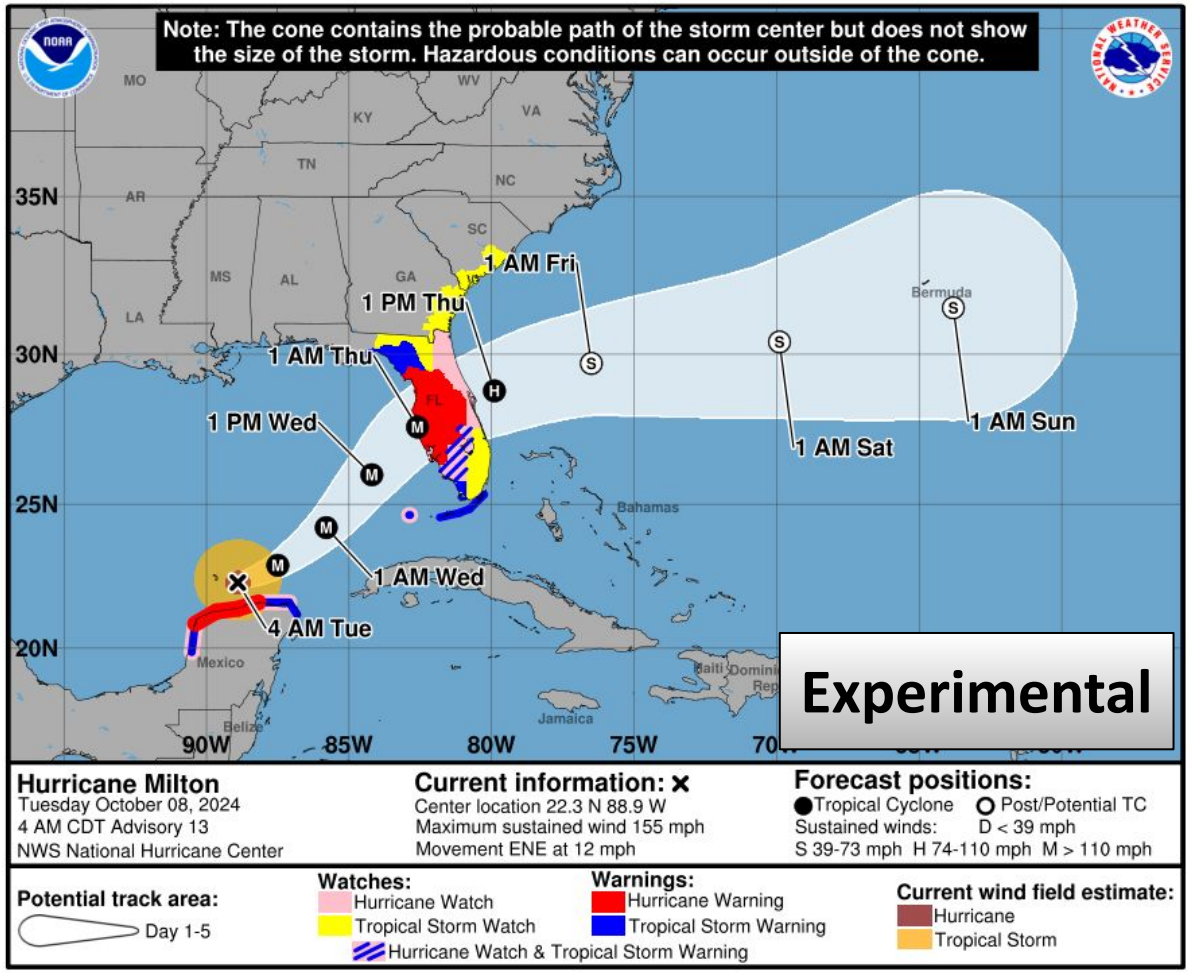




Inland U.S. Watches/Warnings on Cone Graphic (Experimental)

Less emphasis on the cone itself while users are able to focus on watches and warnings depicting wind risk

