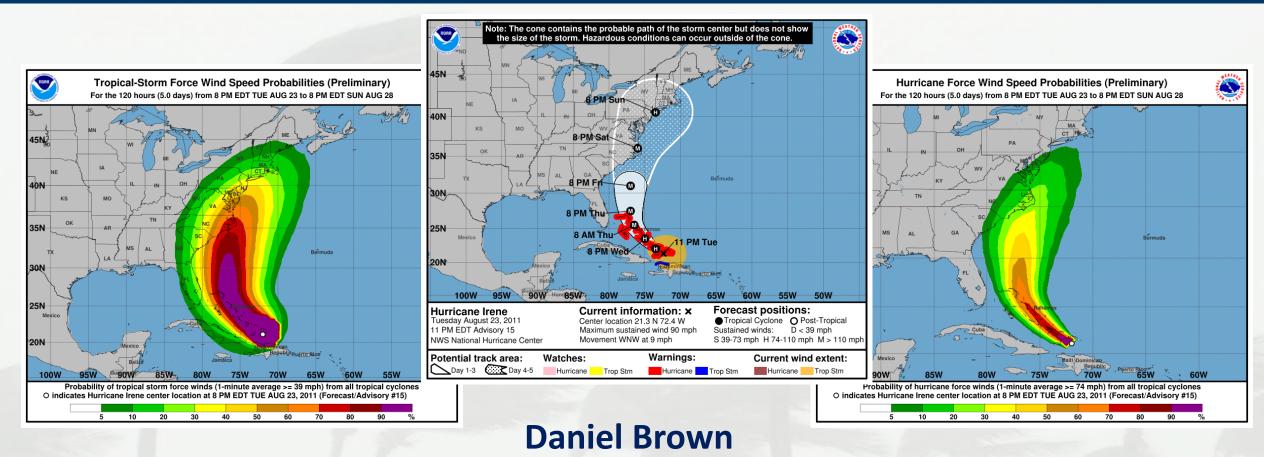
## Wind Speed Probabilities



National Hurricane Center

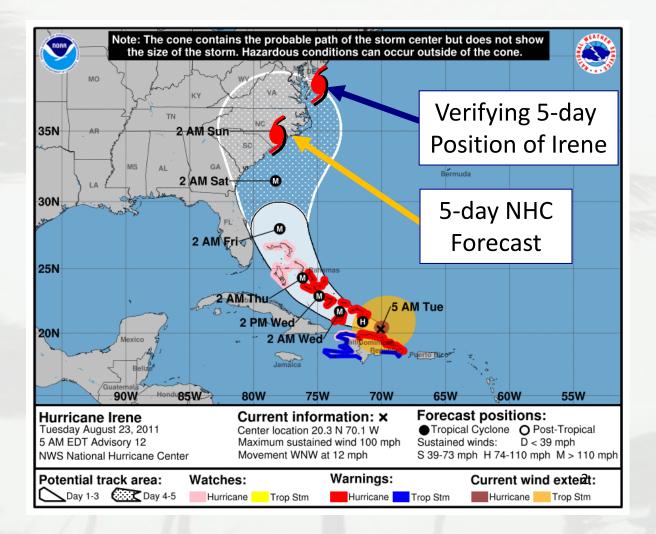
2022 WMO Course

3 March 2022

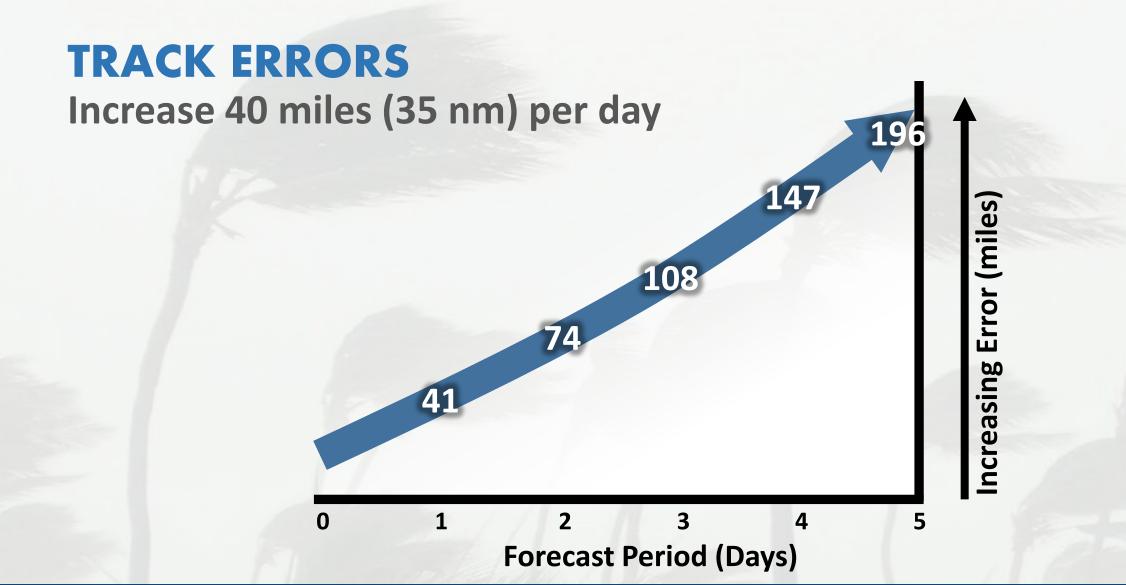
## Wind Speed Probabilities A Tool to Deal with Uncertainty

