



UNITED STATES DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND  
ATMOSPHERIC ADMINISTRATION



# Record Breaking Hurricane Season 2020 and What's New for 2021

Ken Graham  
NOAA/National Weather Service  
National Hurricane Center

2021 Florida Tropical Training



# Just a Few of the 2020 Records (Preliminary)

**\*\*\*6th straight year with at least one named storm prior to the official start of the Atlantic hurricane season**

**\*\*\*Most named storms in a 170 years of record keeping with 30, 14 hurricanes (7 major), and 22 storms had watches/warnings for land areas or made landfall**

**\*\*\*Most U.S. landfalls with 11, surpasses 9 back in 1916**

**5 tropical storms (Bertha, Cristobal, Fay, Beta, Eta (2))**

**6 hurricanes (Hanna, Isaias, Laura, Sally, Delta, Zeta)**

**4 landfalls in Louisiana (TS Cristobal, H Laura, H Delta, H Zeta)**

**8 landfalls along the Gulf Coast (Cristobal, Hanna, Laura, Sally, Beta, Delta, Zeta, Eta)**

**\*\*\*Only the second time on record having 5 or more tropical cyclones at the same time**

**\*\*\*Tied with 1886 and 1985 for the most hurricane landfalls in season for the U.S.**

**\*\*\*\*13 International landfalls, two CAT4 landfalls in Nicaragua two weeks and 15 miles apart with Eta and Iota. Subtropical Storm Alpha made landfall in Portugal.**



# Just a Few of the 2020 Records (Preliminary)

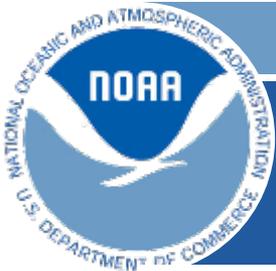
**\*\*\*One of the highest storm surge events for Louisiana during Hurricane Laura, around 18 ft (5.49 m)**

**\*\*\*Third most hours flown for the USAF 53<sup>rd</sup> hurricane hunters, only 1985 and 2005 were higher. NOAA AOC highest ever, 681.3 hours, over 110% higher than average and more than 10% higher than the previous bench mark in 2005**

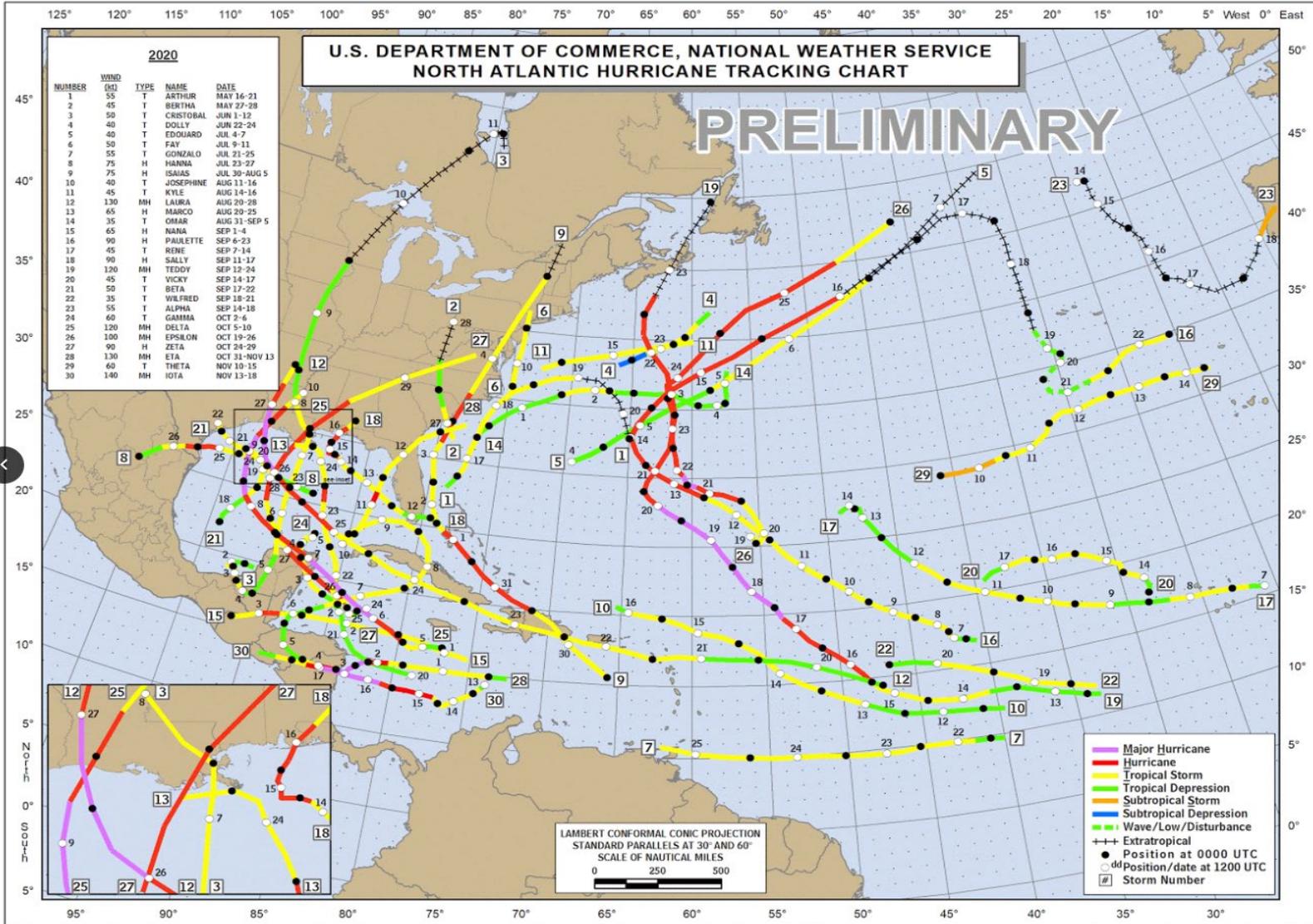
**\*\*\*639 advisory packages in the Atlantic only, for the season, average is 322**

**\*\*\*First time with two major hurricanes in November**

**\*\*\*Latest CAT5 on record**

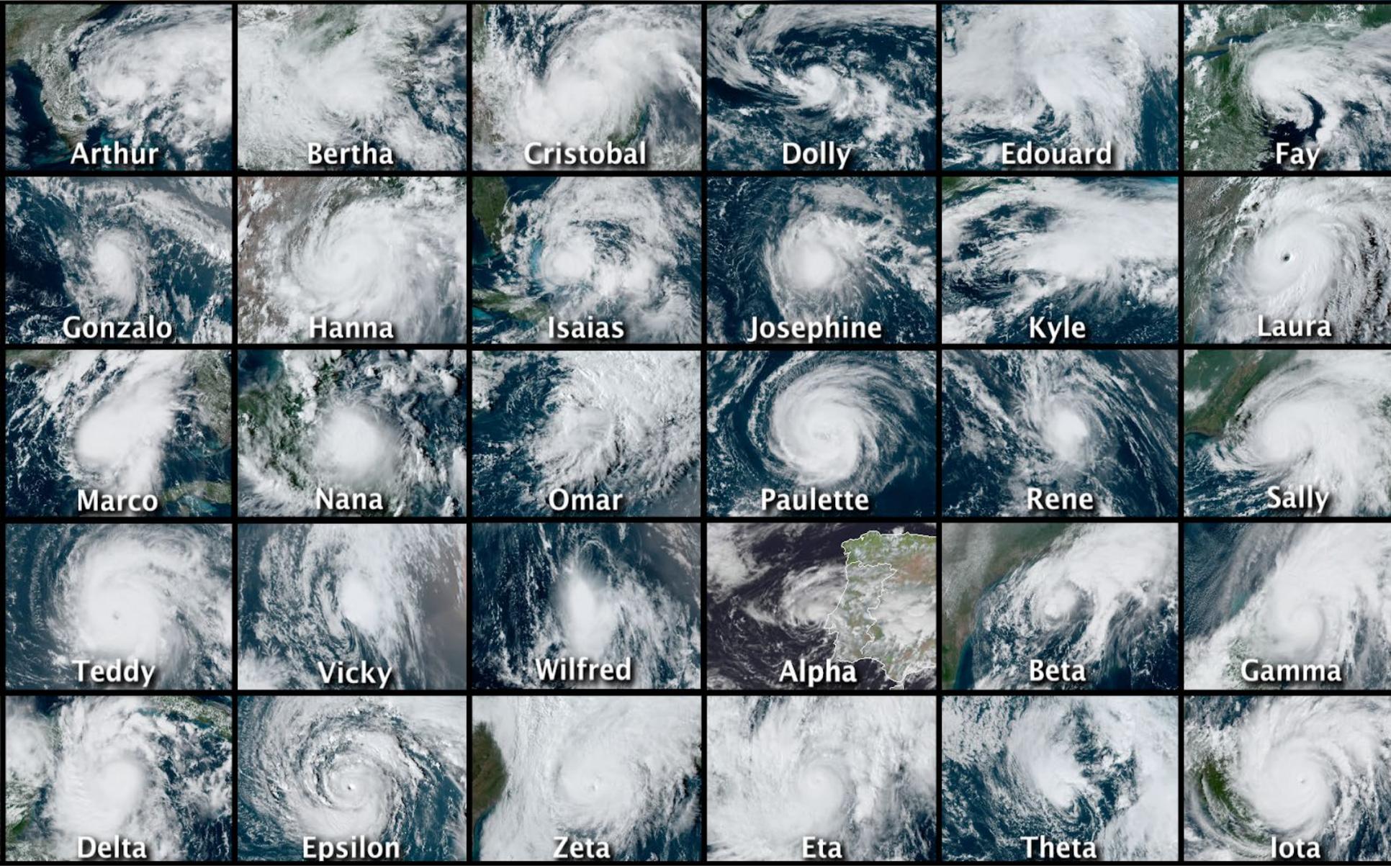


# Deep Into Two Alphabets





# The 2020 Atlantic Hurricane Season





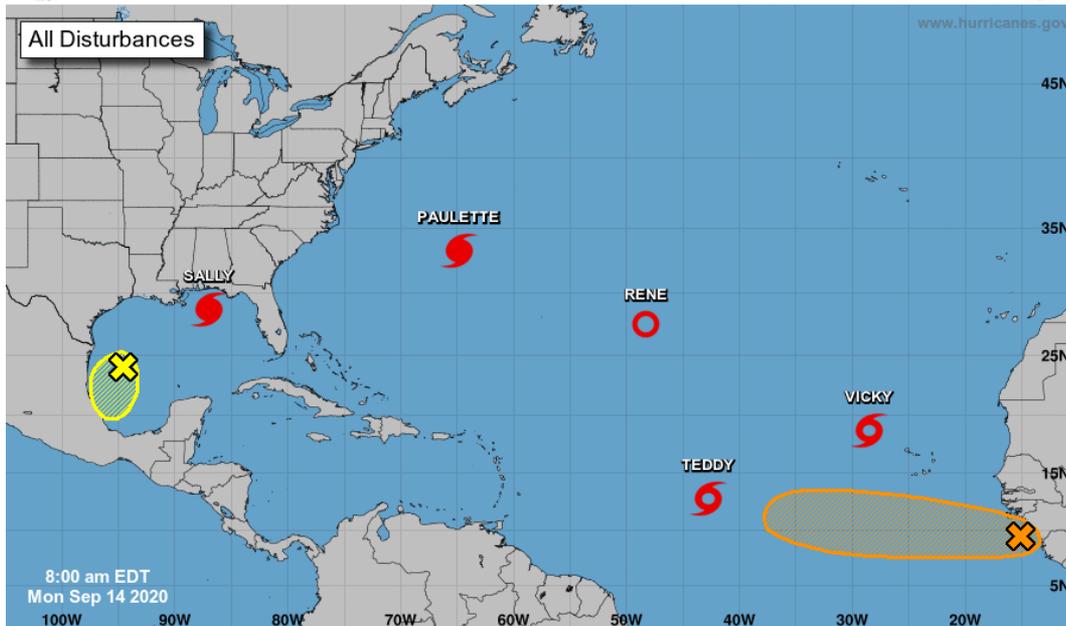
# 10 Named Storms Formed in September

5 active Atlantic TCs on 14-15 September (Paulette, Rene, Sally, Teddy, Vicky)



## Five-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



Current Disturbances and Five-Day Cyclone Formation Chance: < 40% 40-60% > 60%

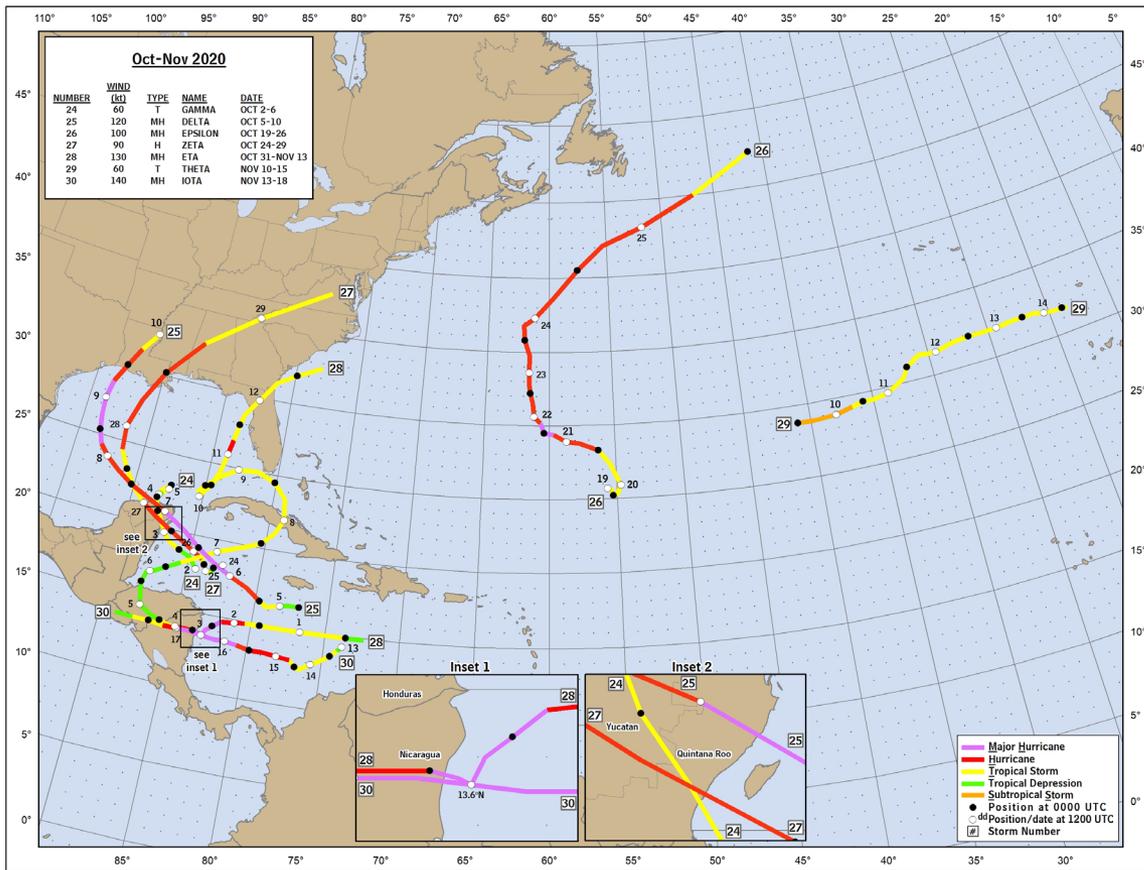
Tropical or Sub-Tropical Cyclone: Depression Storm Hurricane