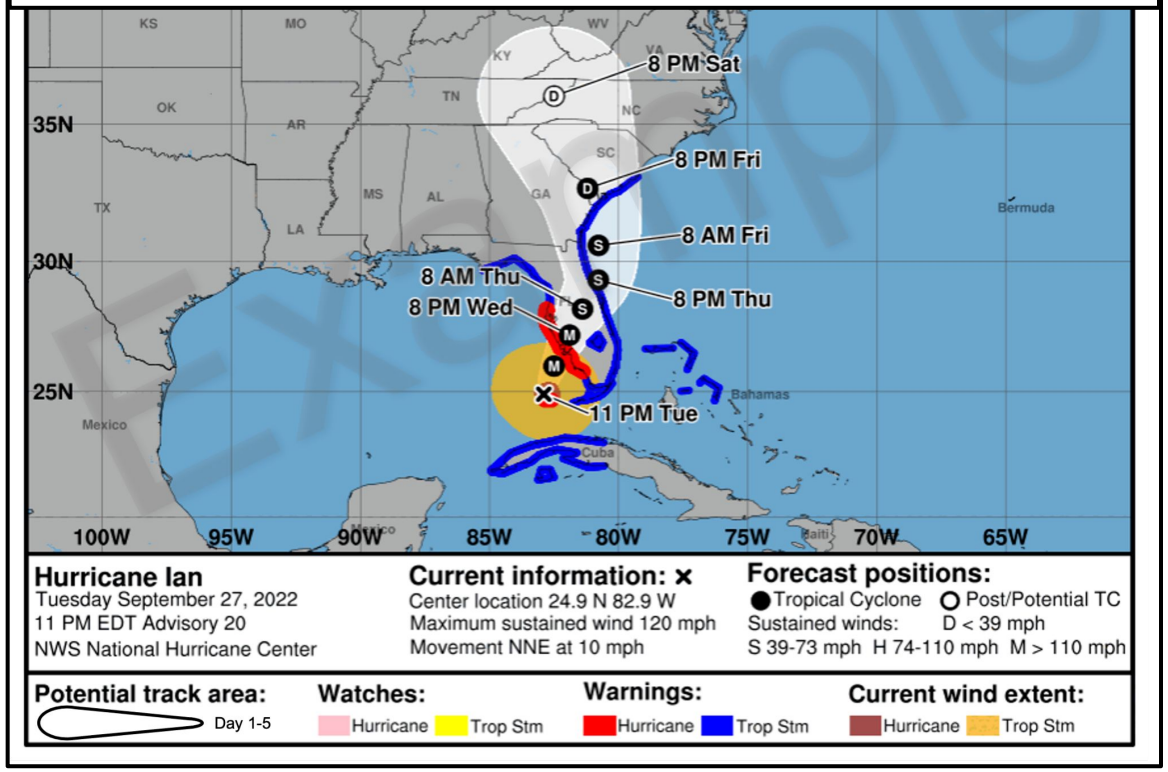




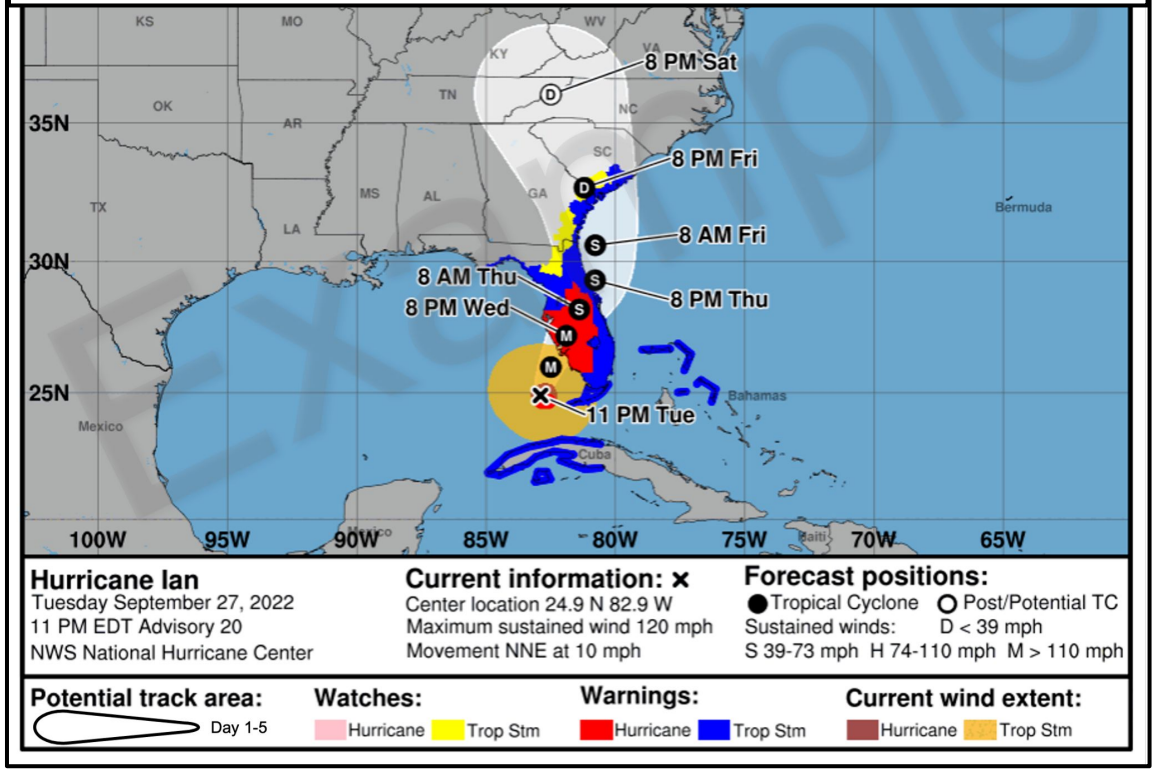
Emergency Manager and Media Feedback (2024)

Which option would more clearly communicate overall wind risk? (n=118)