Hurricane Irene Advisory Number 12 Issued 5:00 AM EDT 23 August 2011

5-day position error about 270 miles



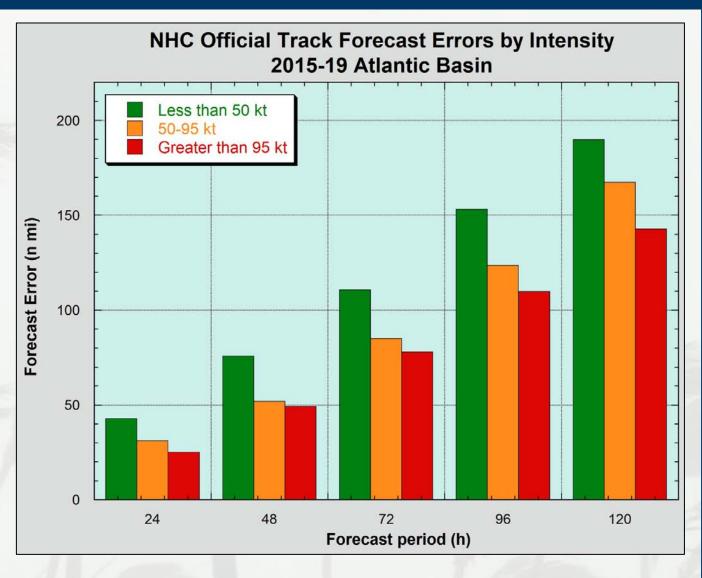
## **FORECAST TRACK ERRORS** *NHC 5-year Averages*



## FORECAST TRACK ERRORS Based on Initial Intensity

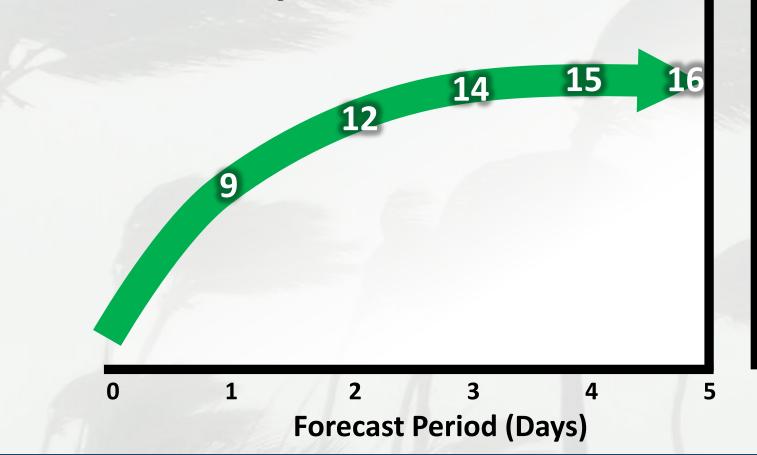
## More Uncertainty for Tropical Depressions and low-end Tropical Storms

Track errors for TDs and lowend TSs increase by 40 to 45 miles (35-40 nm) per day vs. about 40 miles per day overall.



FORECAST INTENSITY ERRORS NHC 5-year Averages

## **INTENSITY ERRORS** Increase the first 2-3 days and then level off



Error (mph)

ncreasing

FORECAST INTENSITY ERRORS NHC 5-year Averages

## **INTENSITY ERRORS**

Ο

The 24 and 48 hour NHC intensity forecasts are on average off by one Saffir-Simpson category.

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2

3

**Forecast Period (Days)** 

4

ncreasing Error (mph)