Post-Tropical Cyclone or Remnants



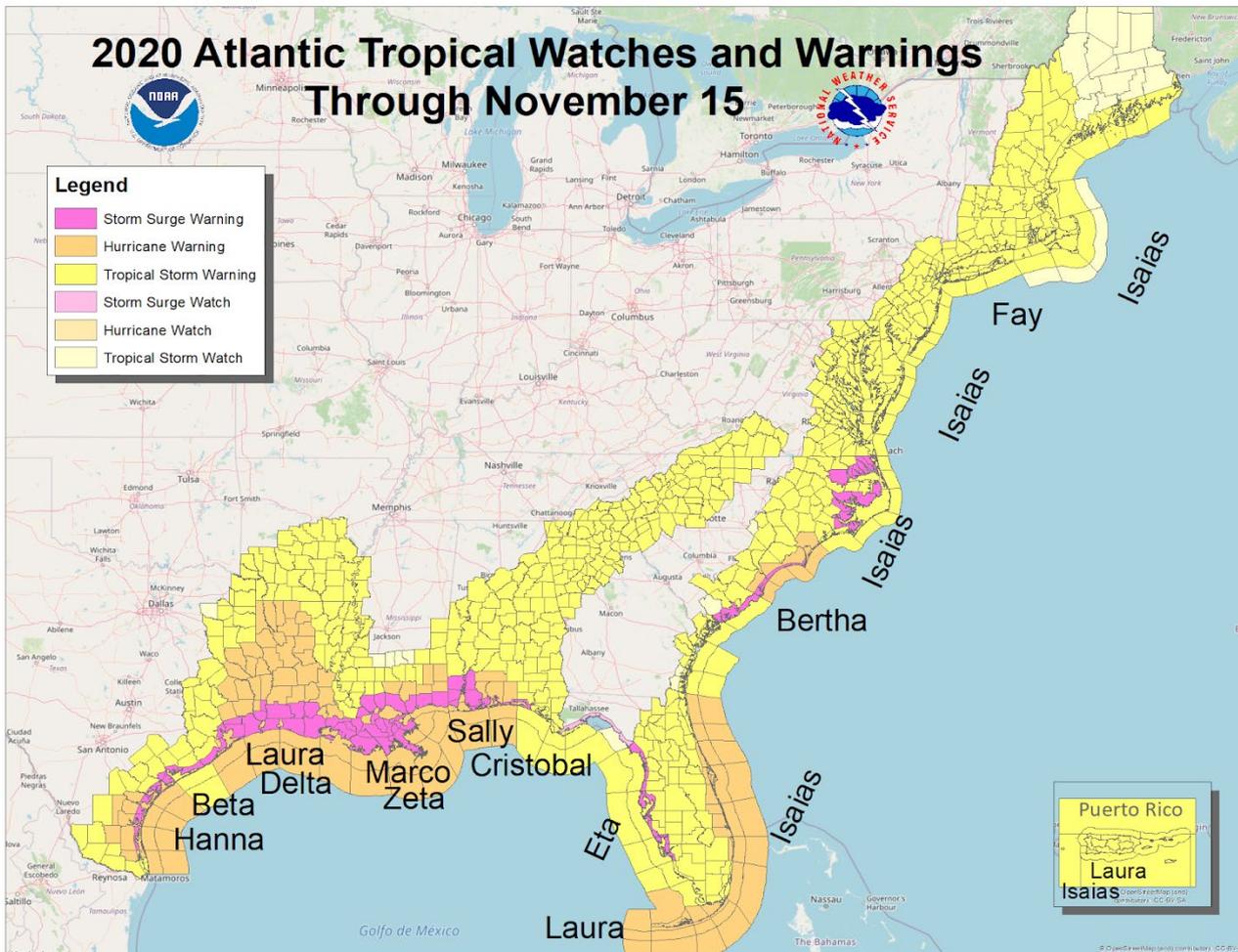
# 7 Named Storms Formed in October and November

7 active Atlantic TCs in October and November (Gamma, Delta, Epsilon, Zeta, Eta, Theta, Iota)





# A Whole Team Effort



- Atlantic U.S. coastal hurricane warnings in effect: **378 hours (15.75 days)**

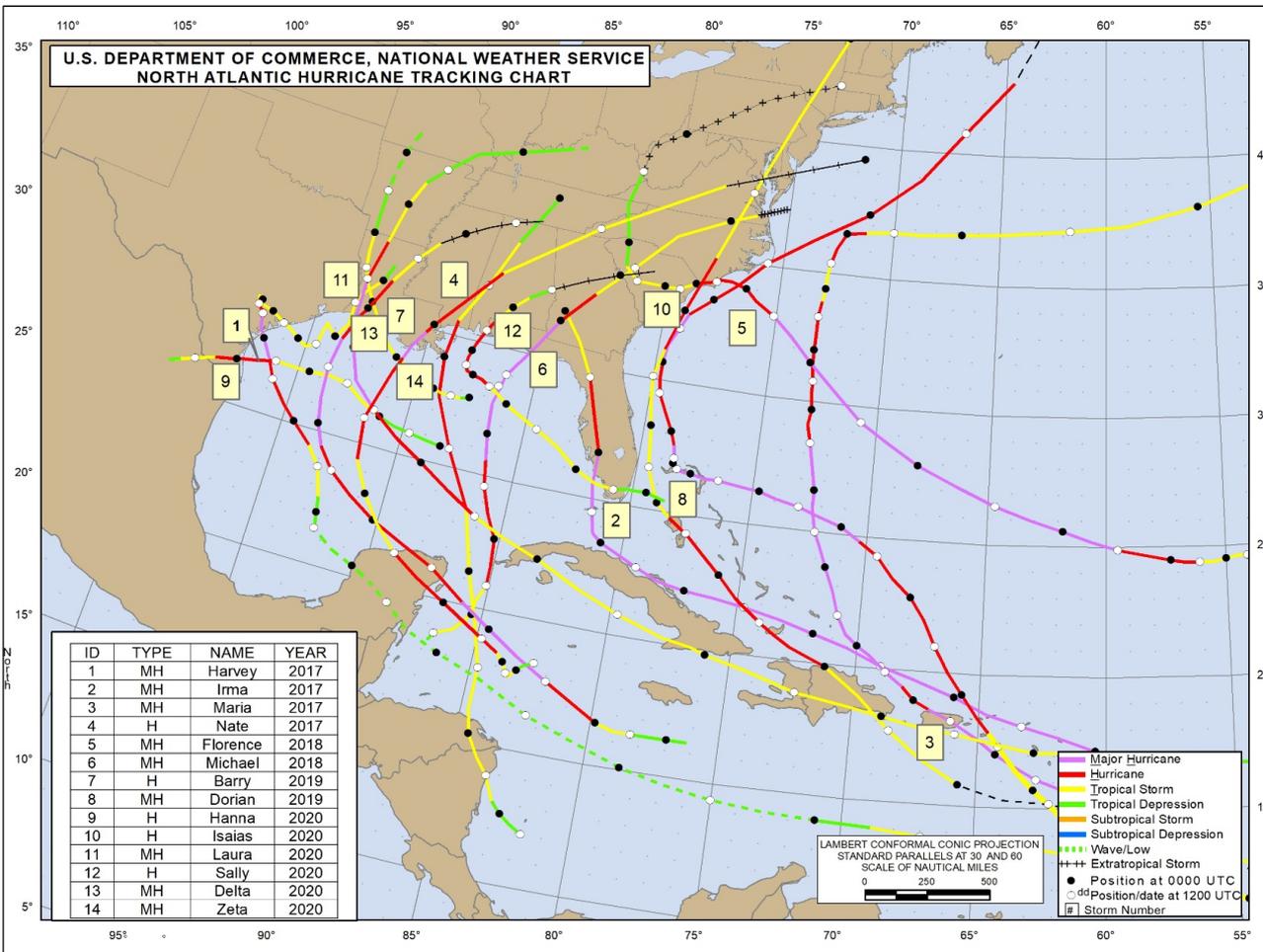
- Coastal watches and warnings in effect for Louisiana: **474 hours (19.75 days)**

- 14 systems required issuance of watches or warnings on first advisory

Image courtesy Penny (Zabel) Harness, WFO Corpus Christi



# Yes, it has been active

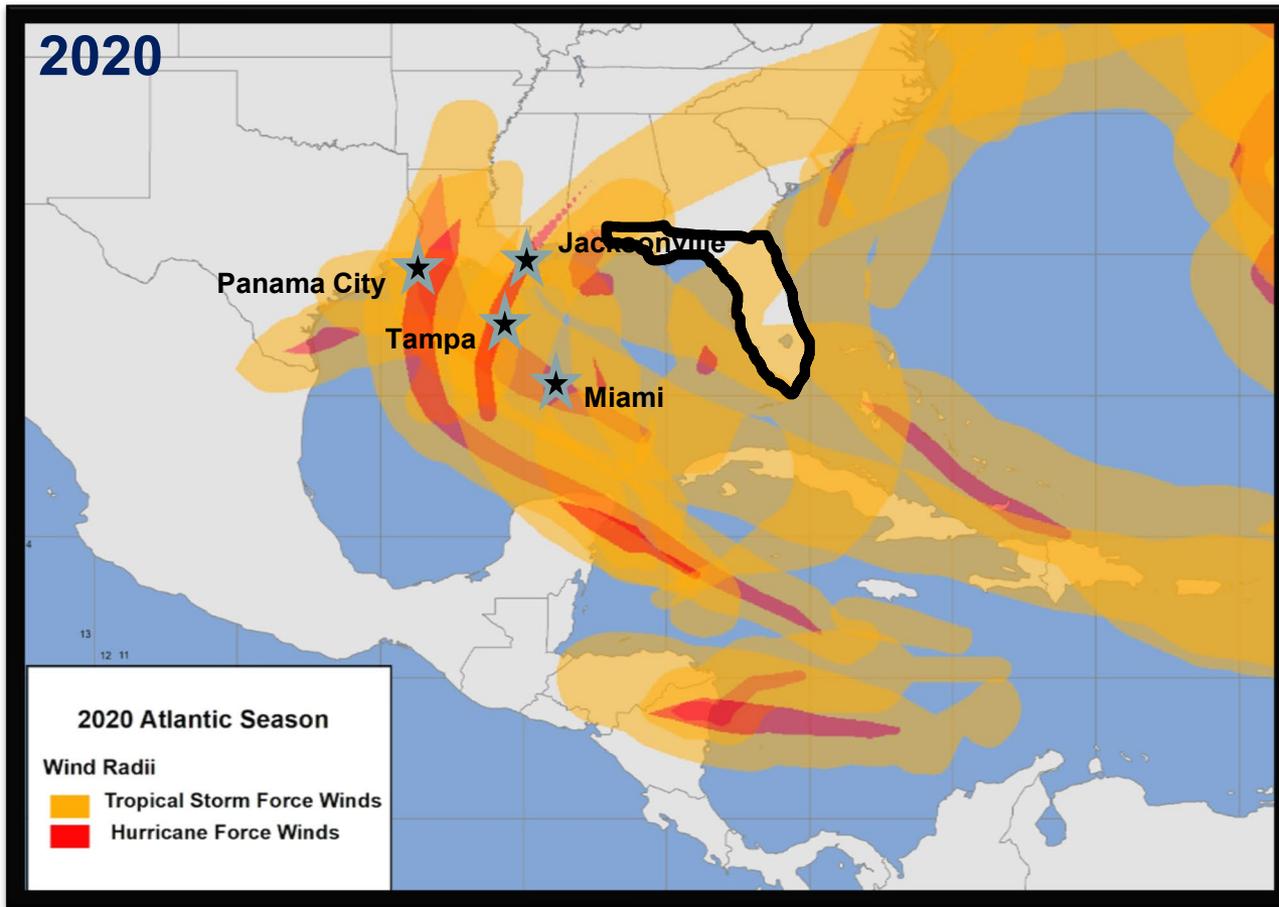


• **14 hurricanes** have made landfall in the U.S. since 2017 (6 were major)

- Total U.S. Damage:
  - **\$353 Billion**
- Number billion dollar storms:
  - **12**
- Number 10 billion dollar storms:
  - **6**

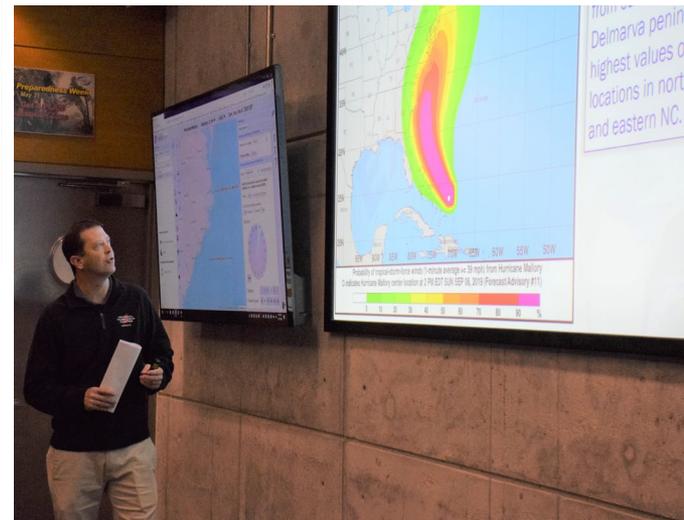


# Florida, what if?



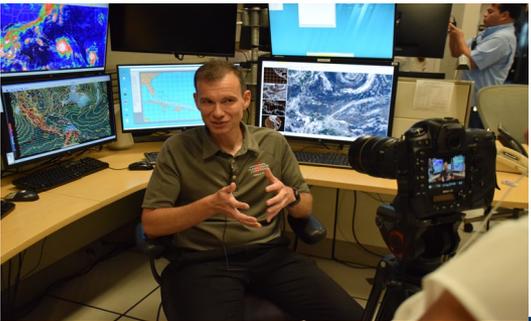


# Normal Pre-Season





# Normal Pre-Season



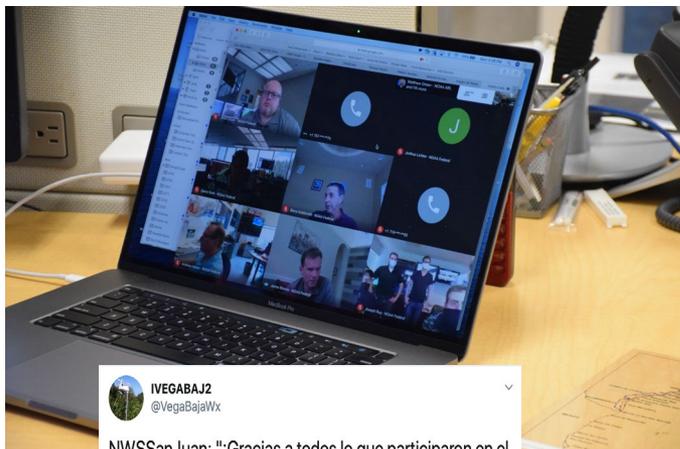


# Normal Pre-Season





# Pandemic Season



### NHC Gone Virtual with Hurricanes at Home and New Tools to Collaborate – Keeping us safe so we can keep the public safe!



**IVEGABAJ2**  
@VegaBajaWx

NWSSanJuan: "¡Gracias a todos lo que participaron en el webinar de hoy!

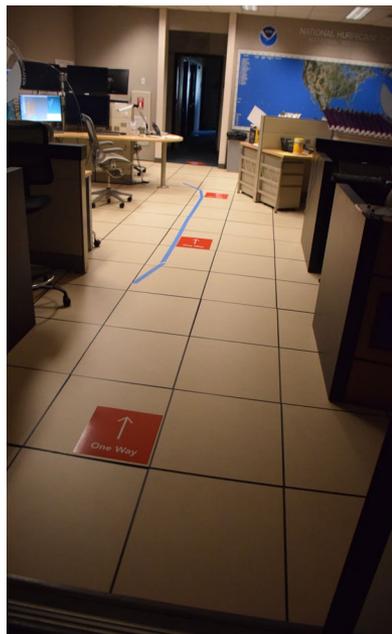


Pendientes al 2do webinar en español que será este miércoles.

Registrate: [register.gotowebinar.com/register/63014...](https://register.gotowebinar.com/register/63014...)

