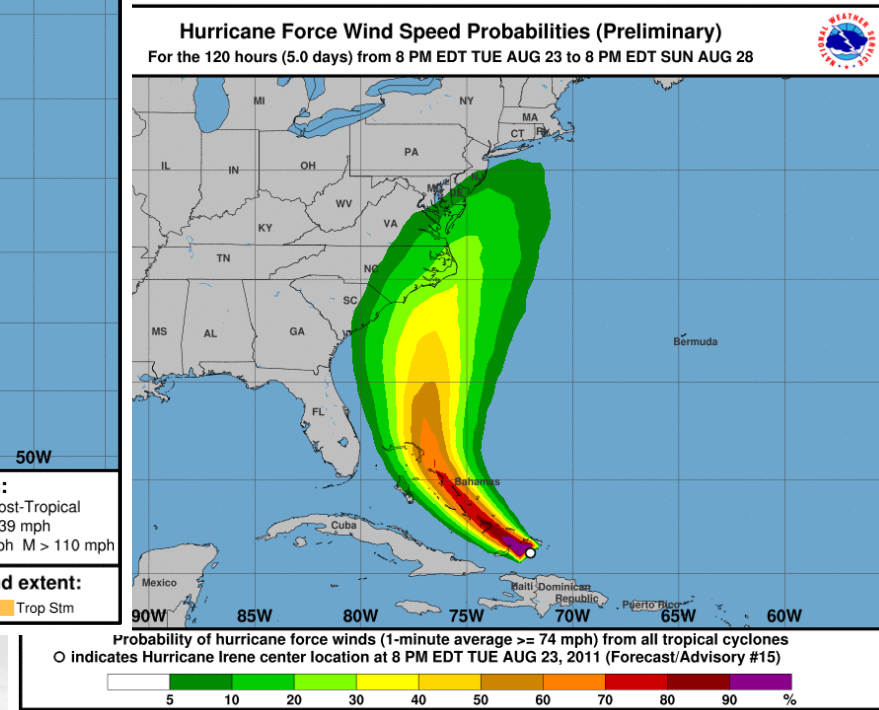
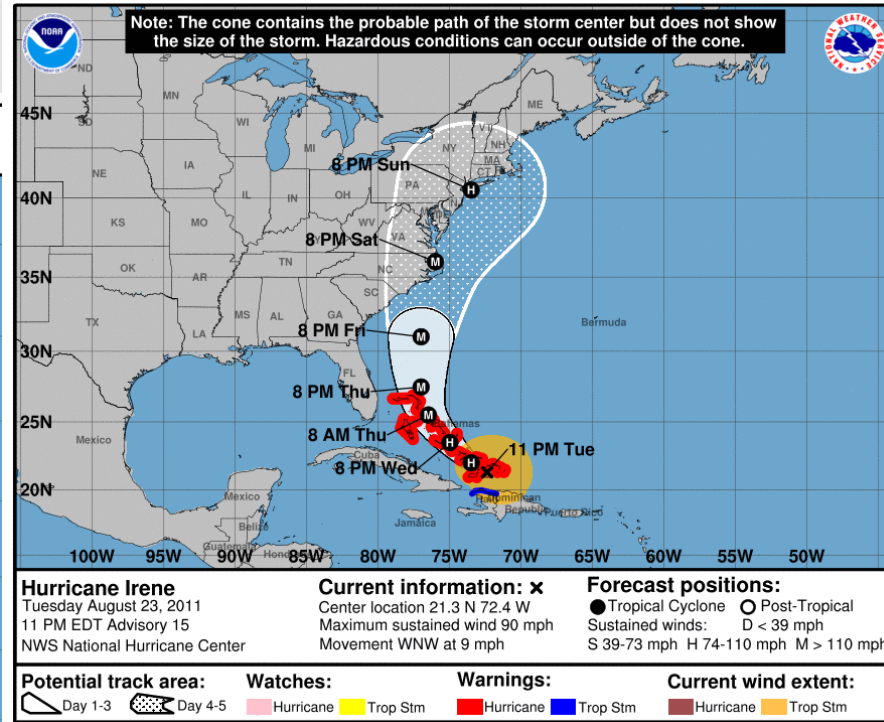