5

## FORECAST INTENSITY ERRORS Rapid Strengthening

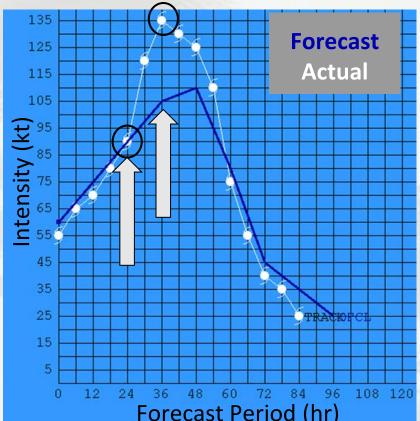
## **RAPID INTENSIFICATION**

# Rapid intensification remains a forecast challenge and often results in very large errors

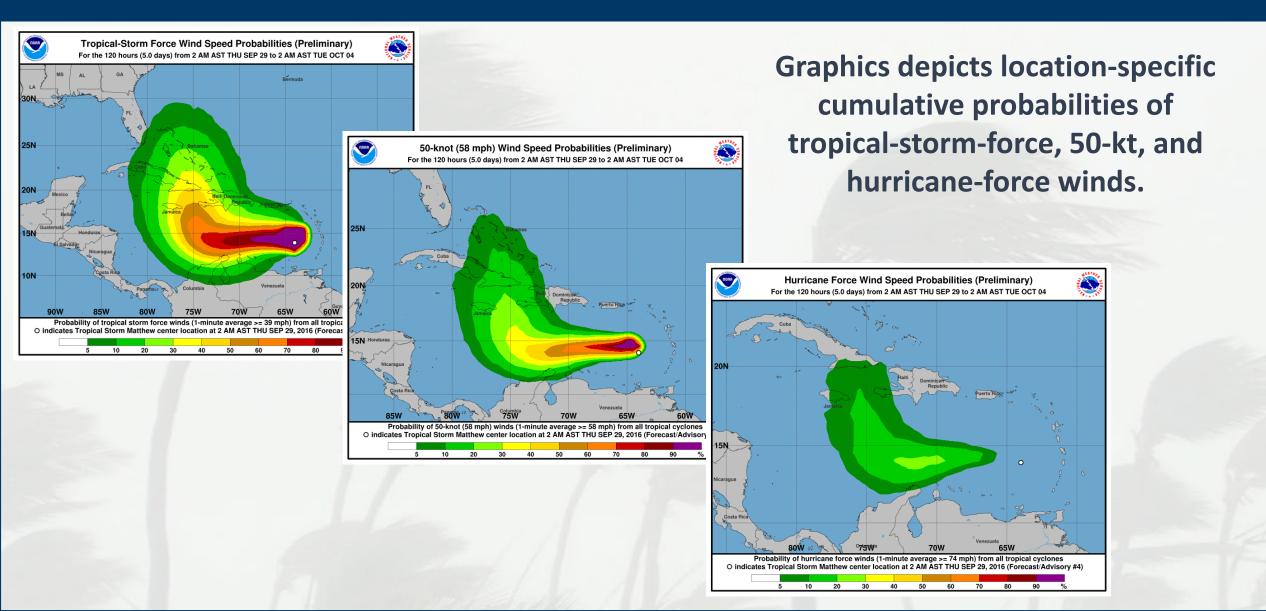
 Our ability to recognize conditions that favor rapid intensification has improved, however forecasting the extent and timing of that intensification remains difficult.

#### Example: lota Advisory 7 (2020)

Initial Intensity:	55 kt	Initial Intensity:	55 kt
24h Forecast:	90 kt	36h Forecast:	105 kt
Actual Intensity:	90 kt	Actual Intensity:	135 kt
24 h Error:	0 kt	36 h Error:	<b>30 kt</b>



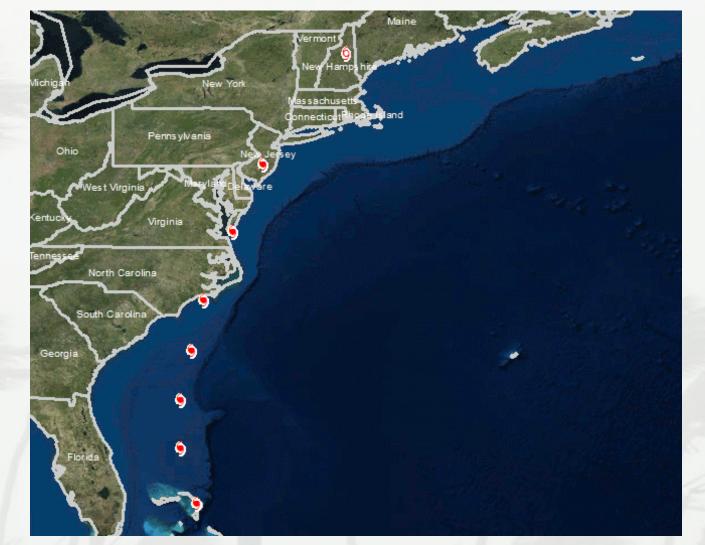
## Wind Speed Probabilities How Likely. Arrival Times. Inland Threat



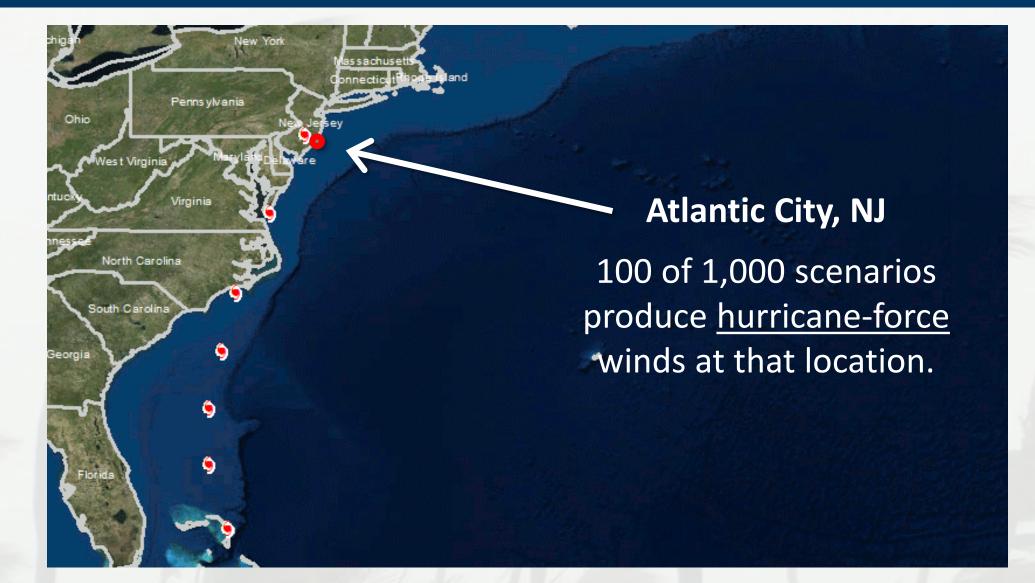
## WIND SPEED PROBABILITIES How are they generated?