#HurricanesAtHome NWSNHC"

Translate Tweet



**Tonya**  
@tvrivers

Watching the Hurricanes at Home Webinar. Thanks @NHC\_Atlantic and @NWSWakefieldVA for doing this for our students. 🌊



# Pandemic Season

- 1) Moved Workstations
- 2) Cohort Schedule
- 3) Limit those in the building
- 4) Safety plan
- 5) Distancing at all times
- 6) Masks and PPE
- 7) Combination of office and telework
- 8) COOP planning and testing
- 9) Virtual shift change
- 10) Video collaboration





# Keeping us safe, so we can keep the public safe!





# Pre-Deployment COOP



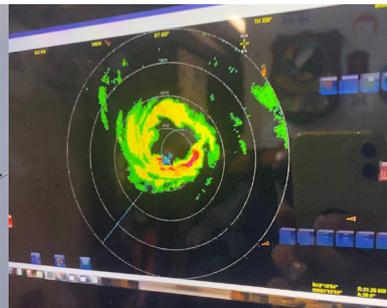
NHC pre-COOP College Park, MD



# Challenging Aircraft Coordination

- Aircraft reconnaissance

- Huge workload with systems near land and numerous simultaneous systems
- Forward deployment limitations, staffing and maintenance challenges with the pandemic
- Multiple evacuations of Keesler AFB by 53RD WRS complicated their operations
- Overflight clearances

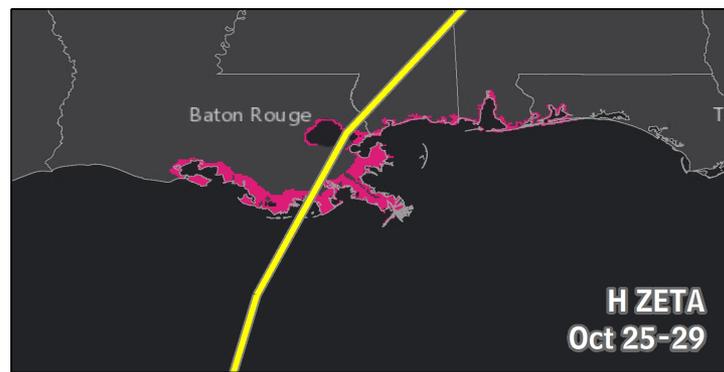
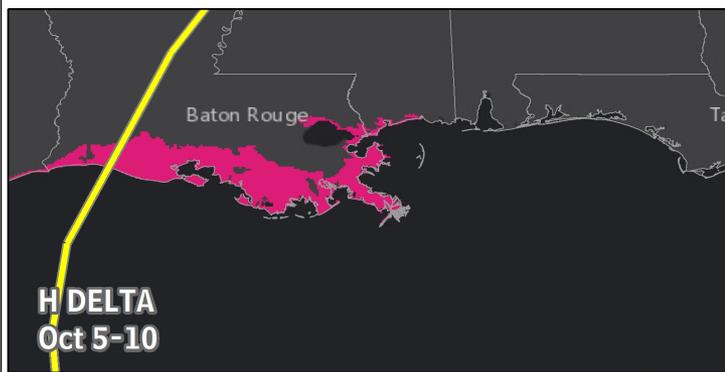
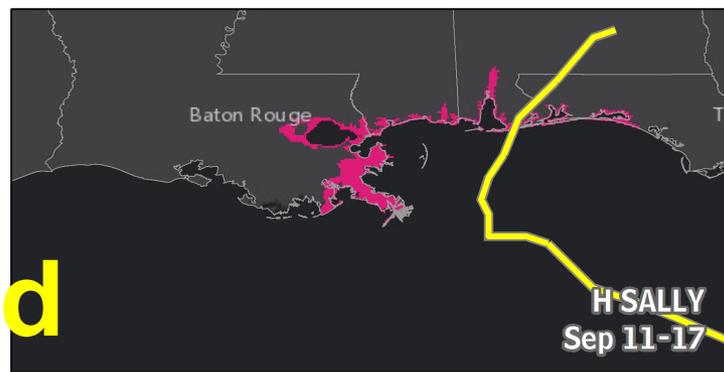
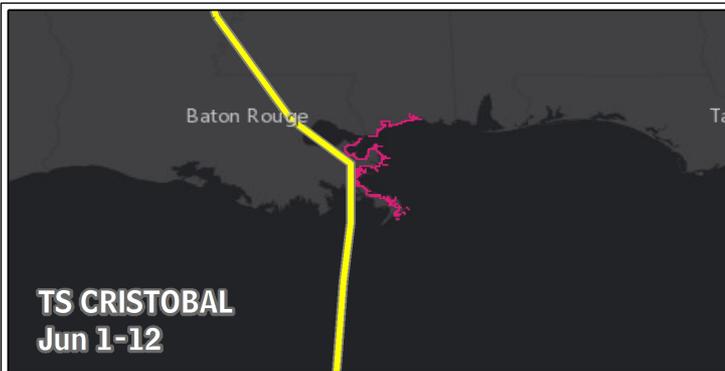




# A Few Thoughts Going Forward



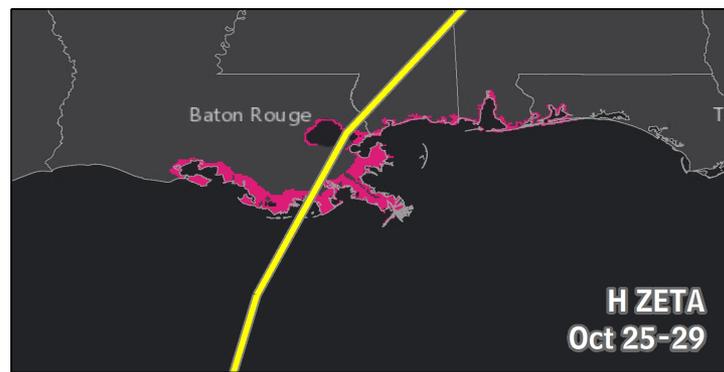
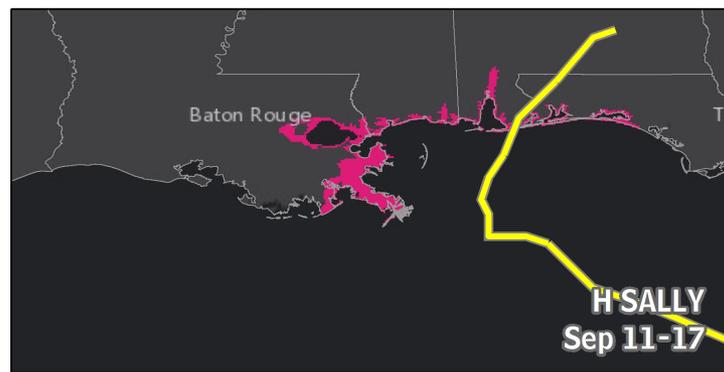
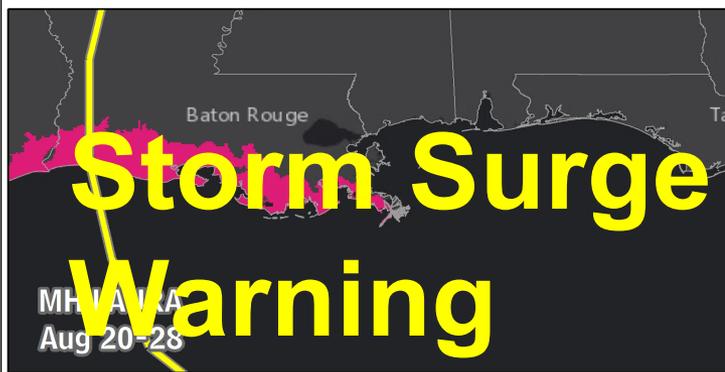
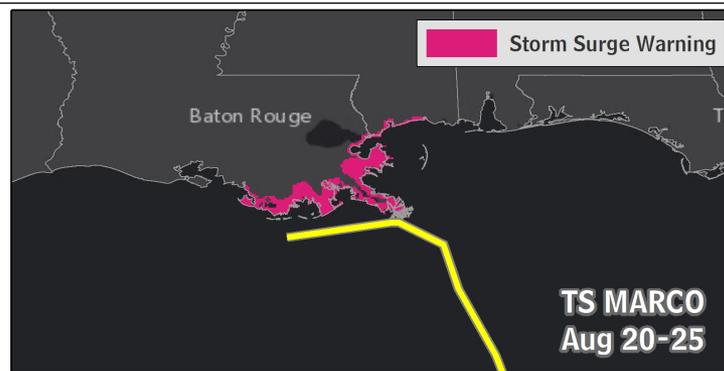
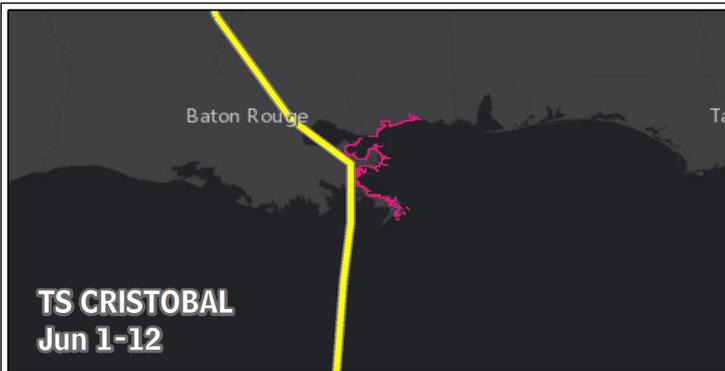
# 1. Words Matter



15 to 20 feet  
Above Ground



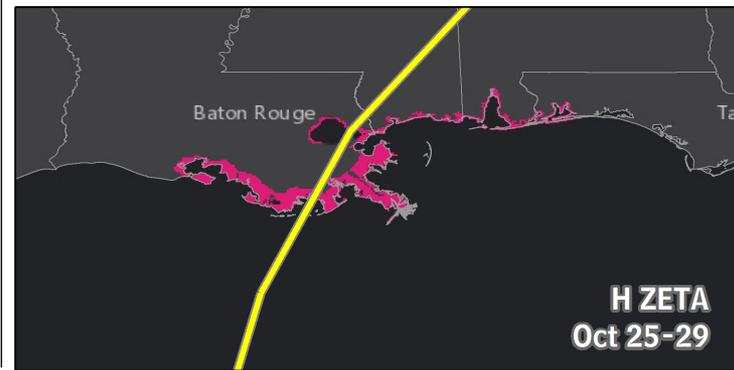
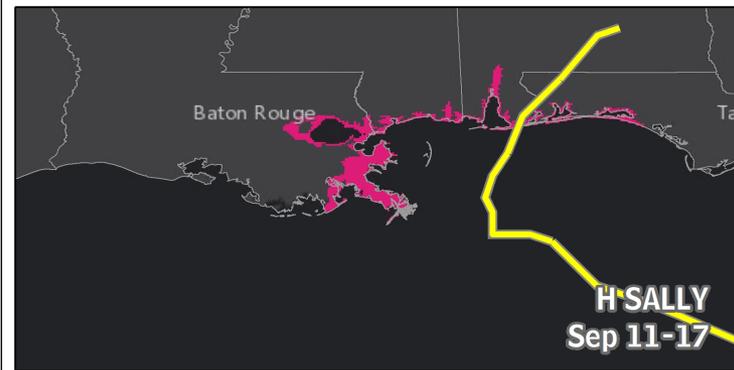
# 1. Words Matter



**Storm Surge  
Warning**



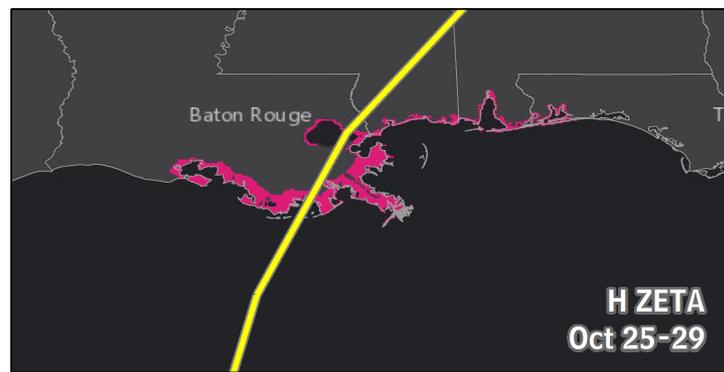
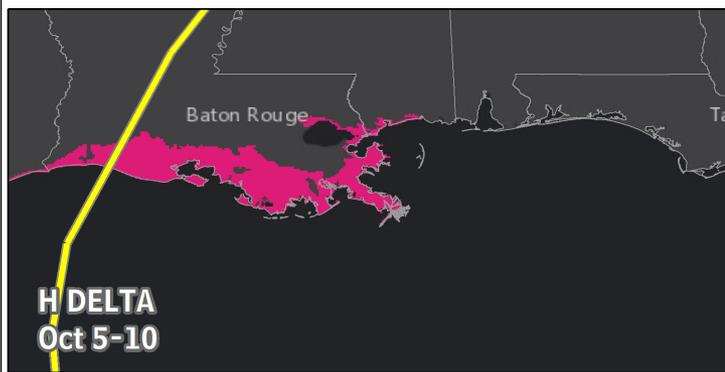
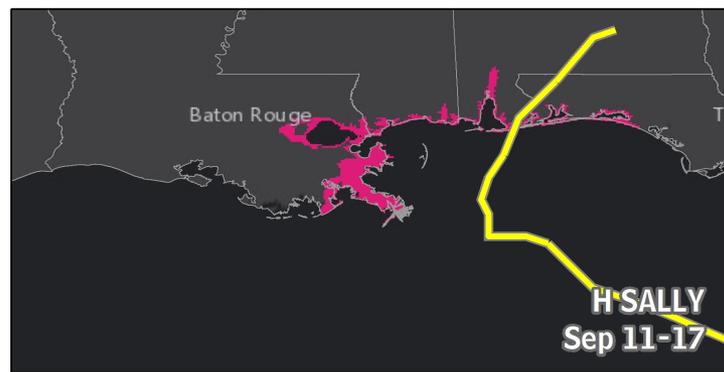
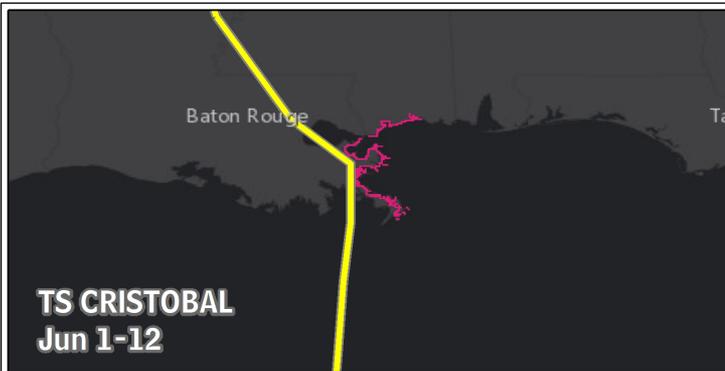
# 1. Words Matter



**“We still have  
people not  
evacuating,  
what can we  
say?”**

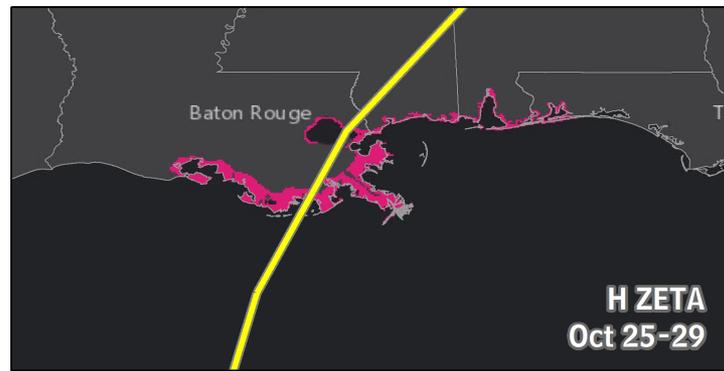
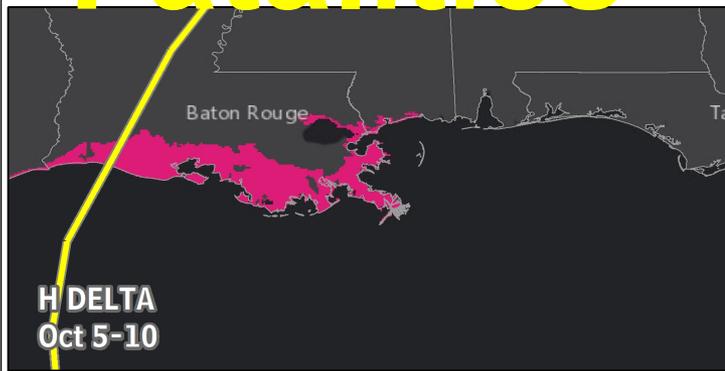
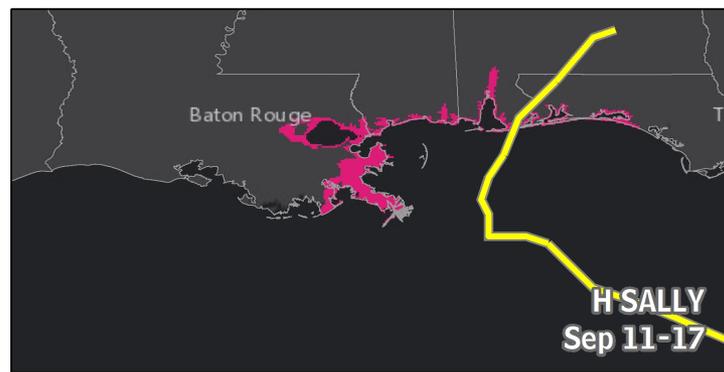
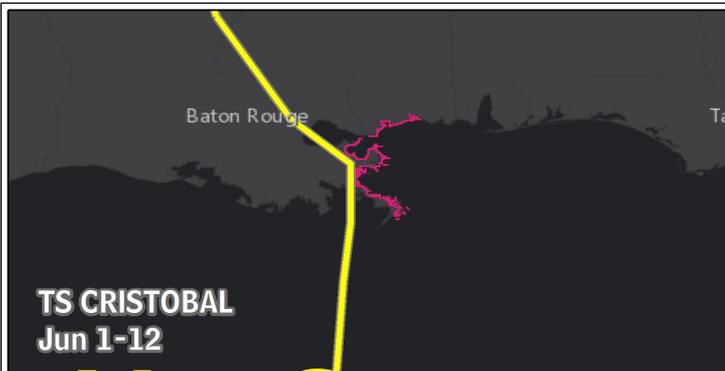