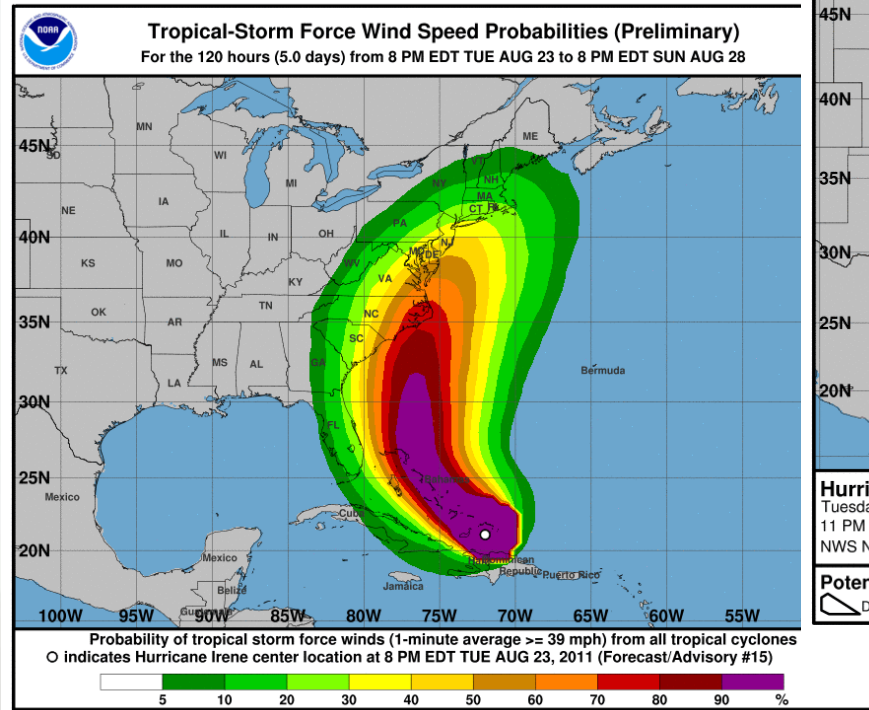