## **MORE SCENARIOS**

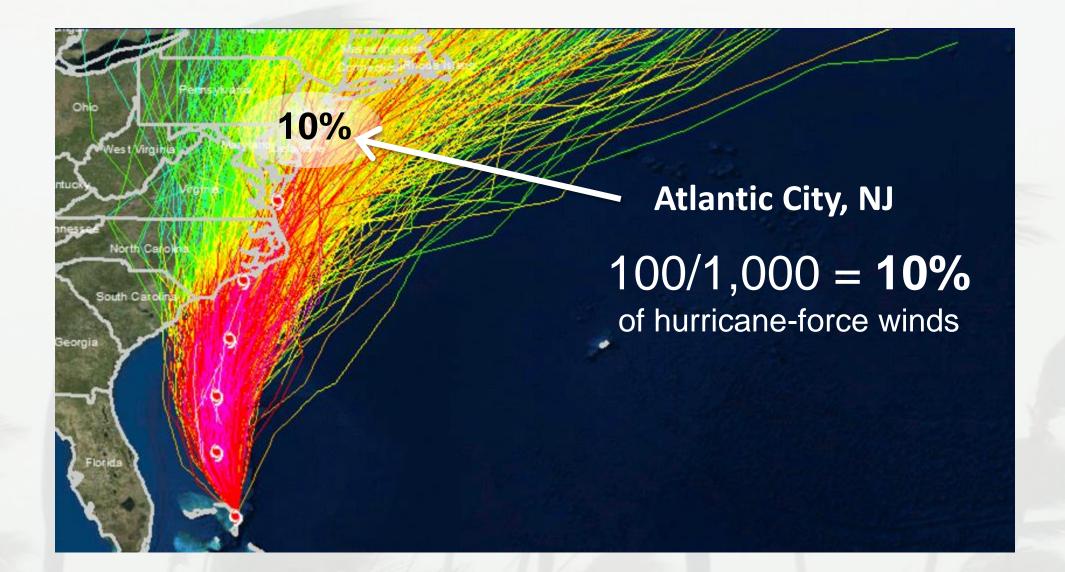
- 1,000 realistic alternative scenarios are generated
  - Official NHC forecast
  - Historical track and intensity forecast errors
- Weakening over land
- Track model spread
  - Forecast track errors are correlated to the spread of model guidance



## WIND SPEED PROBABILITIES How are they generated?

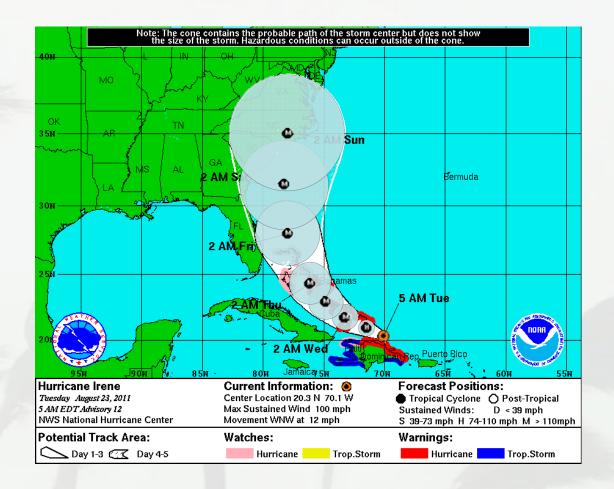


## WIND SPEED PROBABILITIES How are they generated?



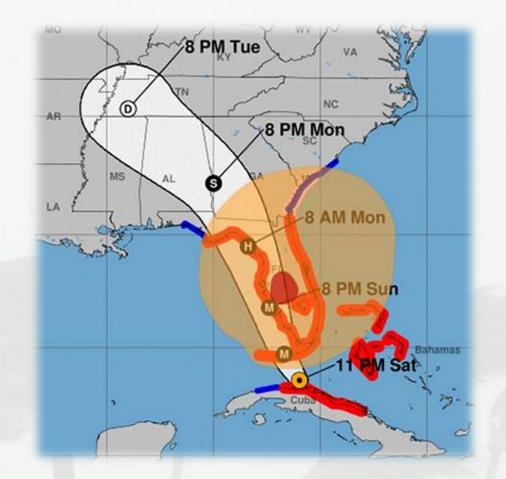
## **NHC FORECAST CONE** *The cure for the skinny black line?*

- Represents probable track of tropical cyclone center
- Formed by connecting circles centered on each forecast point
- The size of each circle is created using NHC track errors, so that the actual storm position will be within the circle 67% of the time.