# 1. Words Matter





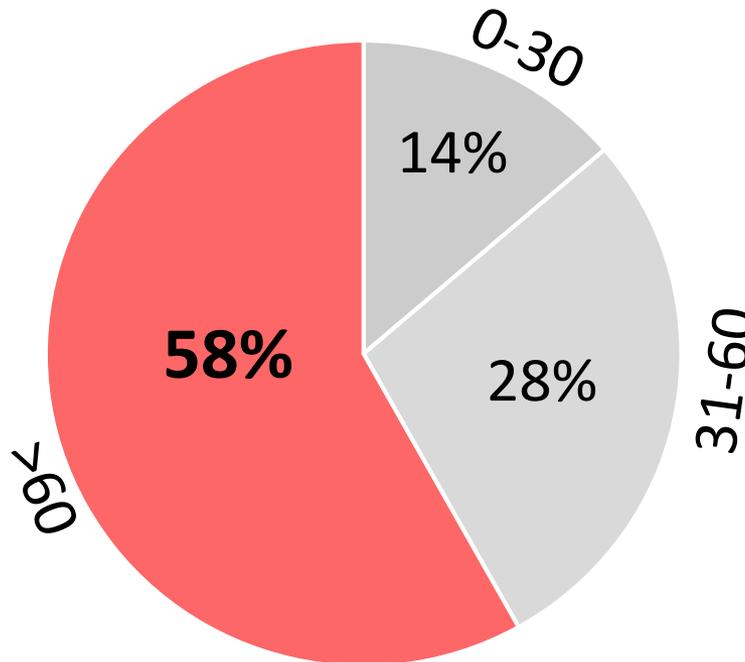
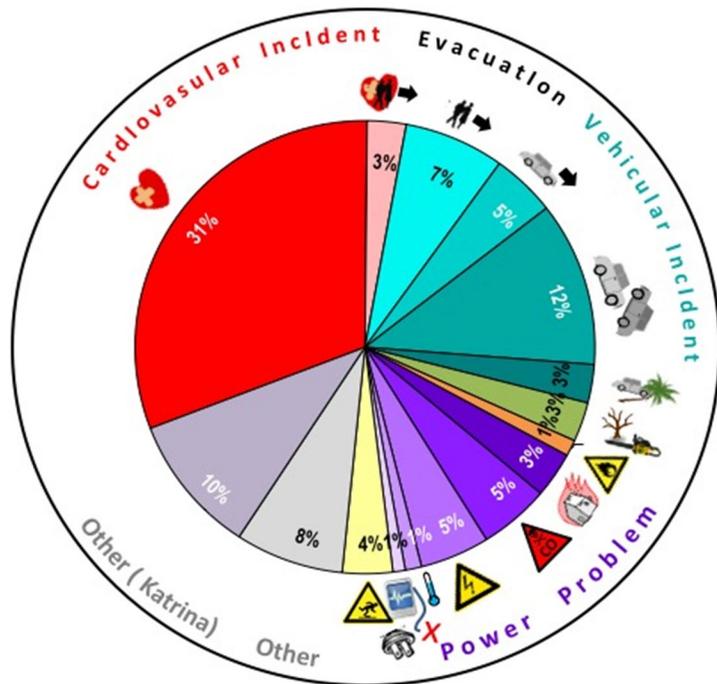
# 1. Words Matter



**No Storm Surge Fatalities**

# 2. Indirect Fatalities

“The storm is past me, I’m safe now”



1963-2012 indirect deaths (heart attacks, power problems (e.g., no A/C, lights, medical equipment), etc.). Outnumber direct deaths in some storms.

Based on Rappaport and Blanchard (2016)

Rappaport and Blanchard, 8/7/2015

8 *times* as many victims age over 60 as under 21 years old



## 2. Indirect Fatalities

Hurricane Laura:	7 Direct Fatalities (Wind 5, 2 Rip Current) 34 Indirect Fatalities (16 from carbon monoxide)
Since 2017:	14 Hurricane Landfalls, 6 Were Major Hurricanes 7 Storm Surge Fatalities
Preliminary 2020:	46 Direct Fatalities (Rip Currents 16, Wind 14, Freshwater 9, Marine 3, Surge 2, Tornado 2) 51 Indirect, with at least 19 carbon monoxide.

Historically, storm surge is the leading cause of fatalities in tropical systems.

In the last 4 years, we've lost more people to carbon monoxide poisoning after a storm than we have storm surge.



# 3. Little Wiggles Matter

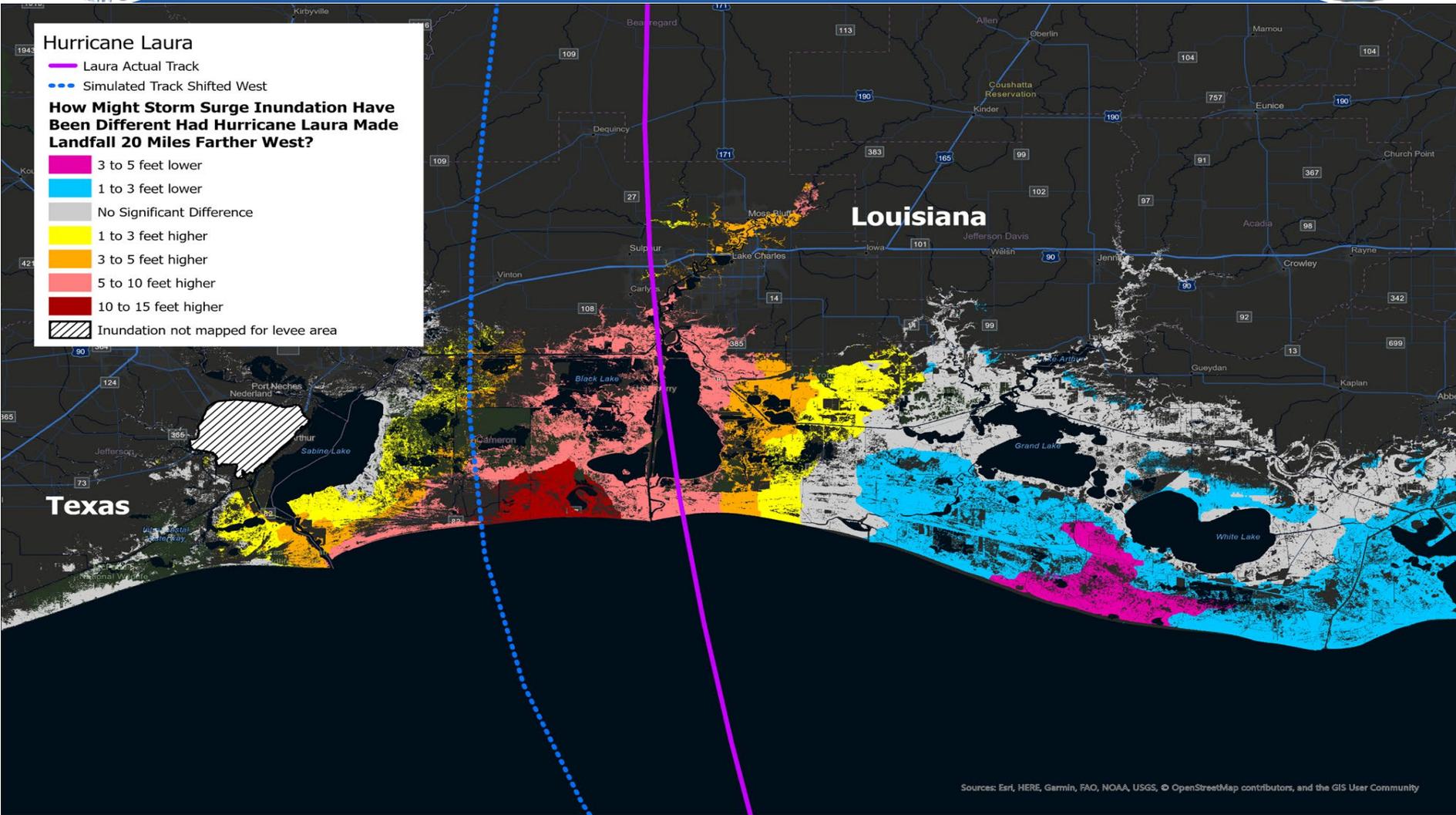
## Hurricane Laura

— Laura Actual Track

... Simulated Track Shifted West

### How Might Storm Surge Inundation Have Been Different Had Hurricane Laura Made Landfall 20 Miles Farther West?

- 3 to 5 feet lower
- 1 to 3 feet lower
- No Significant Difference
- 1 to 3 feet higher
- 3 to 5 feet higher
- 5 to 10 feet higher
- 10 to 15 feet higher
- Inundation not mapped for levee area

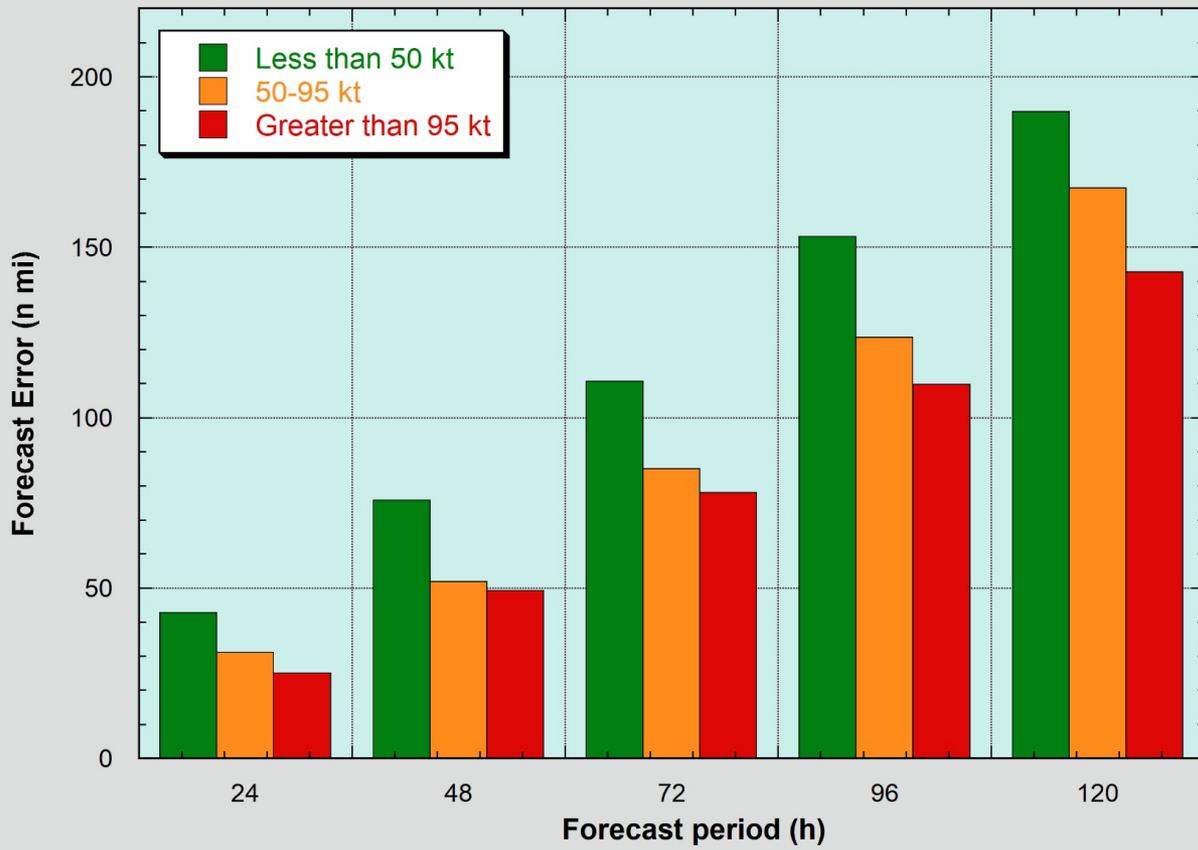


Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



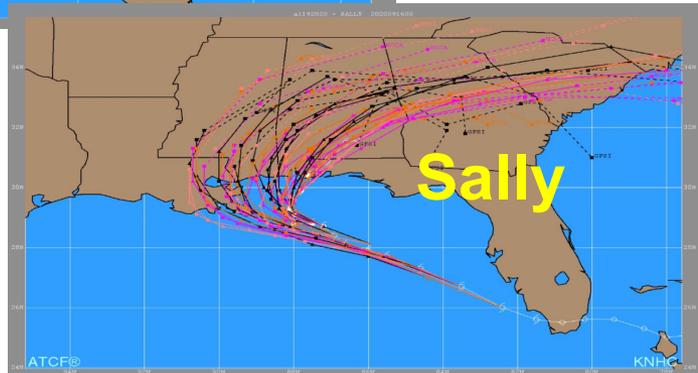
# 4. Every Storm Is Different

**NHC Official Track Forecast Errors by Intensity  
2015-19 Atlantic Basin**



**As the initial intensity of the storm increases, NHC average track error gets smaller!**

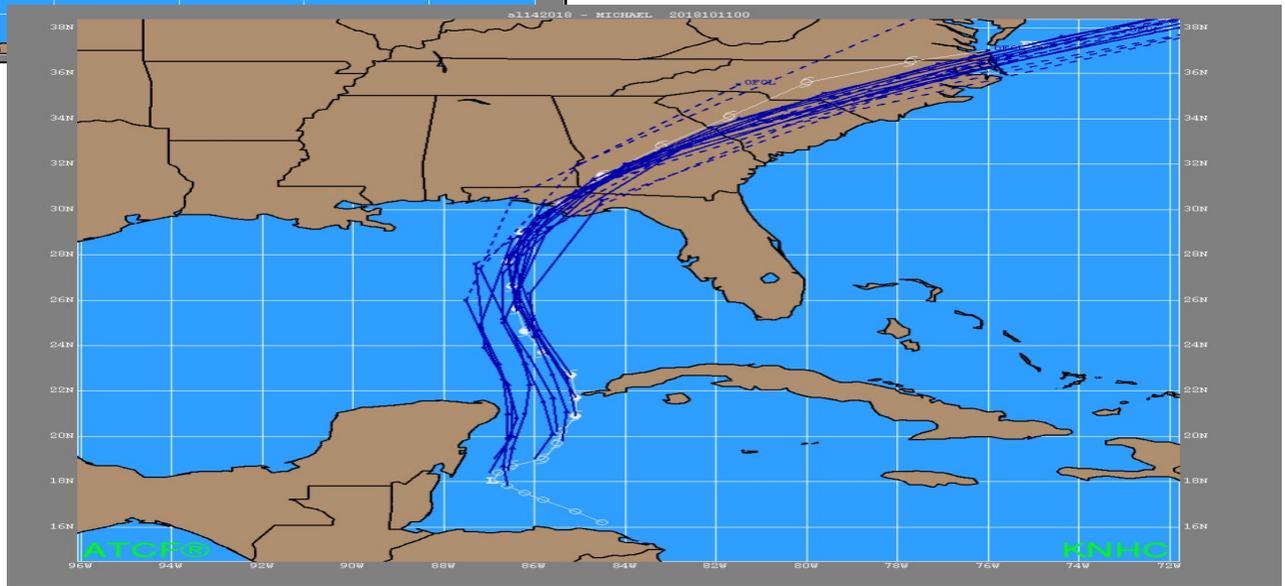
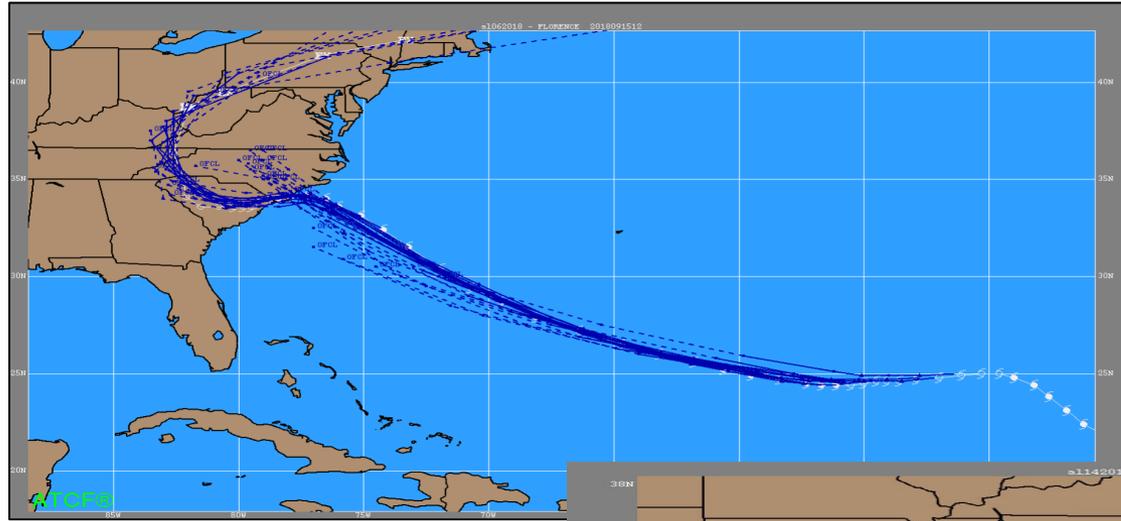
# 4. Every Storm Is Different