# Wind Speed Probabilities



**Daniel Brown**  
National Hurricane Center  
2021 WMO Course  
29 April 2021

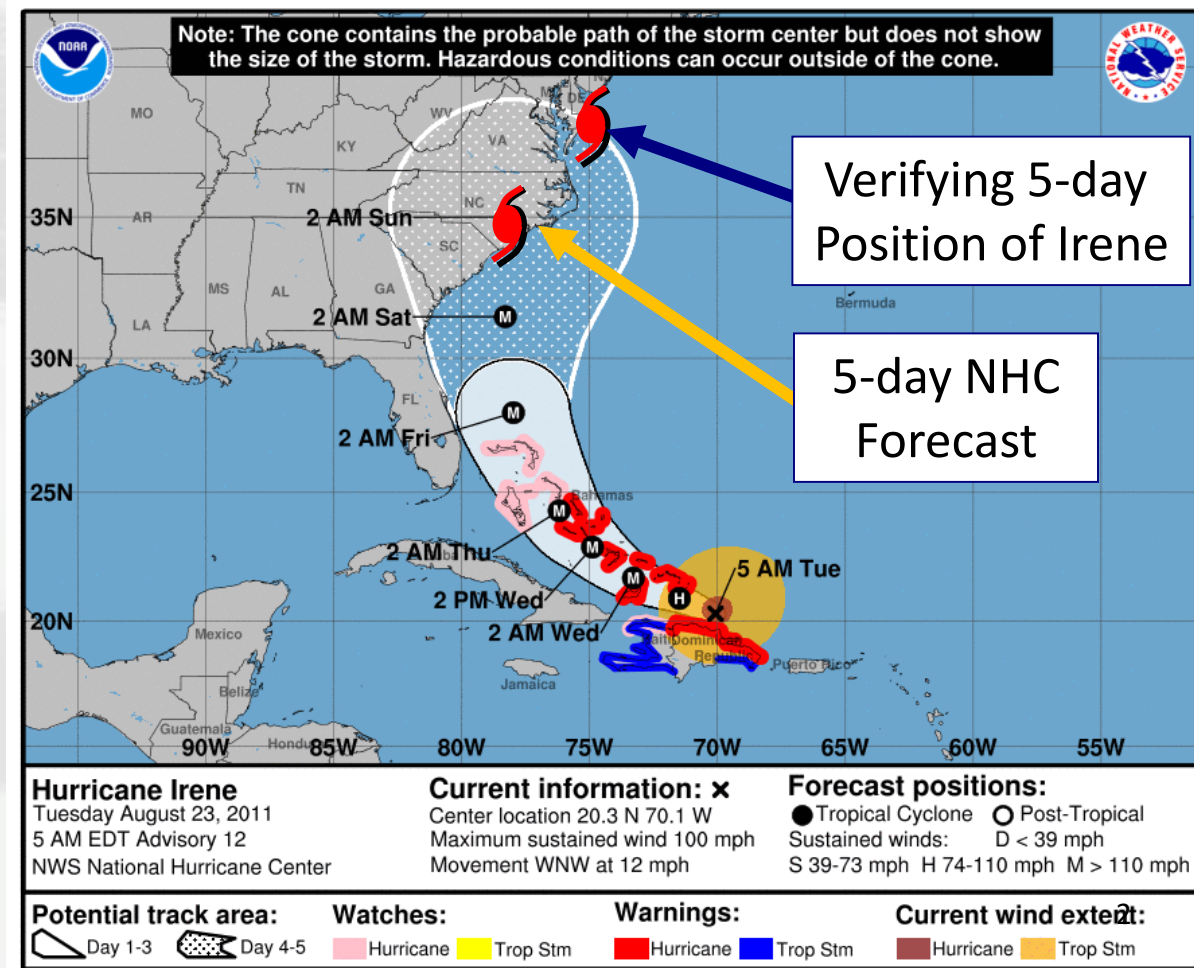
# Wind Speed Probabilities

## *A