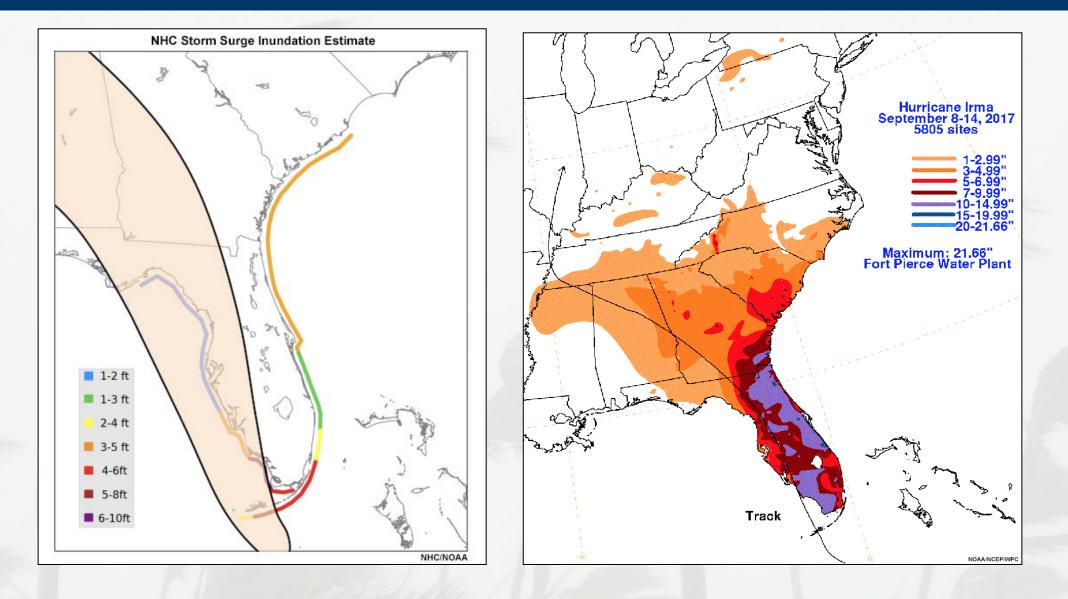


## **NHC FORECAST CONE** *No worries, not in the cone?*

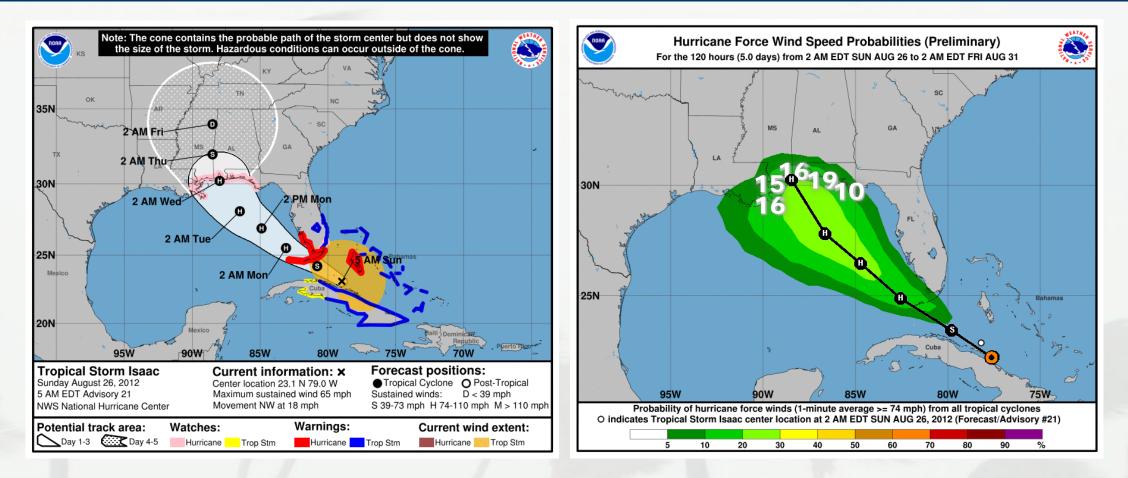
- The cone only displays information about track uncertainty
- It contains no information about specific impacts
- Tropical Cyclone impacts can occur well outside the area enclosed by the cone
  - TC center is expected to move outside the cone about 1/3 of the time