**Other factors come into play; interaction with other storms, forward speed, wind shear, eyewall structure, and confidence in weather patterns**



# 5. Hurricanes Don't Care About Your Timelines



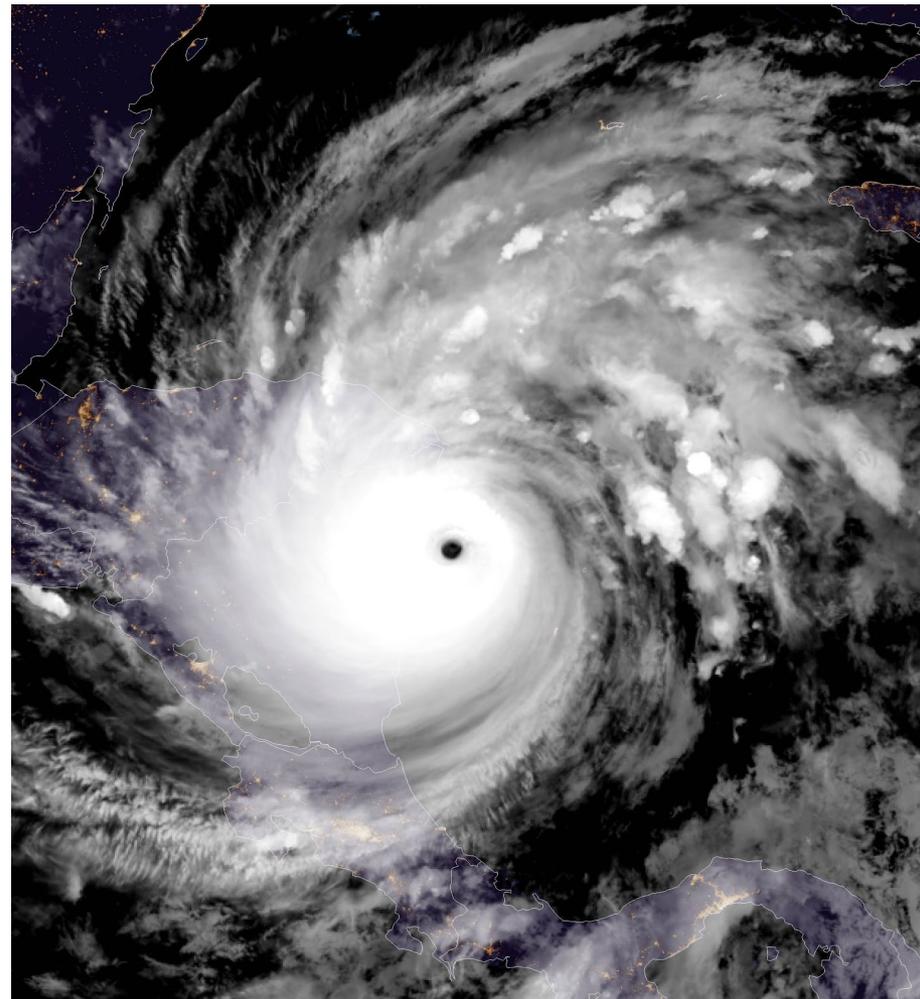


# 5. Hurricanes Don't Care About Your Timelines

9 Atlantic TCs in 2020 underwent RI, **several just before landfall and several rapidly weakened and/or fluctuated**

Largest 24-h intensity change:

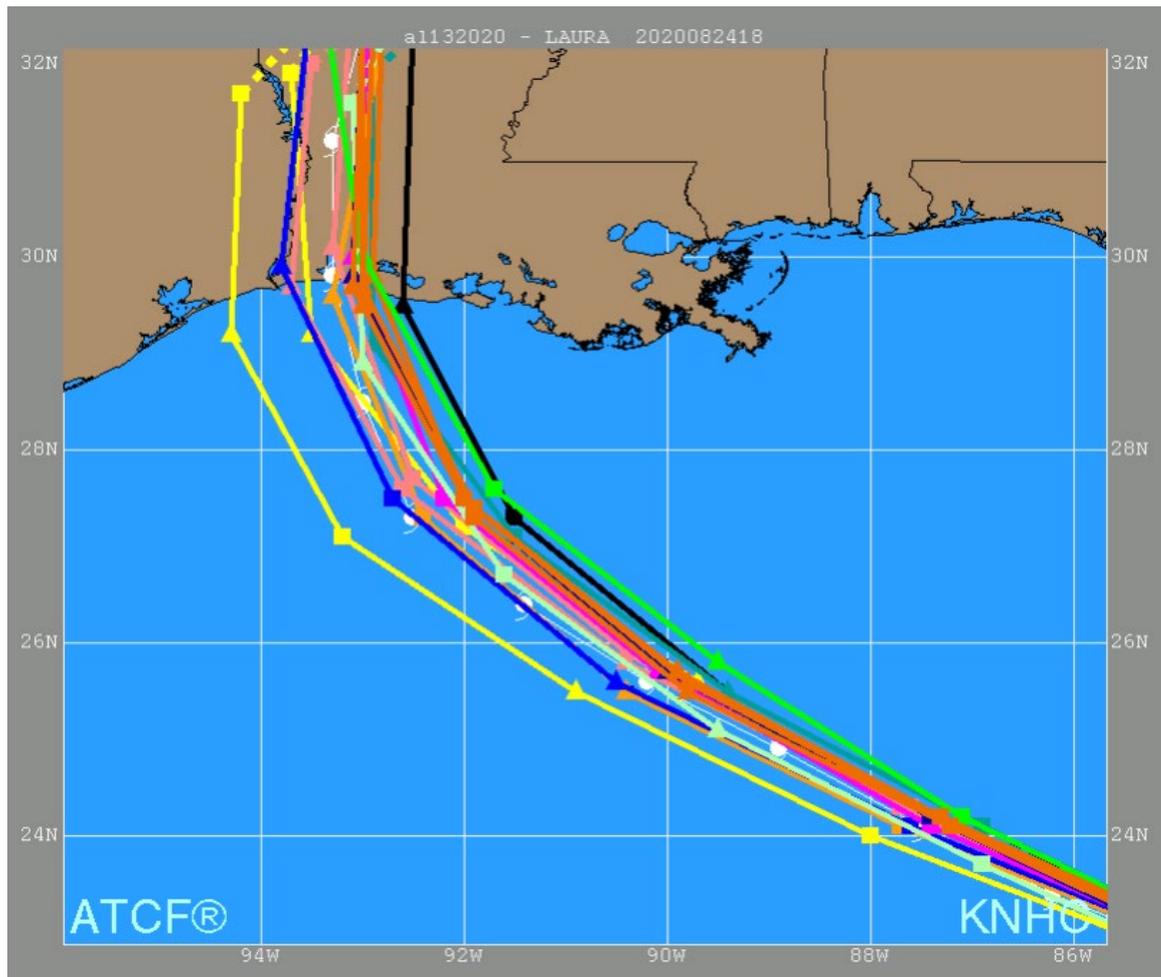
- Hanna: 30 kt (50 -> 80 kt)
- Laura: 40 kt (90 -> 130 kt)
- Sally: 20 kt in 12 h (70 -> 90 kt)
- Teddy: 35 kt (85 -> 120 kt)
- Delta: 65 kt (55 -> 120 kt)
- Epsilon: 45 kt (55 -> 100 kt)
- Zeta: 40 kt (55 -> 95 kt)
- Eta: 70 kt (60 -> 130 kt)
- Iota: 70 kt (70 -> 140 kt)





# 6. Deterministic Concerns

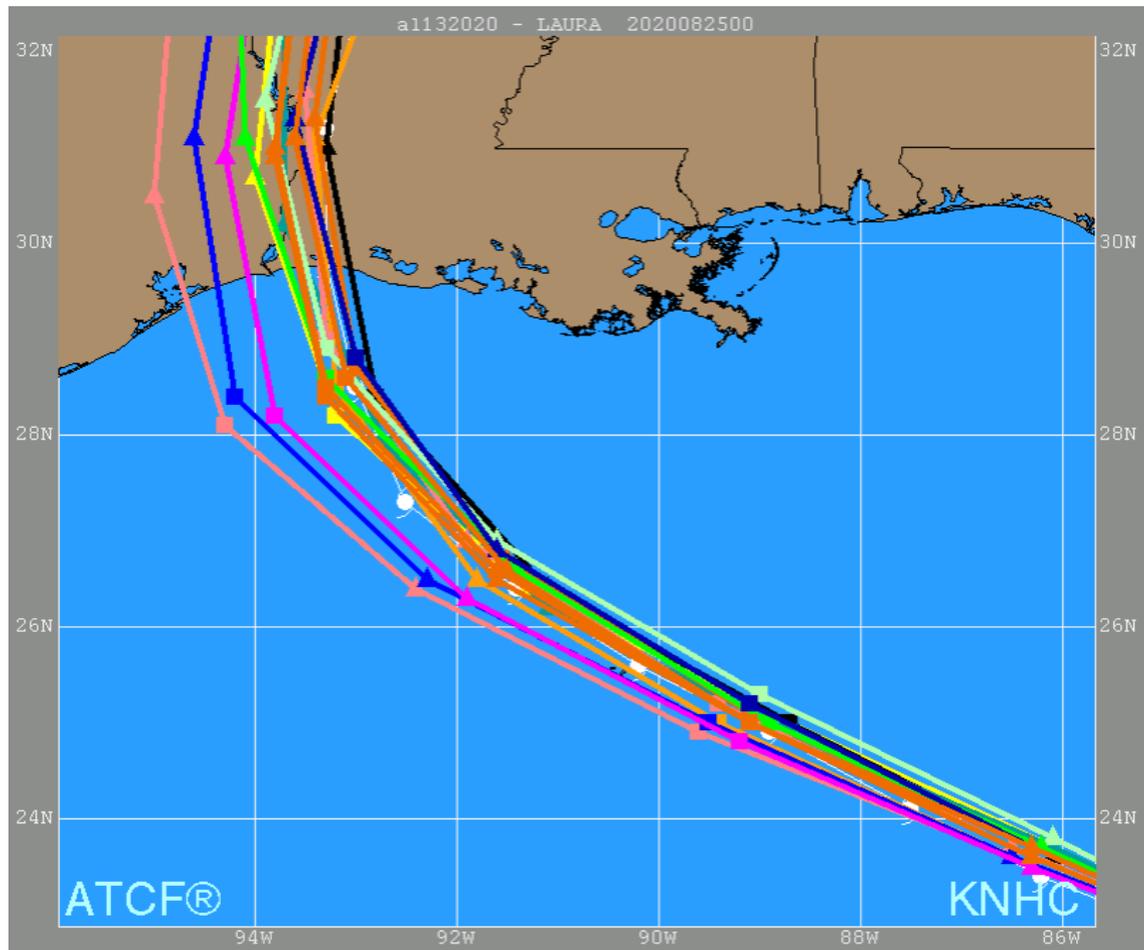
Hurricane  
Laura -  
Guidance  
1800 UTC  
August 24





# 6. Deterministic Concerns

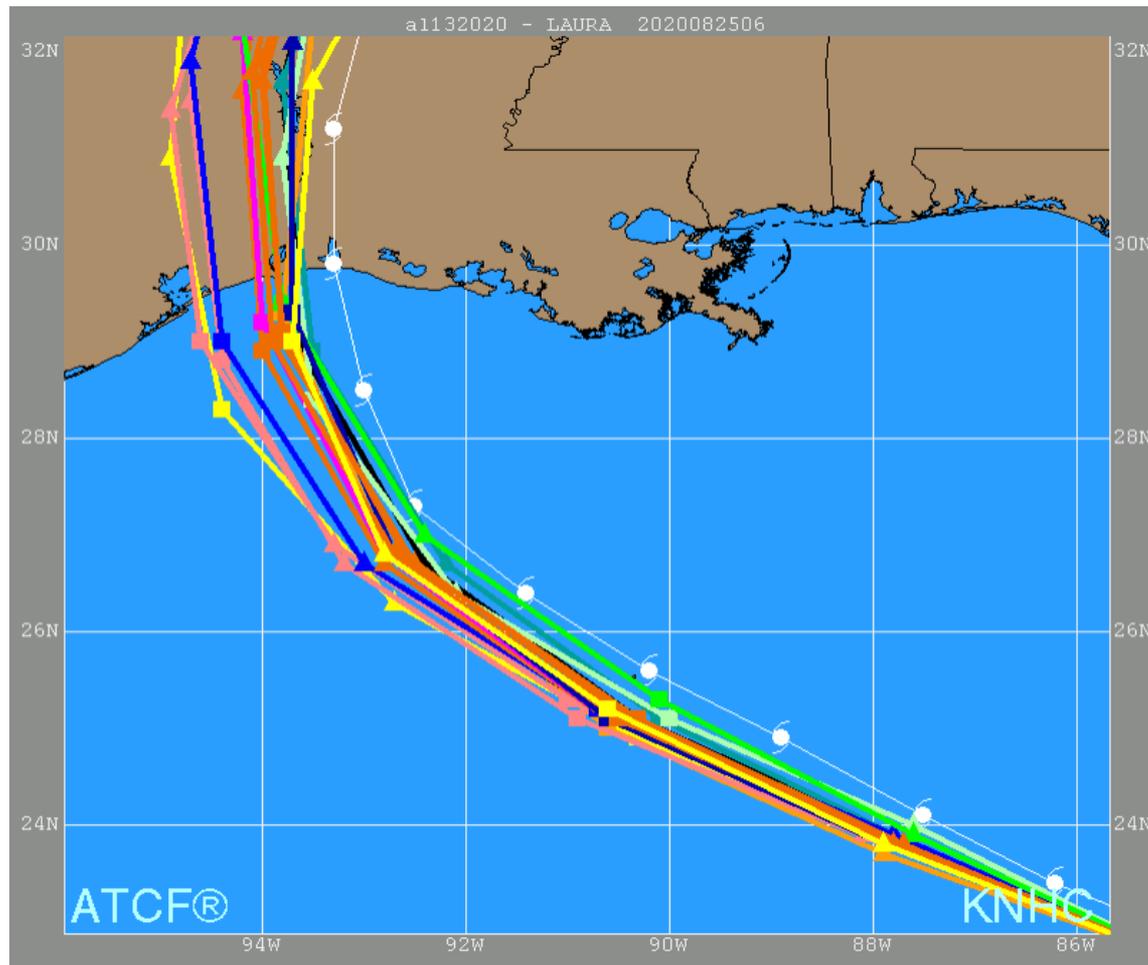
Hurricane  
Laura -  
Guidance  
0000 UTC  
August 25