Tool to Deal with Uncertainty*

Hurricane Irene  
Advisory Number 12

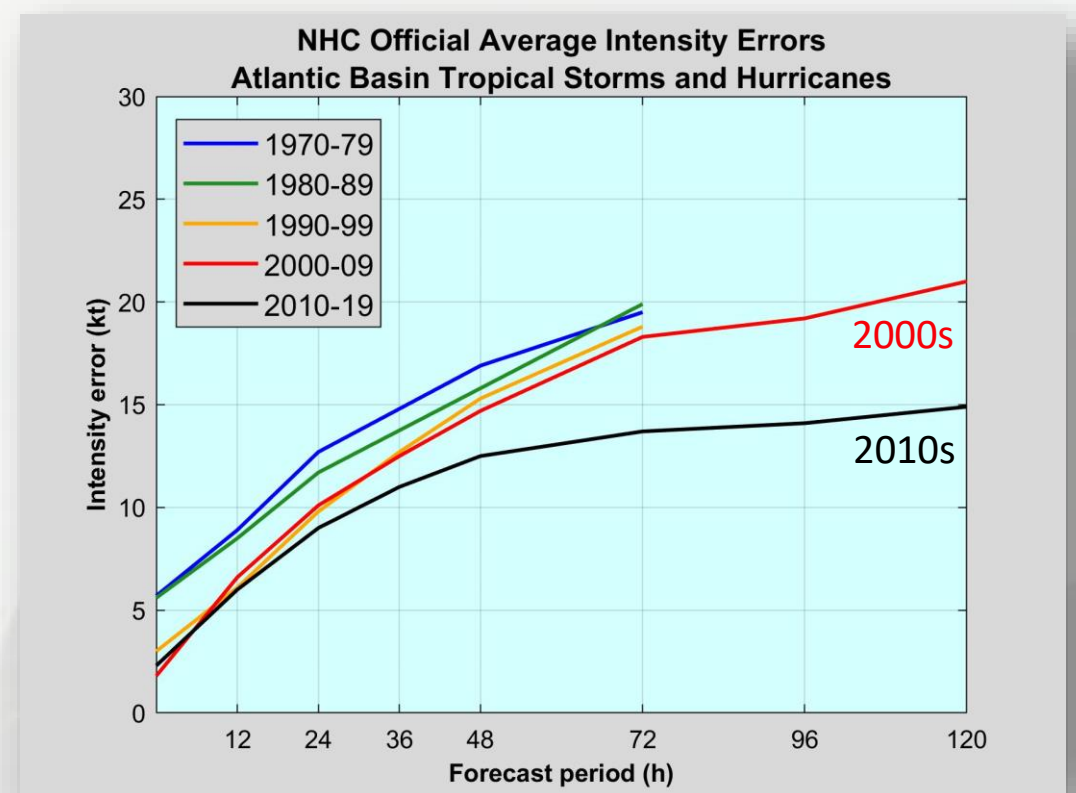
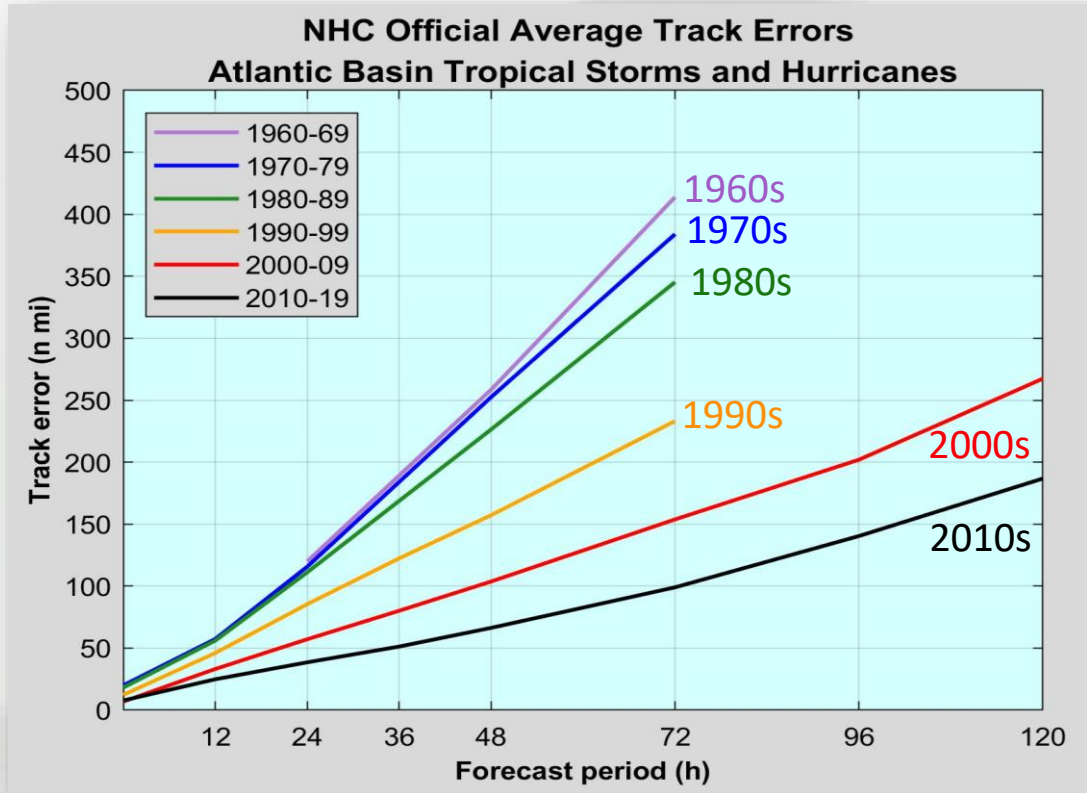
Issued 5:00 AM EDT  
23 August 2011