National Hurricane Conference: 4%
Governor's Hurricane Conference: 0%

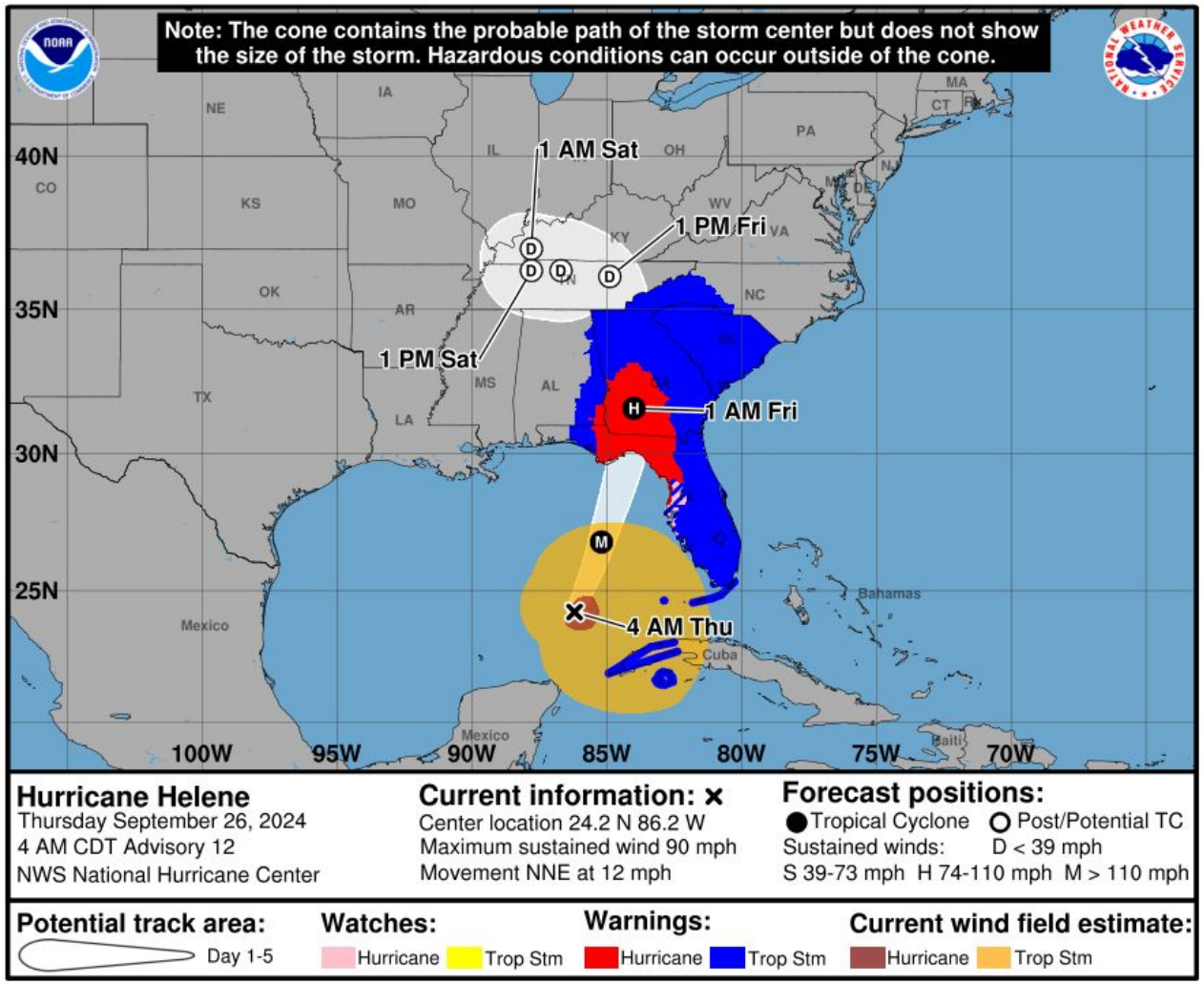


National Hurricane Conference: 96%
Governor's Hurricane Conference: 100%

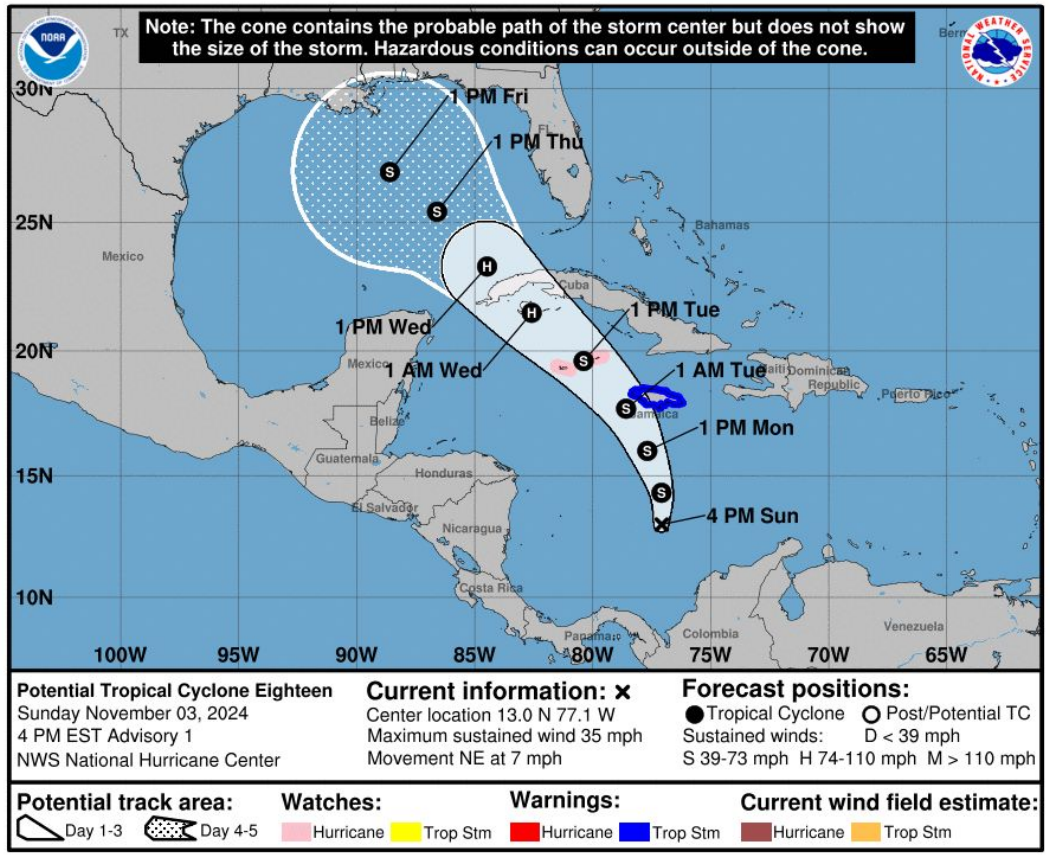


Summary of Public Survey Results (2024)

- AI and manual human analysis of comments
- Positives:
  - Shows the true risk
  - Information is vital for decision-making
  - Reduced emphasis on cone
- Potential Modifications:
  - Zoomable interface and more geographic references
  - Transparency/Translucence
  - Explain the hatching on the legend