## **NHC FORECAST CONE** *No worries, not in the cone?*

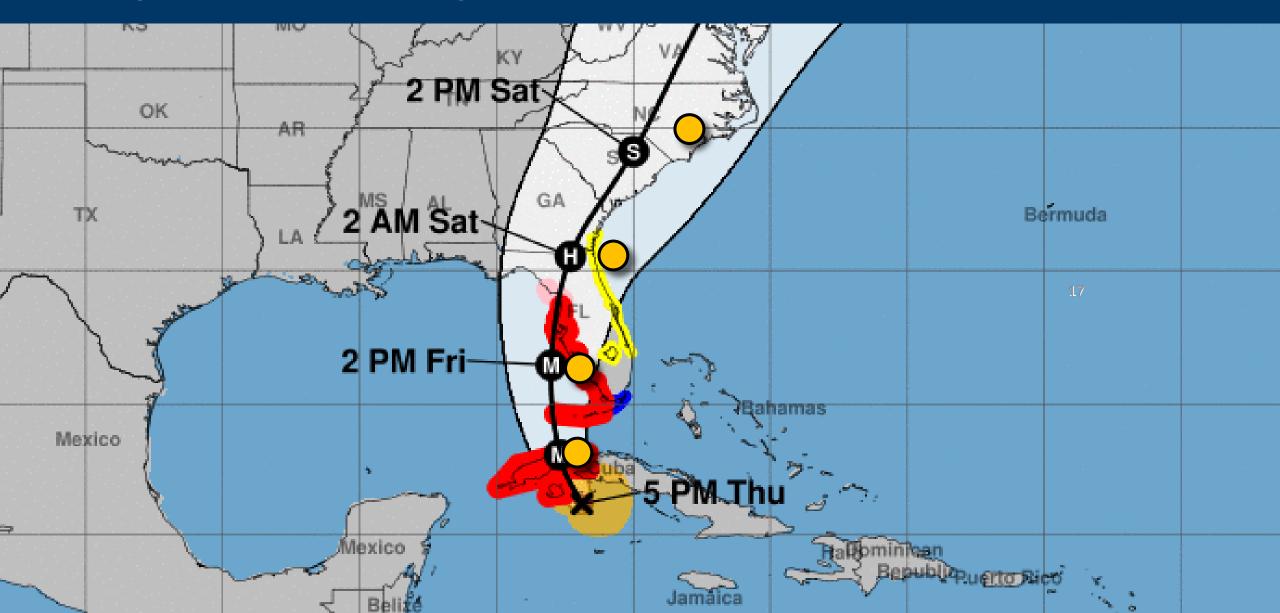


## **WIND SPEED PROBABILITIES** *Probabilities vs. The Cone?*

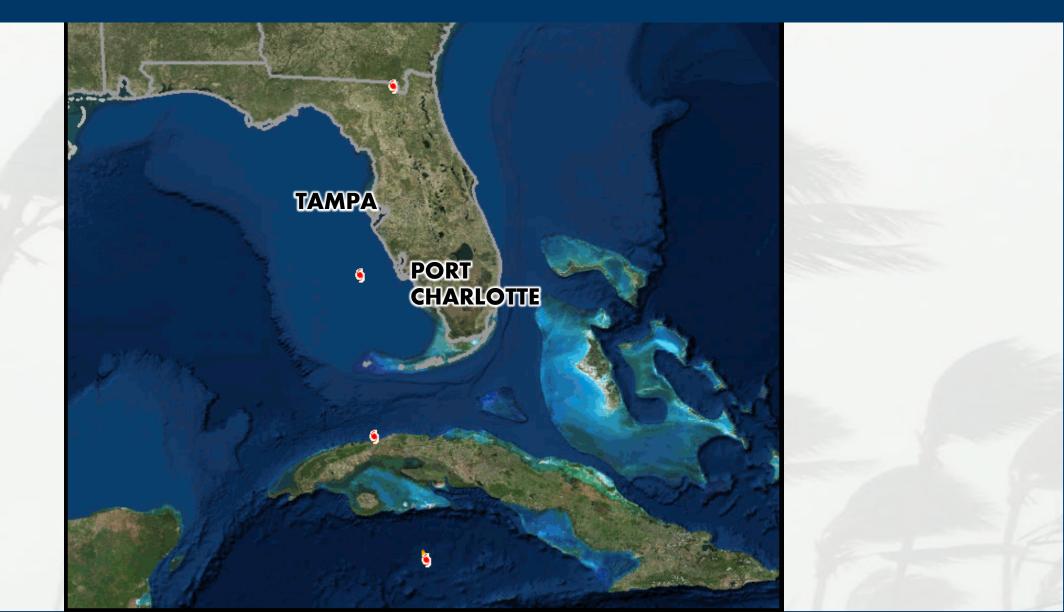


Tropical Storm Isaac Advisory 21 5:00 AM EDT 26 Aug 2012

### **HURRICANE CHARLEY** Don't focus on the skinny black line.



## **HURRICANE CHARLEY** *Would alternate scenarios help?*



## HURRICANE CHARLEY Would alternate scenarios help?



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#### **Cumulative Probabilities**

• Total chance through the time period

## **WIND SPEED PROBABILITIES** 5-Day Cumulative Graphic

	DNAL			ENTER	R		8
TIME	FROM 06Z MOI	FROM 182 MON	FROM 06Z TUE	FROM 18Z TUE	FROM 06Z WED	FROM 06Z THU	FROM 06Z FRI
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#### **Location-Specific Probabilities**

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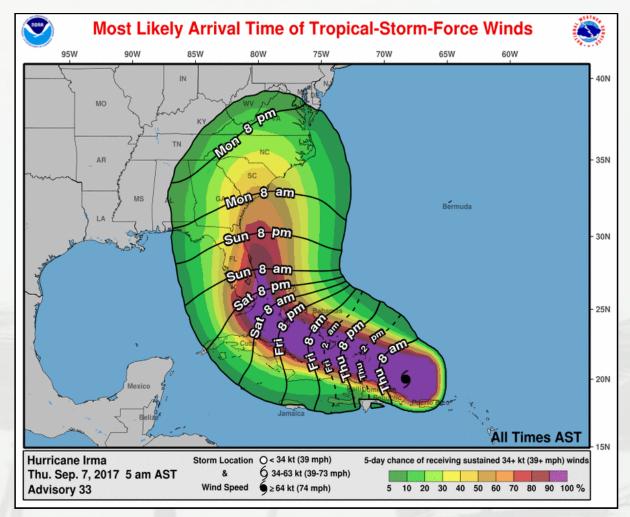
• Tropical-Storm-Force

•58 mph

• Hurricane-Force

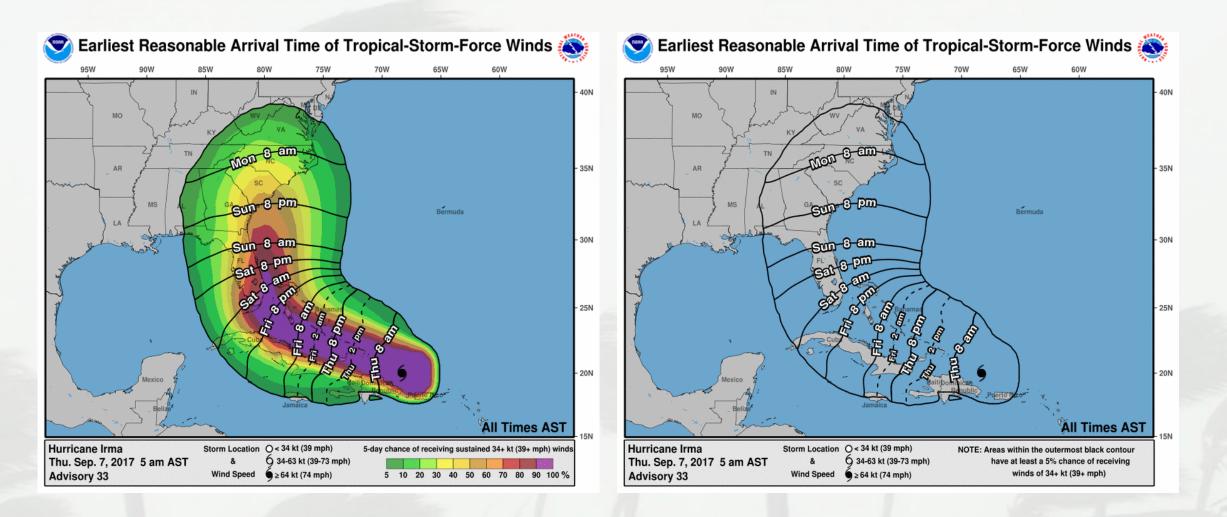
## **TIME OF ARRIVAL OF TS-FORCE WINDS** Information on Arrival of Wind Hazzard