# 6. Deterministic Concerns

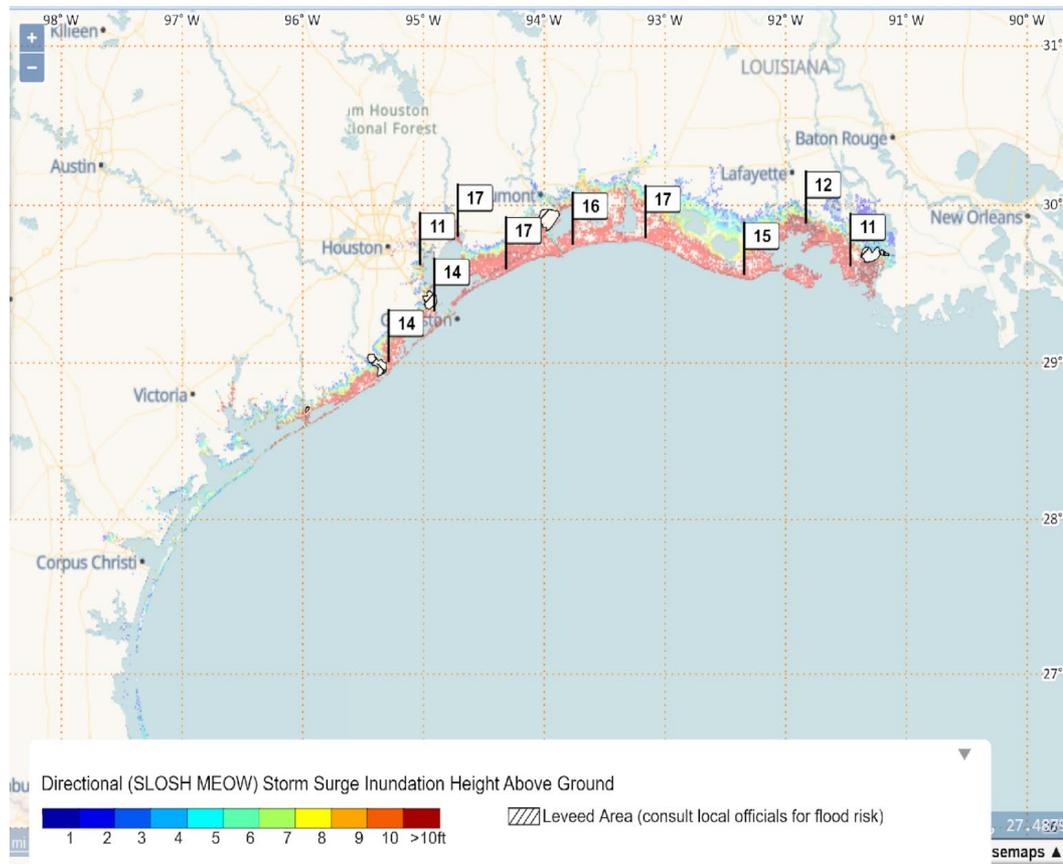
Hurricane  
Laura -  
Guidance  
0600 UTC  
August 25



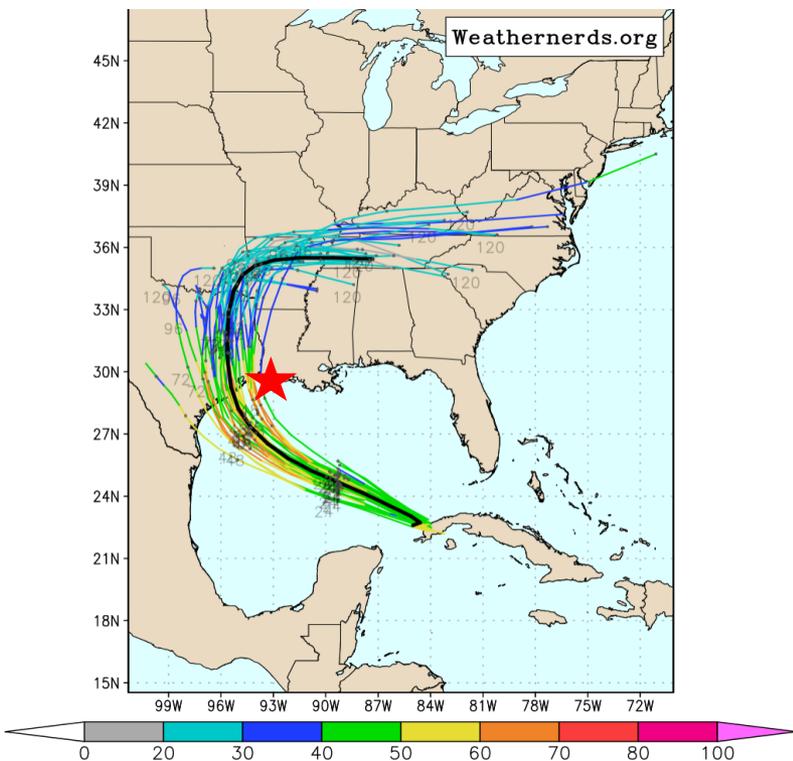


# 6. Deterministic Concerns

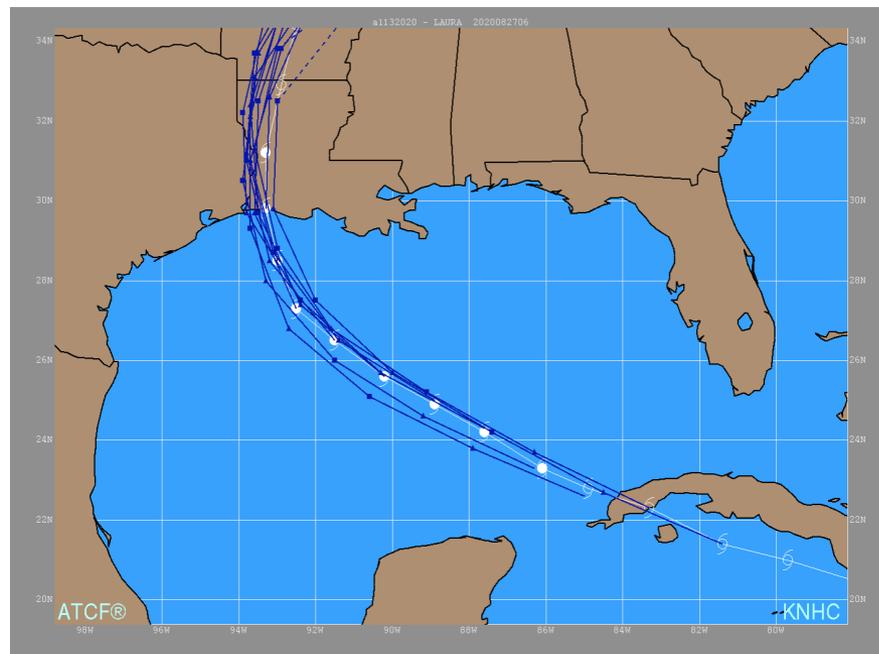
Hurricane  
Laura - Many  
Tracks  
Guidance  
MEOW for  
Storm Surge



# 6. Deterministic Concerns



Every ECMWF ensemble member was too far west

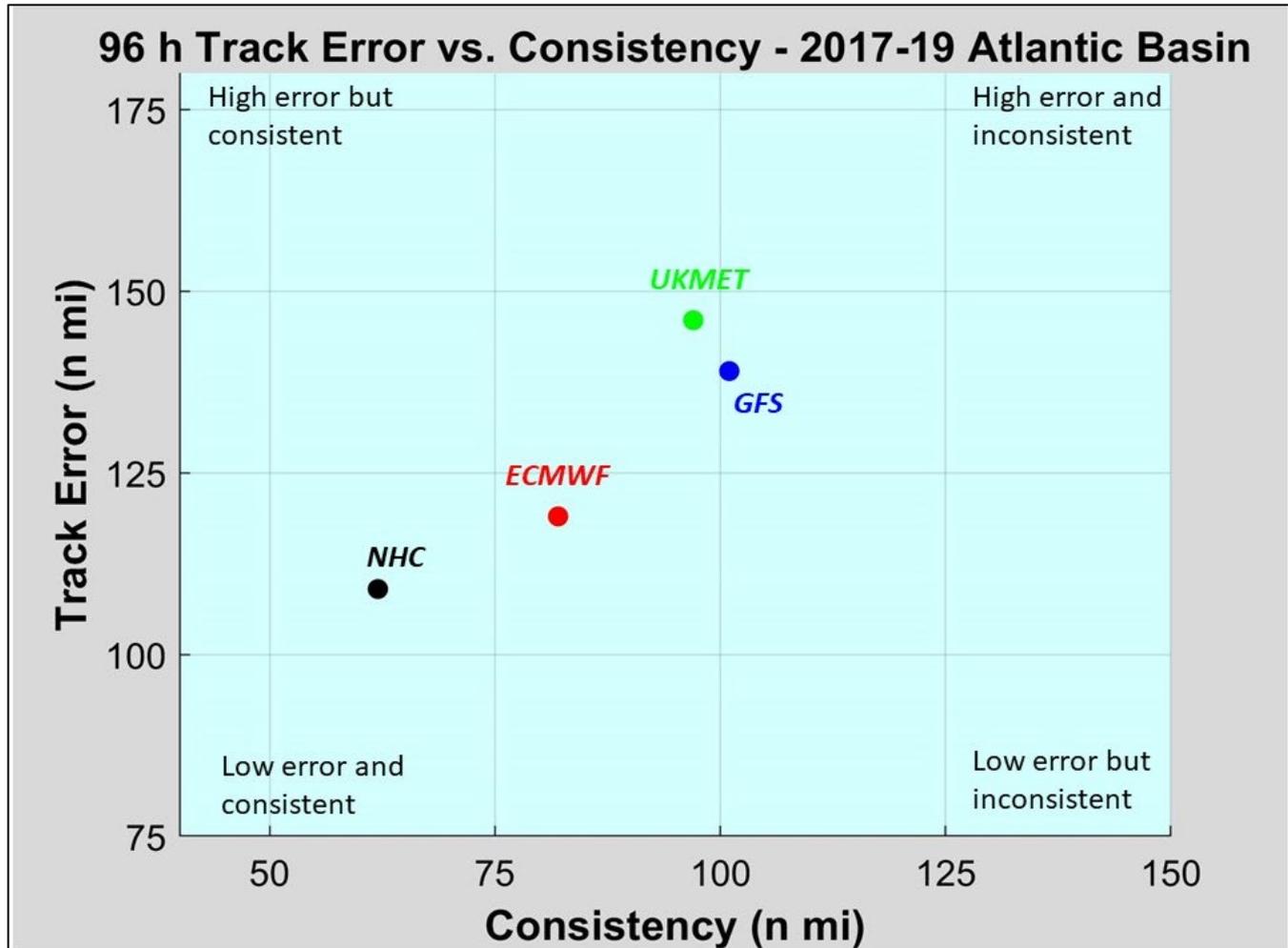


Consistency of NHC track forecasts during Laura



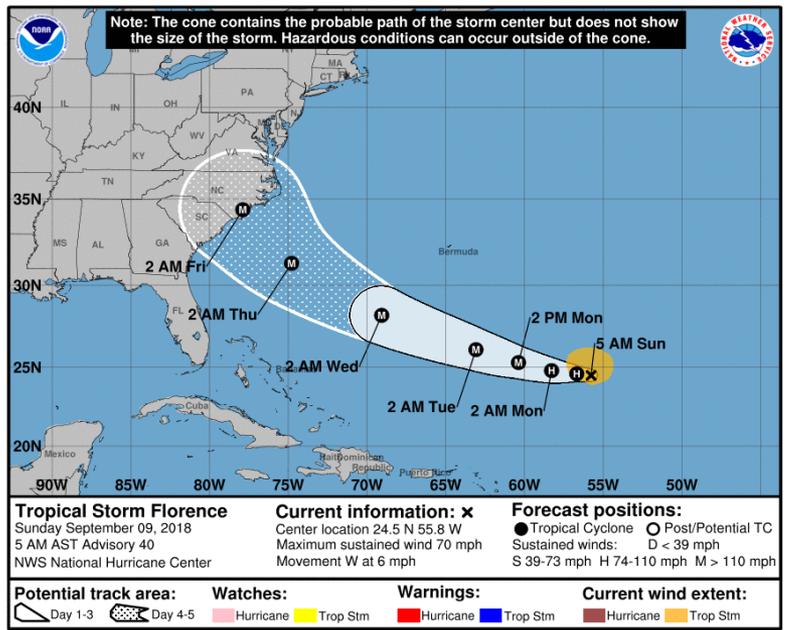
# 6. Deterministic Concerns

The forecast from NHC has a lower average track error and is more consistent than any individual model overall