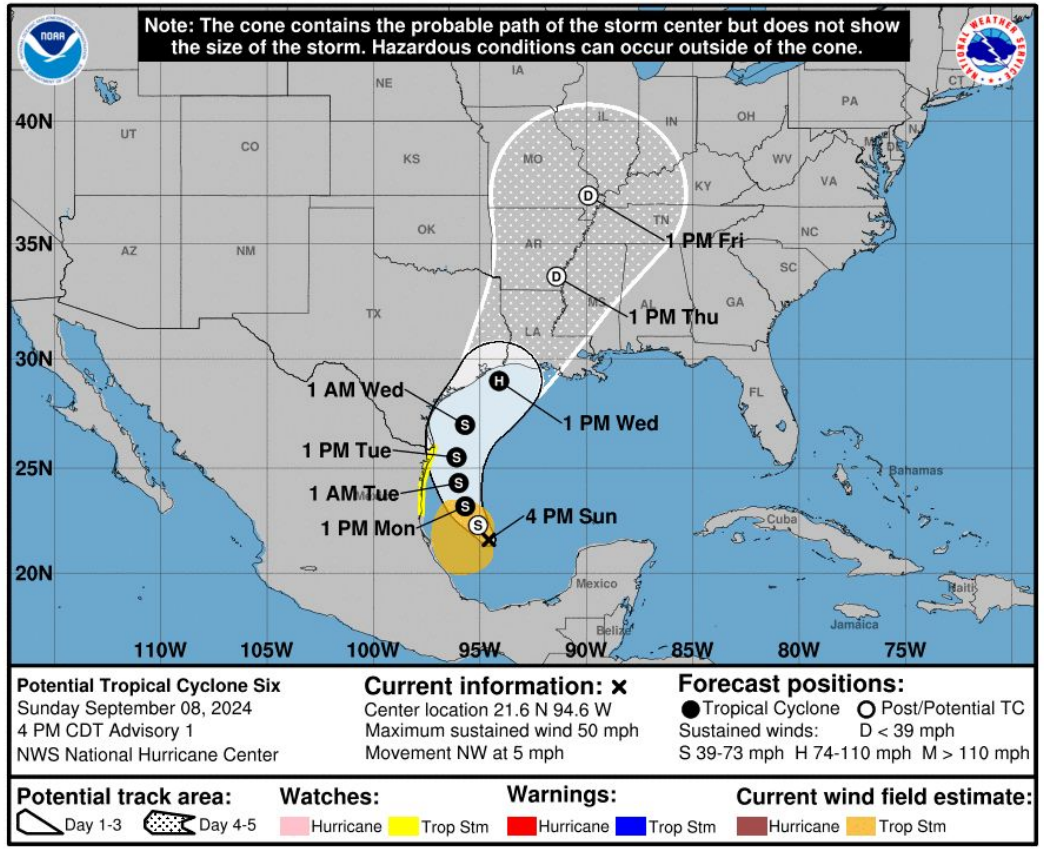


Potential Tropical Cyclone Advisories



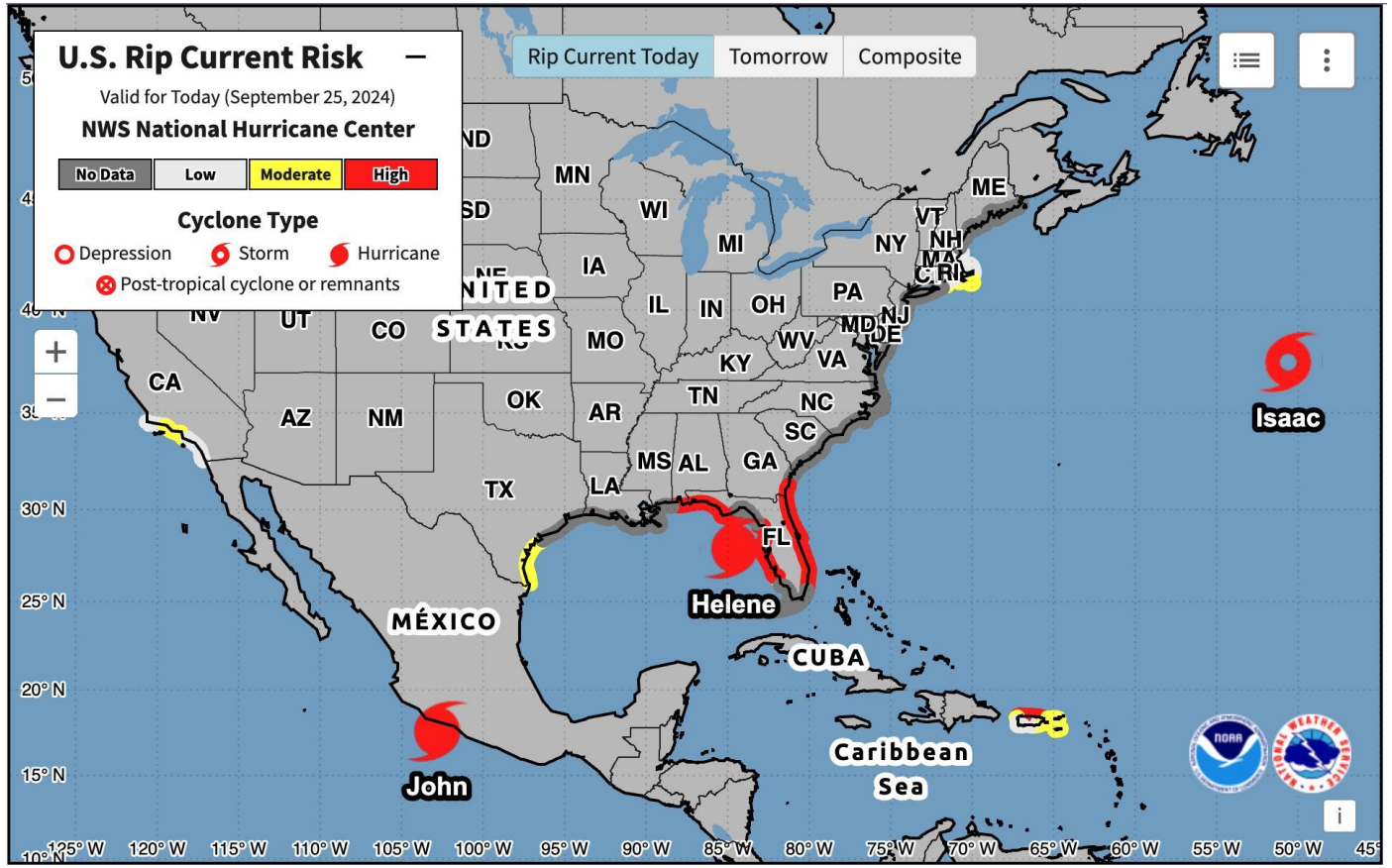
- Starting in 2017, Potential Tropical Cyclone advisories gave NHC the ability to issue tropical storm and/or hurricane watches for systems that are not yet a tropical cyclone but have the potential to bring tropical storm or hurricane conditions to land areas within the next 48 hours.
- Only issued when watches/warnings needed for land areas (within 48 hours of impacts)
- Used numerous times, giving an average of 21 h of additional lead time on watch/warnings for those systems
- Invoked for nine systems in 2024

Expanded Criteria Starting in 2025 – Up to 72 Hours Before Significant Wind/Surge Impacts



- Beginning in 2025, NHC will have the option to issue PTC advisories when there is high confidence in significant wind and surge impacts within 72 hours
- PTC advisories provided enhanced services to significantly impacted U.S. areas for Francine and Helene before the typical 48-hour watch lead time ***only because*** other watches/warnings went into effect beforehand
- The issuance of watches or warnings is not the sole determining factor for the issuance of potential tropical cyclone advisories by NHC or CPHC

U.S. Rip Current Risk Viewer



- Rip currents and heavy surf are the **3rd-highest** cause (16%) of direct U.S. fatalities from tropical cyclones (based on 2013-2023 data)
- Many rip current deaths occur from hurricanes that are well offshore
- In 2025, NHC will provide a rip current risk viewer during active tropical cyclones that will mirror the rip current information provided by local NWS offices in their Surf Zone Forecasts