- Separate graphics provide most likely and earliest reasonable arrival times of TSforce winds
- Accounts for typical track, intensity, and size uncertainty
- Provides time when preparations should be complete
- Earliest Reasonable best for users with low tolerance for risk



Earliest Reasonable Time of Arrival

## **TIME OF ARRIVAL OF TS-FORCE WINDS** *Versions of the graphics with and without the location specific wind speed probabilities*



## WIND TIMING UNCERTAINTY Importance and Causes

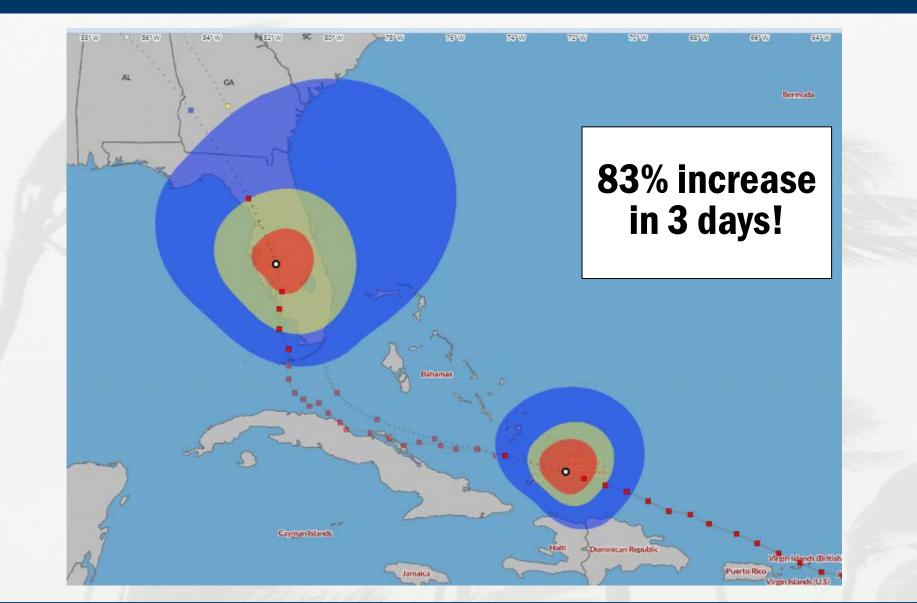
## WIND TIMING

**Critical for preparedness and evacuation decision making** 

- Major sources of uncertainty in wind timing:
  - Track Forward speed, direction of motion, and location of center relative to given location
  - Storm Size How far will TS winds extend from the center? Difficult to forecast and highly variable
- Time of Arrival graphics designed to account for uncertainty in arrival of TS-force winds and provide timing information



## WIND TIMING UNCERTAINTY Importance and Causes



## WIND TIMING UNCERTAINTY Current product limitations

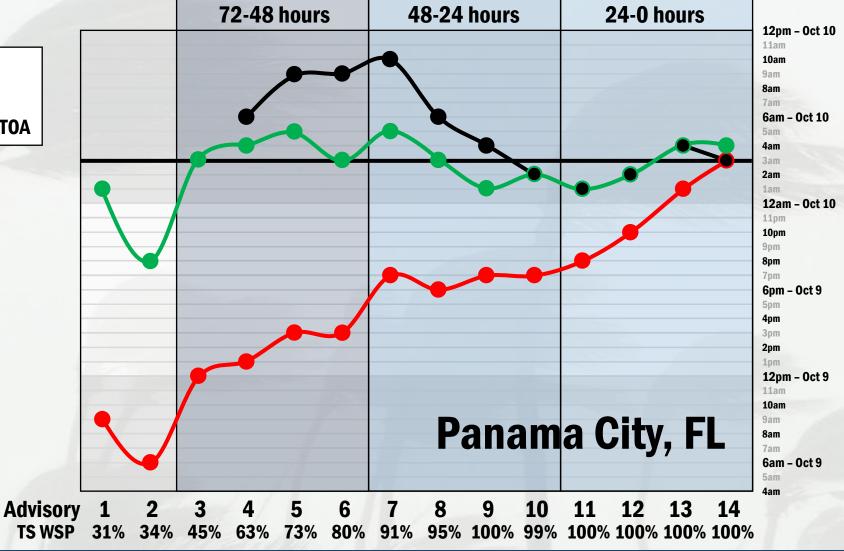
## TIME OF ARRIVAL

**Current Time of Arrival (TOA) products have some limitations:** 

- Storms that stall or move very slowly (<5 mph)</li>
  - TOA products can show much earlier onset times than what is conveyed in the official forecast (e.g., Dorian)
- Storms with much larger/smaller than typical wind fields
  - TOA products will not handle the timing of these storms well, especially beyond the first 24-36 hours.