# Forecast Accuracy

## Forecast Models

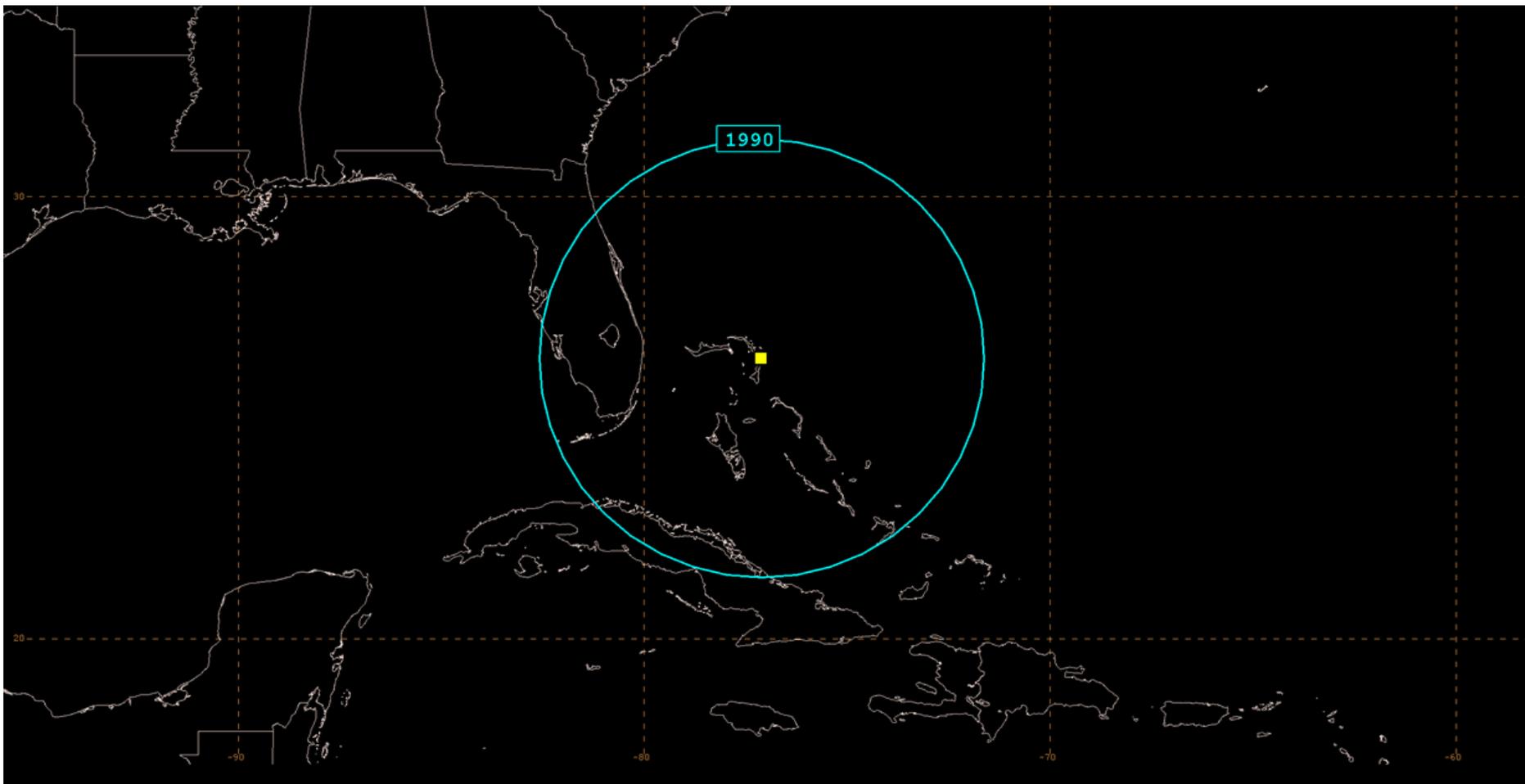


*Be careful looking at one run of one model. We are looking at more than 50!*



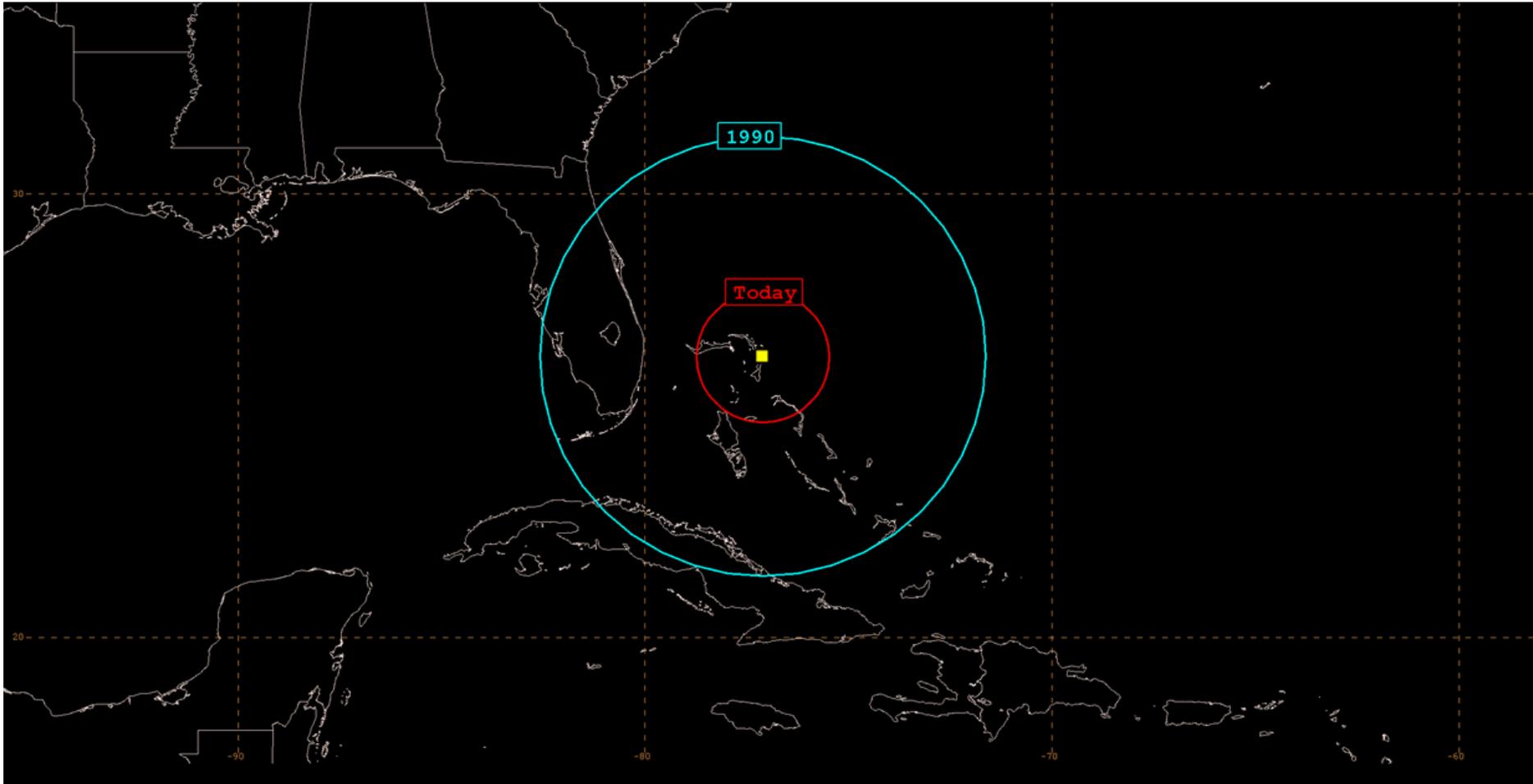


# Uncertainty





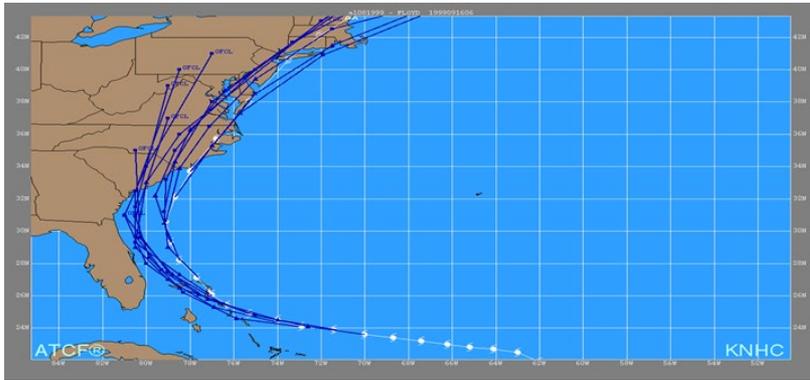
# Uncertainty





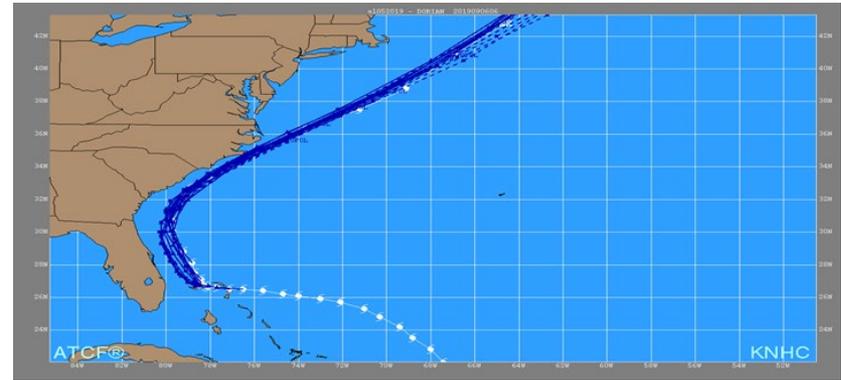
# Forecast Accuracy

## Why does this matter?



**NHC Track Forecasts for Floyd from  
06Z 13 Sep - 06Z 16 Sep 1999**

**2.6 million people evacuated**



**NHC Track Forecasts for Dorian from  
06Z 1 Sep - 06Z 6 Sep 2019**

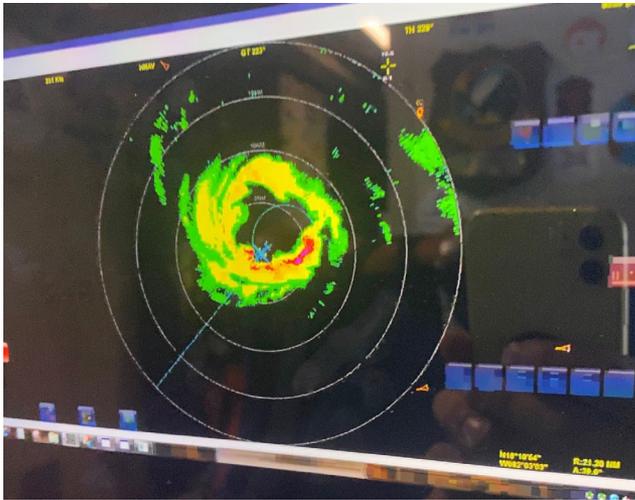
**As many as 3 million people NOT evacuated**



# Forecast Accuracy

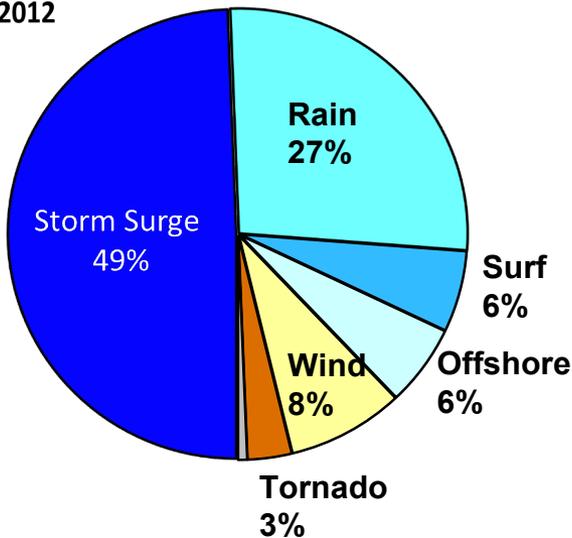
## Hurricane Hunters

NOAA OMAO Aircraft Operations Center (AOC) Hurricane Hunters fly the P3 and G-IV, with the US Air Force Reserve flying the WC-130J, all for hurricane surveillance and in-situ data reconnaissance

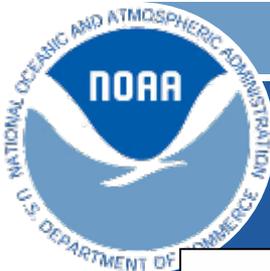


# What's New?

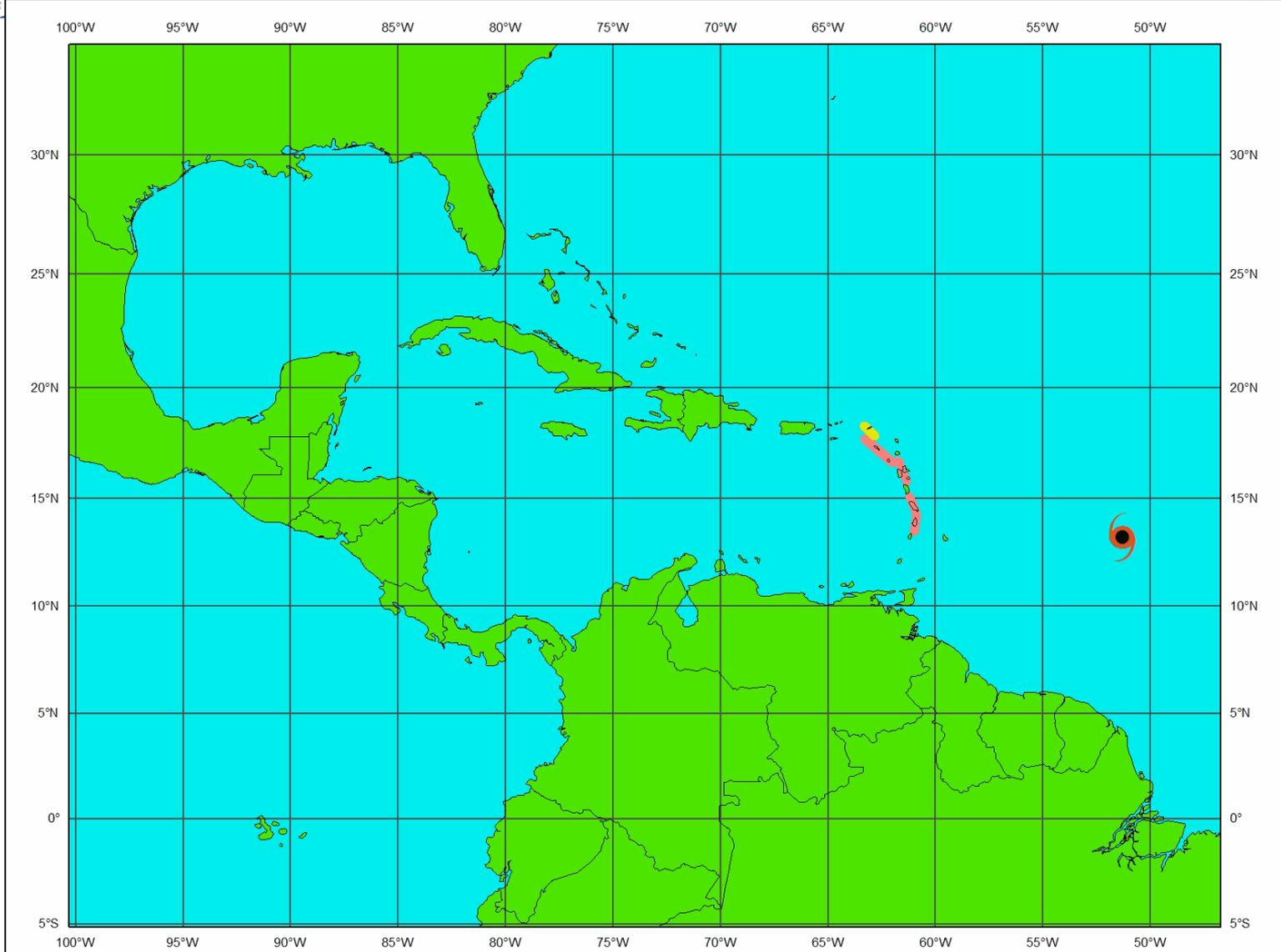
U.S. Tropical Cyclone Fatalities  
1963-2012



## Storm Surge Graphic



# Domestic and International Coordination





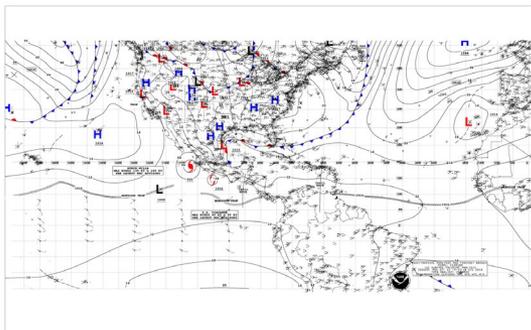
# What's New?

The screenshot shows a Zoom meeting interface. The main window displays a weather map of the Atlantic Ocean region, with various colored lines and markers representing storm tracks. The map is titled "ATCF - Area of Operations (NH) - ETA #292020 (on rbr-to-actfwr1.nhc.noaa.gov)". The meeting details panel on the right lists 15 participants, all identified as "NOAA Federal". The meeting is being presented by Michael Brennan. The bottom of the screen shows standard Zoom controls like mute, video, and chat.

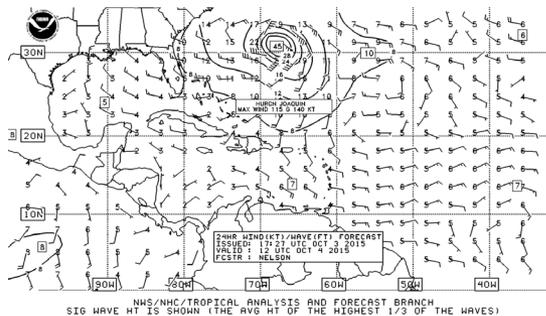
## Domestic and International Collaborative Tools



# What's New?



Oceanic Surface Analysis



Marine Charts

SPOT FORECAST FOR USCG SAR RC...USCG  
 NWS NATIONAL HURRICANE CENTER MIAMI FL  
 1118 PM EST Wed Dec 26 2018

Forecast is based on forecast start time of 2300 UTC on December 26.  
 If conditions become unrepresentative...contact the NWS  
 National Hurricane Center/Tropical Analysis and Forecast  
 Branch at (305)229-4425.

.DISCUSSION...

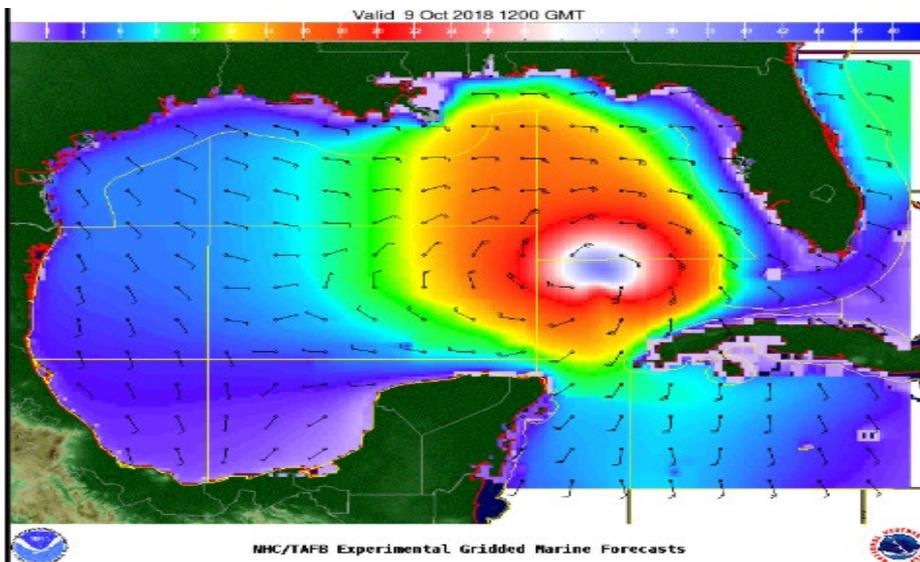
For the SAR area...Fresh trade winds will increase to fresh to strong Thu and Thu night as strong high pres builds down from the N. Significant wave heights will build from 6 feet to 12 feet by early Fri. Isolated showers and thunderstorms will be possible the next few days.