60- and 72-Hour Hurricane-Force Wind Radii Forecasts and 4-Meter Seas

```
ZCZC MIATCMAT2 ALL
TTAA00 KNHC DDHHMM

HURRICANE KIRK FORECAST/ADVISORY NUMBER   9
NWS NATIONAL HURRICANE CENTER MIAMI FL       AL122024
2100 UTC TUE OCT 01 2024

HURRICANE CENTER LOCATED NEAR 16.2N  40.1W AT 01/2100Z
POSITION ACCURATE WITHIN  30 NM

PRESENT MOVEMENT TOWARD THE NORTHWEST OR 305 DEGREES AT  10 K

ESTIMATED MINIMUM CENTRAL PRESSURE  986 MB
MAX SUSTAINED WINDS  65 KT WITH GUSTS TO  80 KT.
64 KT..... 25NE   0SE   0SW   0NW.
50 KT..... 60NE  40SE   0SW  40NW.
34 KT.....170NE 170SE  70SW 130NW.
4 M SEAS....270NE 180SE  90SW 210NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTI
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRAN

REPEAT...CENTER LOCATED NEAR 16.2N  40.1W AT 01/2100Z
AT 01/1800Z CENTER WAS LOCATED NEAR 15.9N  39.7W

FORECAST VALID 02/0600Z 17.1N  41.5W
MAX WIND  75 KT...GUSTS  90 KT.
64 KT... 25NE   0SE   0SW  20NW.
50 KT... 60NE  50SE  30SW  50NW.
34 KT...170NE 180SE  80SW 130NW.

FORECAST VALID 02/1800Z 18.3N  43.1W
MAX WIND  85 KT...GUSTS 105 KT.
64 KT... 30NE  20SE  15SW  20NW.
50 KT... 70NE  60SE  30SW  50NW.
34 KT...180NE 180SE  80SW 130NW.

FORECAST VALID 03/0600Z 19.4N  44.6W
MAX WIND  95 KT...GUSTS 115 KT.
64 KT... 40NE  30SE  20SW  30NW.
50 KT... 70NE  70SE  40SW  60NW.
34 KT...170NE 160SE  80SW 130NW.

FORECAST VALID 03/1800Z 20.4N  46.0W
MAX WIND 100 KT...GUSTS 120 KT.
64 KT... 50NE  35SE  25SW  40NW.
50 KT... 90NE  80SE  50SW  70NW.