5-day position error  
about 270 miles



# FORECAST TRACK ERRORS

*Improving, but not perfect.*



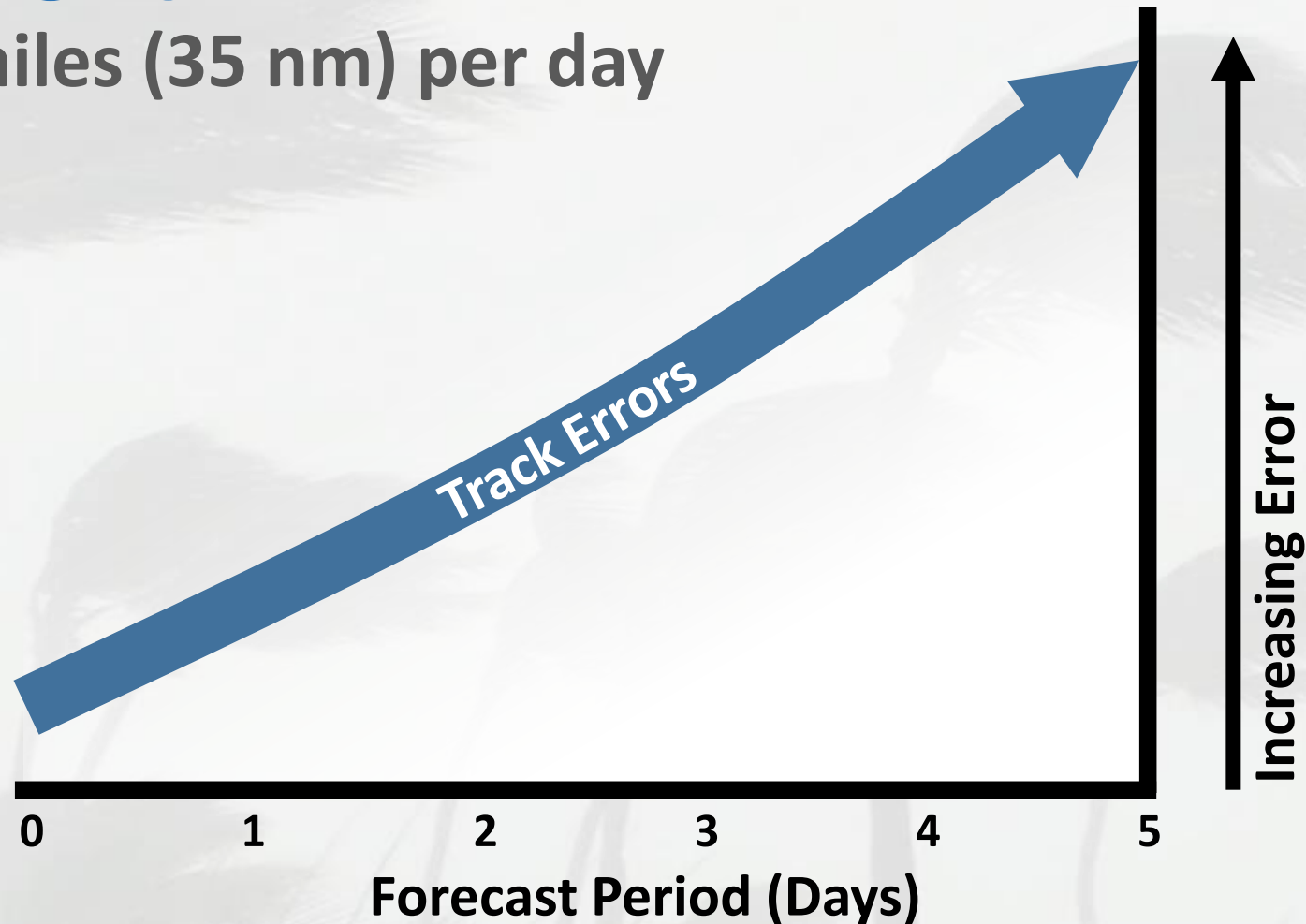
Significant reduction in track forecast errors and a more recent improvement in intensity forecasts.