.REST OF TONIGHT...

Sky/weather.....Clear (0-5 percent).  
 Min temperature....Around 72.  
 Max humidity.....93 percent.  
 Dewpoint.....71 overnight.  
 Surface winds (mph).East winds around 18 knots with gusts to around 26 knots.  
 Swell height.....East swell 1 feet.  
 Wave height.....6 feet.  
 Wave period.....7 SECONDS.  
 Wave period.....7 SECONDS.  
 Wind wave.....6 feet overnight.  
 Sea surface temp....81.2 F.

TIME (UTC)	4 UTC	7 UTC	10 UTC
Sky (%).....	0	0	0
Weather cov.....			
Weather type...NONE	NONE	NONE	
Tstm cov.....			
Temp.....	73	73	73
Dewpoint.....	71	71	71

Marine Lat/Lon Emergency Spot Forecast

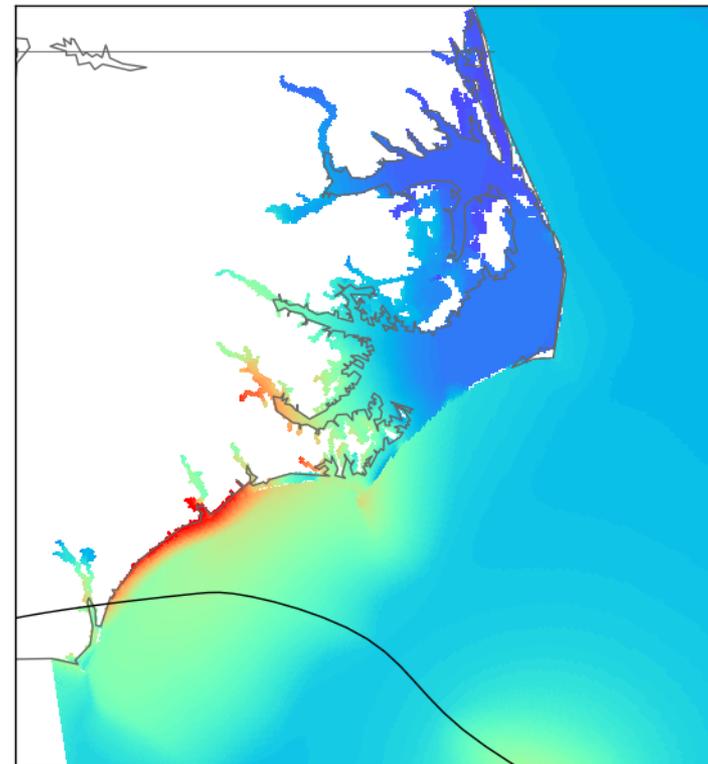
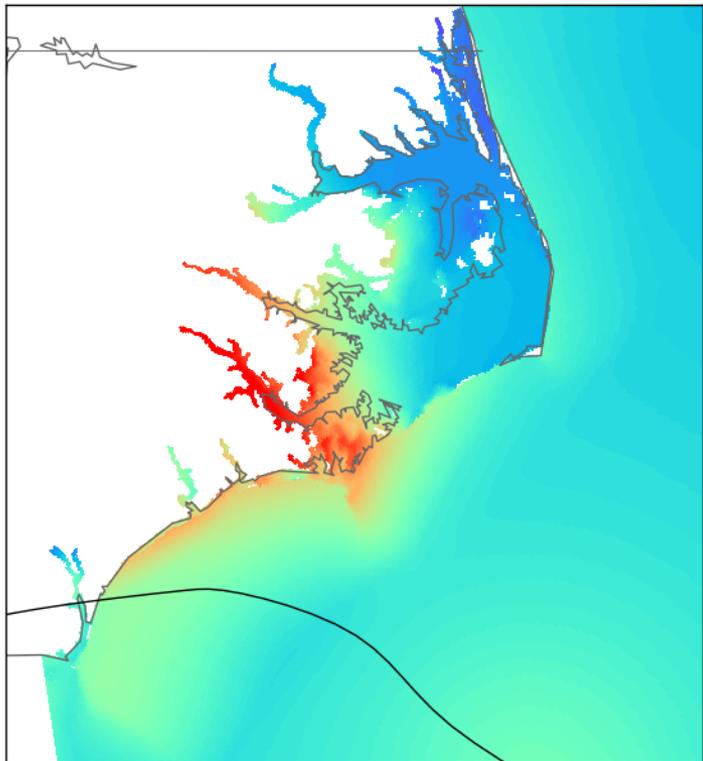


Digital Marine Forecasts



# What's New?

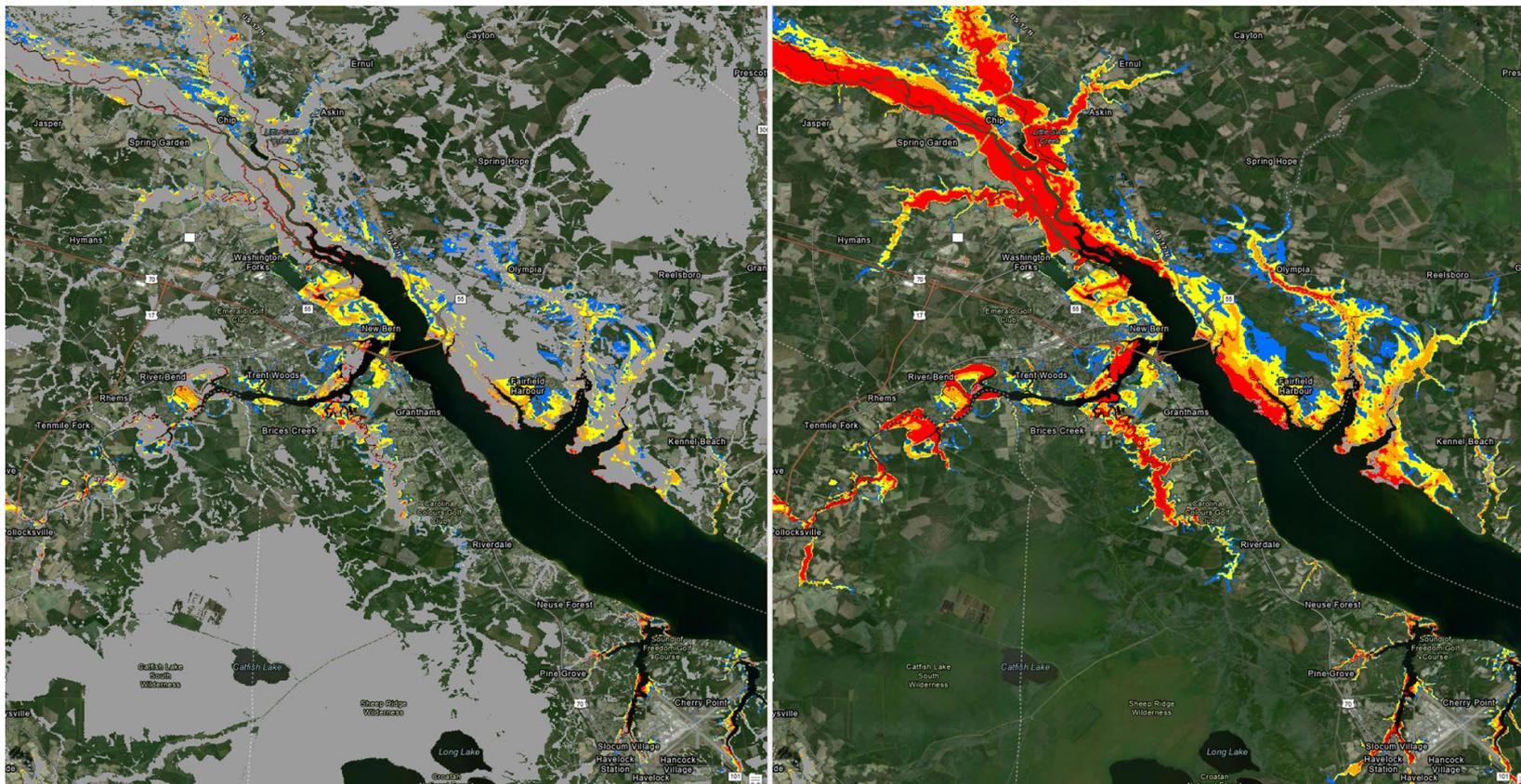
## Structure Matters!



Stronger, Smaller Storm

## Big Upgrade to Storm Surge Model

# What's New?



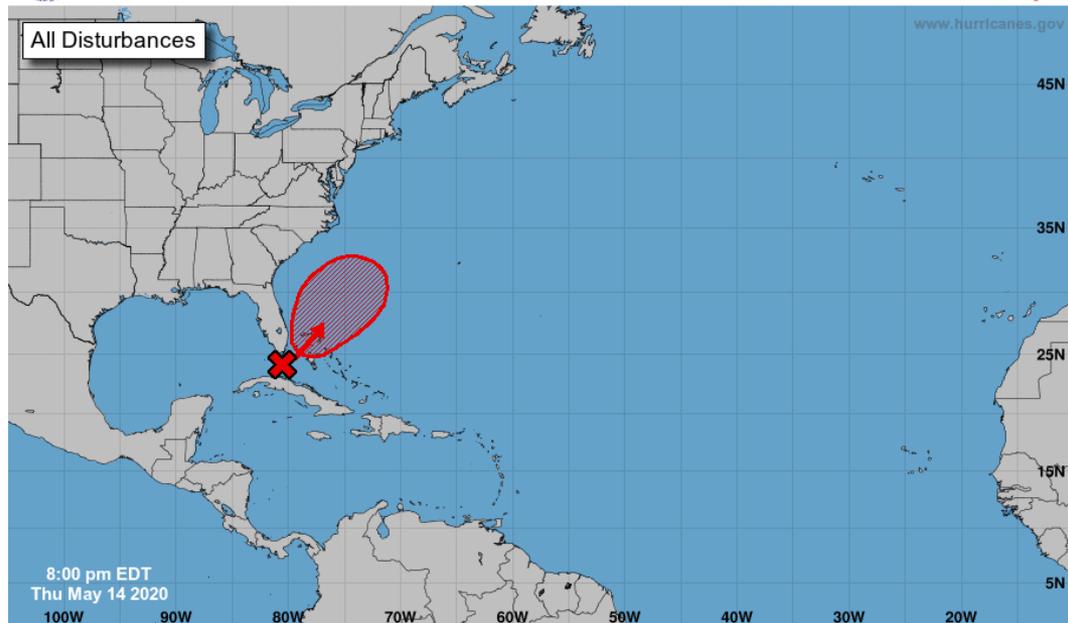
## Better Storm Surge Model Estuary Masking

# What's New?



## Five-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



Current Disturbances and Five-Day Cyclone Formation Chance:  < 40%  40-60%  > 60%

Tropical or Sub-Tropical Cyclone:  Depression  Storm  Hurricane

 Post-Tropical Cyclone or Remnants

## Atlantic Tropical Weather Outlook Now Begins May 15



# What's New?

- World Meteorological Organization Region IV Hurricane Committee is responsible for names

## Retired Tropical Cyclone Names

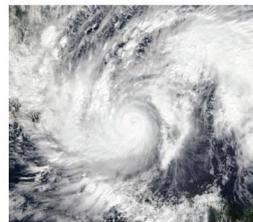
**Dorian**  
2019



**Laura**  
2020



**Eta**  
2020



**Iota**  
2020



**Overflow Name List Does Not Include Greek Alphabet**

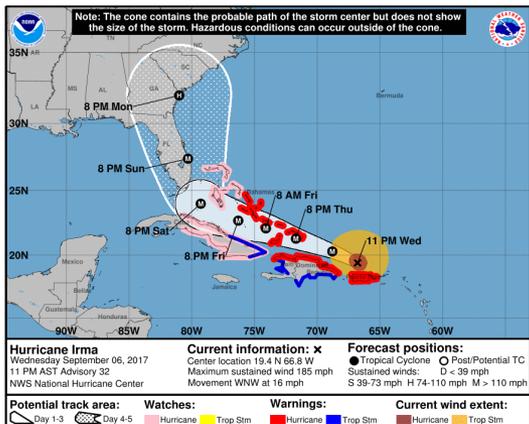


# What's New?

- **World Meteorological Organization Region IV Hurricane Committee is responsible for names**
- **Translation challenges into Spanish, French, and Portuguese**
- **Pronunciation of letters in succession (Zeta, Eta, Theta)**
- **Zeta perceived as the last letter**
- **Focus on the letters took away from critical impact messaging**
- **Rotating name list for 6 years continues**
- **An overflow name list created which remains the same each year**

## **Overflow Name List Does Not Include Greek Alphabet**

# Communicating the Danger



Forecast Cone/Wind Warnings/Size



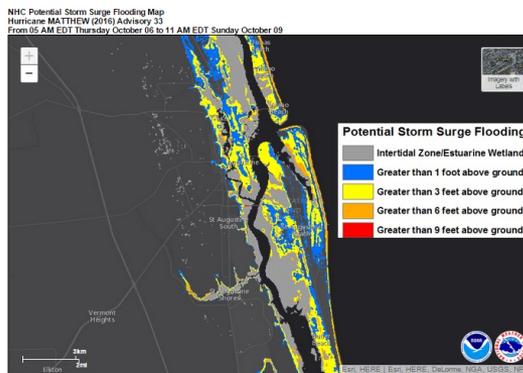
Wind Speed Probabilities



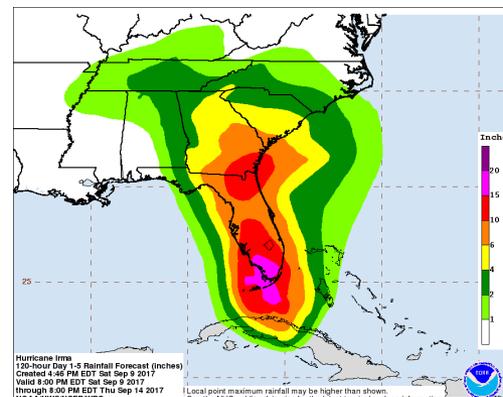
Time of Arrival of Winds



Storm Surge Warnings



Storm Surge Potential Inundation



Weather Prediction Center Rainfall

# Communicating the Danger

It's All About the Impacts



## Key Messages for Hurricane Irma

### Advisory 13: 11:00 AM AST Sat Sep 02, 2017



1. Irma is expected to be a major hurricane when it moves closer to the Lesser Antilles early next week, producing rough surf and rip currents. Irma could also cause dangerous winds, storm surge, and rainfall impacts on some islands, although it is too soon to specify where and when those hazards could occur. Residents in the Lesser Antilles should monitor the progress of Irma through the weekend and listen to any advice given by local officials.

2. It is much too early to determine what direct impacts Irma will have on the Bahamas and the continental United States. Regardless, everyone in hurricane-prone areas should ensure that they have their hurricane plan in place, as we are now near the peak of the season.



**Hurricane Irma**  
Saturday September 02, 2017  
11 AM AST Advisory 13  
NWS National Hurricane Center

**Current information:**  
Center location 18.8 N 43.3 W  
Maximum sustained wind 110 mph  
Movement W at 15 mph

**Forecast positions:**  
● Tropical Cyclone ○ Possible Tropical Storm  
S 39-73 mph H 74-110 mph M > 110 mph

**Warnings:**  
● Tropical Storm ● Hurricane ● Tropical Storm ● Hurricane ● Tropical Storm

**Current wind extent:**  
● Tropical Storm ● Hurricane ● Tropical Storm ● Hurricane ● Tropical Storm



**Wind Speed Probabilities (Preliminary)**  
of the 1-minute (5.0 degree) average from 8 AM AST SAT SEP 02 to 8 AM AST THU SEP 07

Probability of tropical-storm-force winds (1-minute average >= 39 mph) from all tropical cyclones  
○ indicates Hurricane Irma center location at 8 AM AST SAT SEP 02, 2017 (Forecast Advisory #13)

0 10 20 30 40 50 60 70 80 90 %

For more information go to [hurricanes.gov](http://hurricanes.gov)



Thank you from the National Hurricane Center!

Ken Graham  
NOAA/NWS National Hurricane Center  
[kenneth.graham@noaa.gov](mailto:kenneth.graham@noaa.gov)  
[hurricanes.gov](http://hurricanes.gov)