34 KT...170NE 170SE 100SW 150NW.

FORECAST VALID 04/0600Z 21.5N  47.6W
MAX WIND 105 KT...GUSTS 130 KT.
64 KT... 50NE  35SE  25SW  40NW.
50 KT...100NE  90SE  60SW  80NW.
34 KT...180NE 170SE 100SW 150NW.

FORECAST VALID 04/1800Z 22.9N  49.0W
MAX WIND 110 KT...GUSTS 135 KT.
64 KT... 60NE  40SE  30SW  50NW.
50 KT...110NE 100SE  60SW  90NW.
34 KT...190NE 180SE 110SW 160NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 125 NM
ON DAY 4 AND 175 NM ON DAY 5...AND FOR INTENSITY NEAR 15 KT EACH DAY
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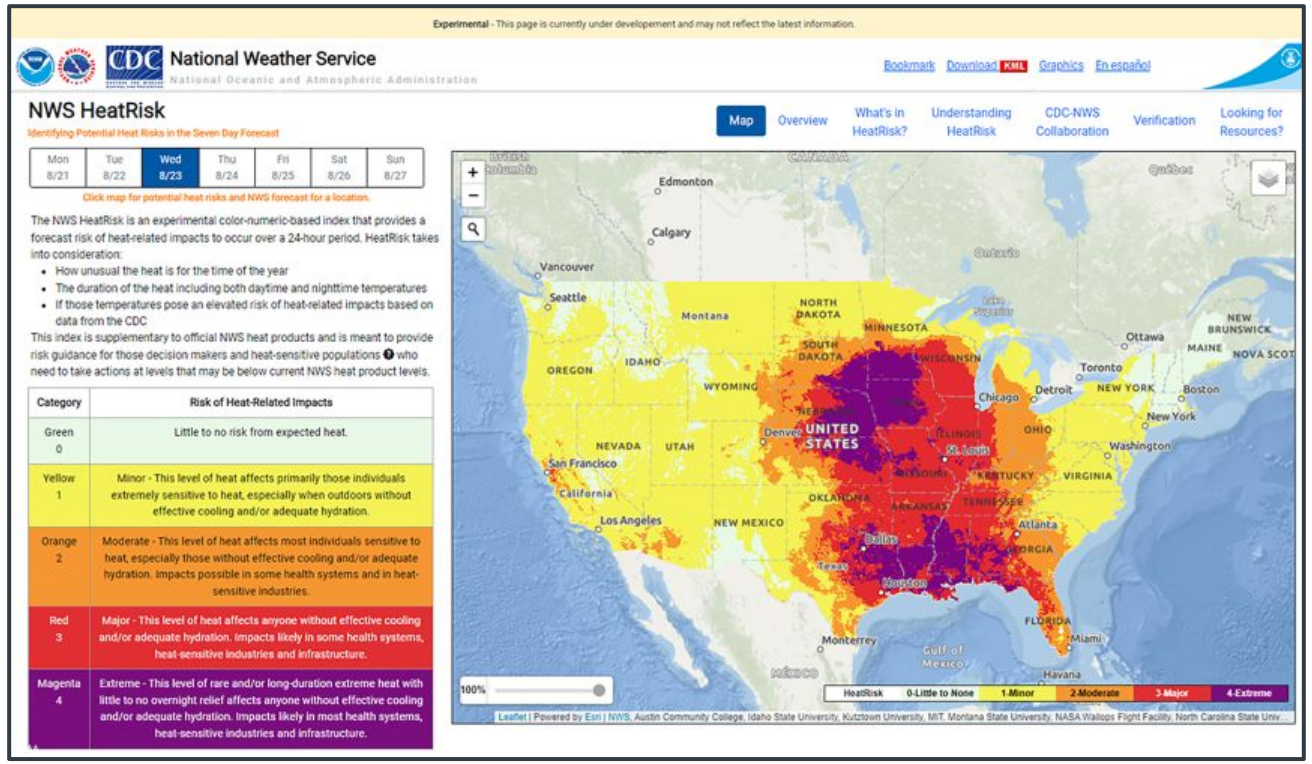
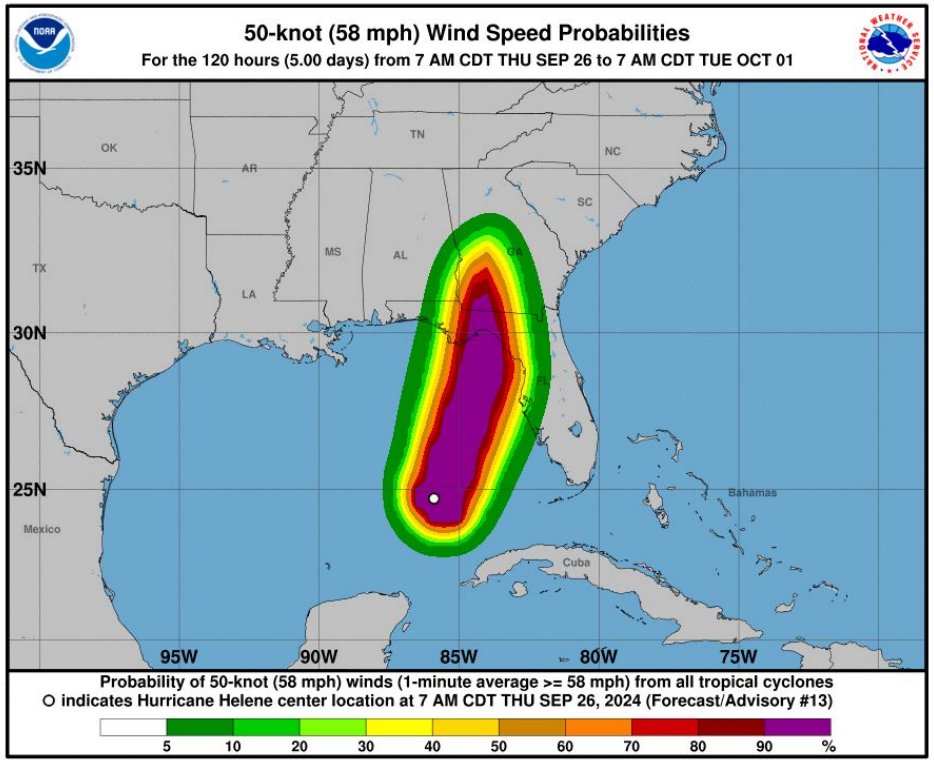
- Hurricane-force wind radii forecasts extended out to 60 and 72 hours forecast periods.
- New radii will improve wind speed probabilities and probabilistic storm surge output
- 4-meter seas serve international marine community

Post-Storm Heat Risk

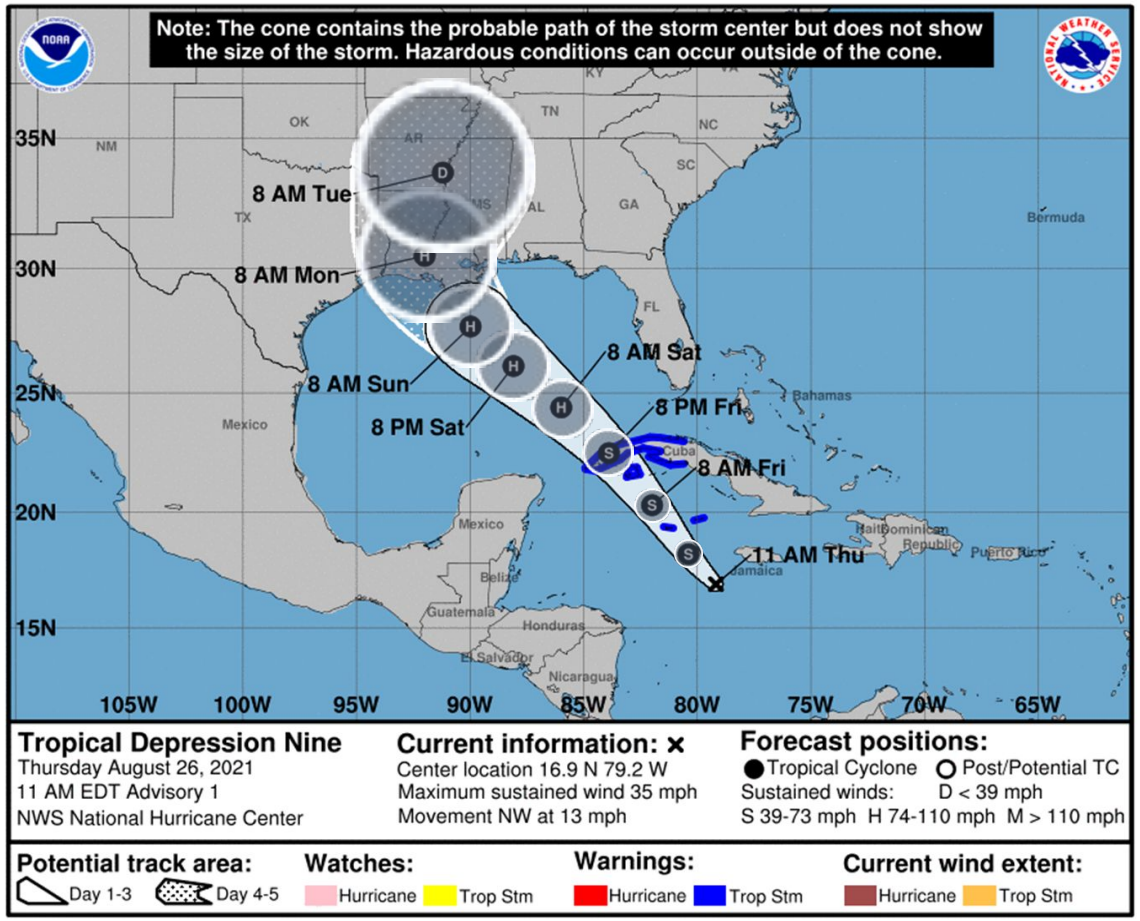




- NHC and the Weather Prediction Center (WPC) are planning to highlight areas that are at risk of heat impacts after a storm due to power loss in NHC's Tropical Cyclone Public Advisory and Key Messages, when appropriate
- Considerations may include:
  - Chance of strong, damaging winds (as a proxy for potential power loss)
  - Risk of heat-related impacts over the ensuing days (including use of NWS HeatRisk)

2025 Cone of Uncertainty Sizes

2025 Track Forecast Cone Two-Thirds Probability Circles (n mi)		
Forecast Period (h)	**Atlantic Basin**	**Eastern North Pacific Basin**