# FORECAST TRACK ERRORS

*NHC 5-year Averages*

## TRACK ERRORS

Increase 40 miles (35 nm) per day

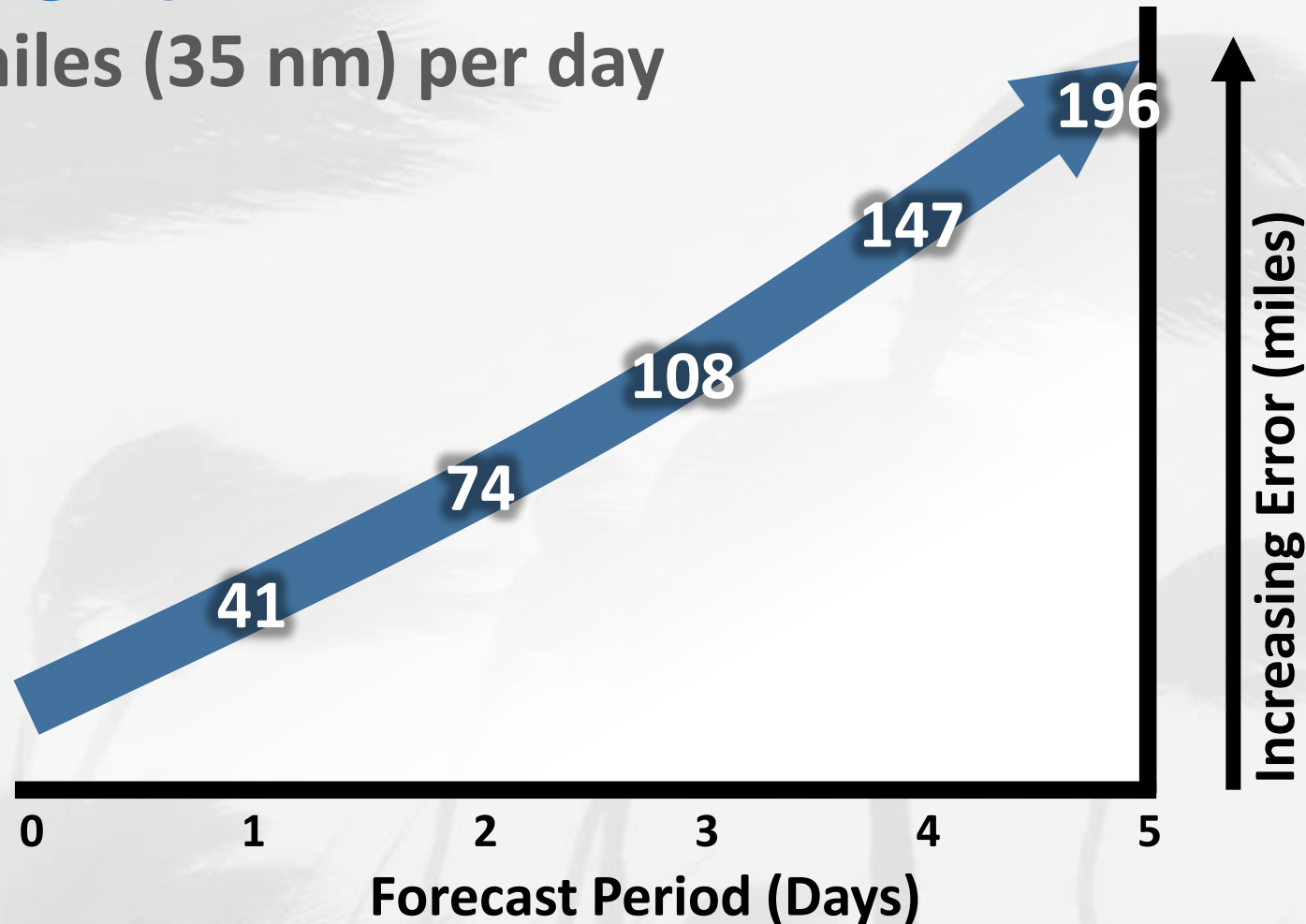


# FORECAST TRACK ERRORS

*NHC 5-year Averages*

## TRACK ERRORS

Increase 40 miles (35 nm) per day