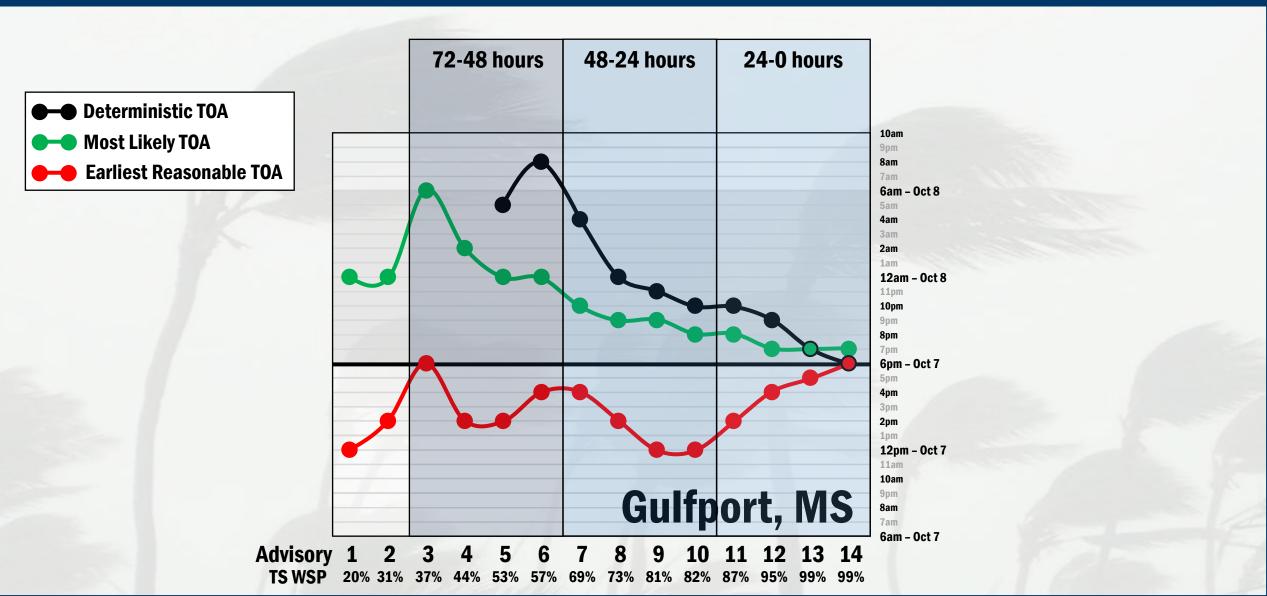
## TIME OF ARRIVAL OF TS WINDS Hurricane Michael (2018)

Deterministic TOA
Most Likely TOA
Earliest Reasonable TOA



## **TIME OF ARRIVAL OF TS WINDS** *Hurricane Nate (2017)*





## WIND SPEED PROBABILITIES Summary



## **SUMMARY**

NHC's forecasts are improving but errors remain

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- Error cone is not the cure for the skinny black line

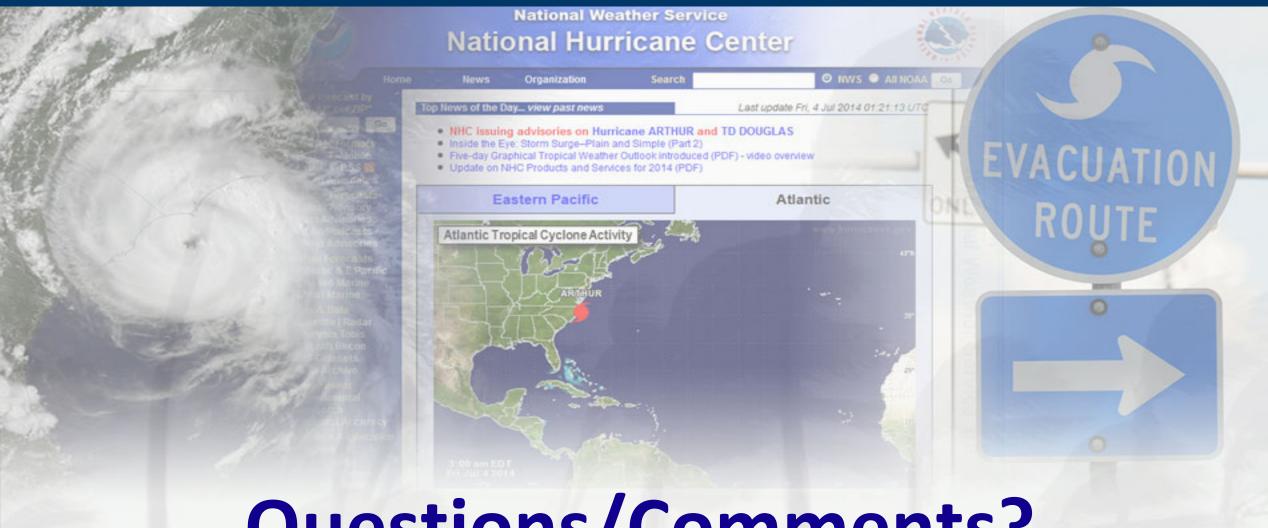
## Wind speed probabilities

- Likelihood of tropical storm and hurricane winds
- Onset timing of wind hazards
- Incorporates track, intensity and size uncertainty
  - Includes weakening due to land
  - Provides an assessment of wind timing and threat that accounts for NHC forecast errors

Bermuda

## **HURRICANE READINESS** *A Short Course*





# **Questions/Comments?**