3	16 (0: 0%)	16 (0: 0%)
12	26 (0: 0%)	26 (0: 0%)
24	39 (-2: -5%)	38 (-1: -3%)
36	52 (-3: -5%)	50 (-3: -6%)
48	67 (-3: -4%)	59 (-6: -9%)
60	83 (-5: -6%)	71 (-5: -7%)
72	100 (-2: -2%)	83 (-9: -10%)
96	142 (-9: -6%)	113 (-6: -5%)
120	213 (-7: -3%)	146 (-6: -4%)



2025 Atlantic Tropical Cyclone Names

Andrea	Humberto	Olga
Barry	Imelda	Pablo
Chantal	Jerry	Rebekah
Dexter	Karen	Sebastien
Erin	Lorenzo	Tanya
Fernand	Melissa	Van
Gabrielle	Nestor	Wendy

Names provided by the World Meteorological Organization

Be prepared: Visit hurricanes.gov and follow @NWS and @NHC_Atlantic on X.

May 2025

2025 East North Pacific Tropical Cyclone Names

Aletta	Ileana	Rosa
Bud	John	Sergio
Carlotta	Kristy	Tara
Daniel	Lane	Vicente
Emilia	Miriam	Willa
Fabio	Norman	Xavier
Gilma	Olivia	Yolanda
Hector	Paul	Zeke

Names provided by the World Meteorological Organization

Be prepared: Visit hurricanes.gov and follow @NWS and @NHC_Pacific on X.

May 2025

2025 Central North Pacific Tropical Cyclone Names

List 1	List 2	List 3	List 4
Akoni	Aka	Alika	Ana
Ema	Ekeka	Ele	Ela
Hone	Hene	Huko	Halola
Iona	Iolana	Lopa	Lune
Keli	Keoni	Kika	Kilo
Lala	Lino	Lana	Loke
Moke	Mele	Maka	Malia
Nolo	Nona	Neki	Niala
Olana	Oliwa	Omeka	Oho
Pena	Pama	Pewa	Pali
Ulana	Upana	Unala	Ulika
Wale	Wene	Wali	Walaka

The next name to be used from the list is Iona
Names provided by the World Meteorological Organization

Be prepared: Visit hurricanes.gov and follow @NWS and @NWSHonolulu on X.

May 2025