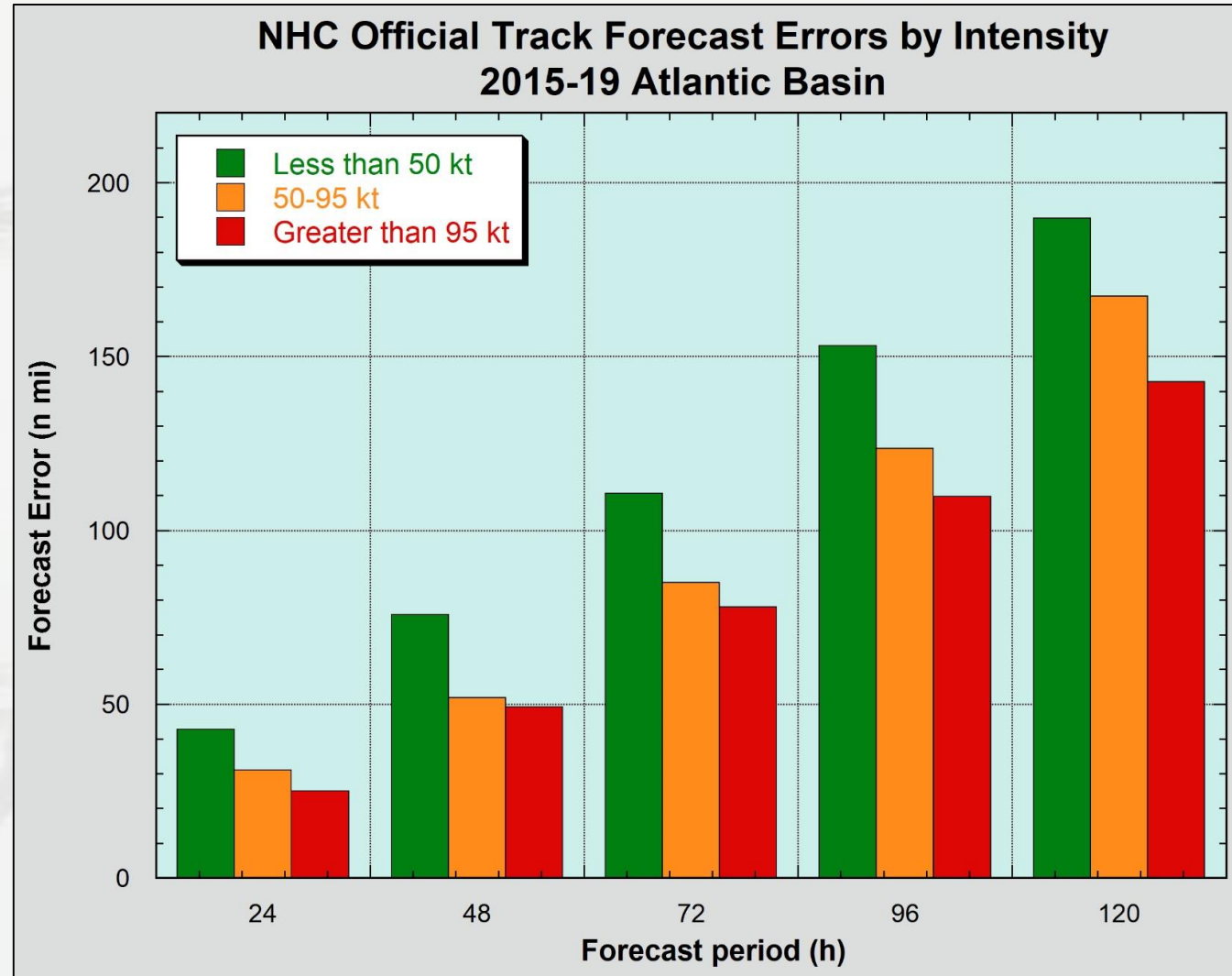


# FORECAST TRACK ERRORS

## *Based on Initial Intensity*

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

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

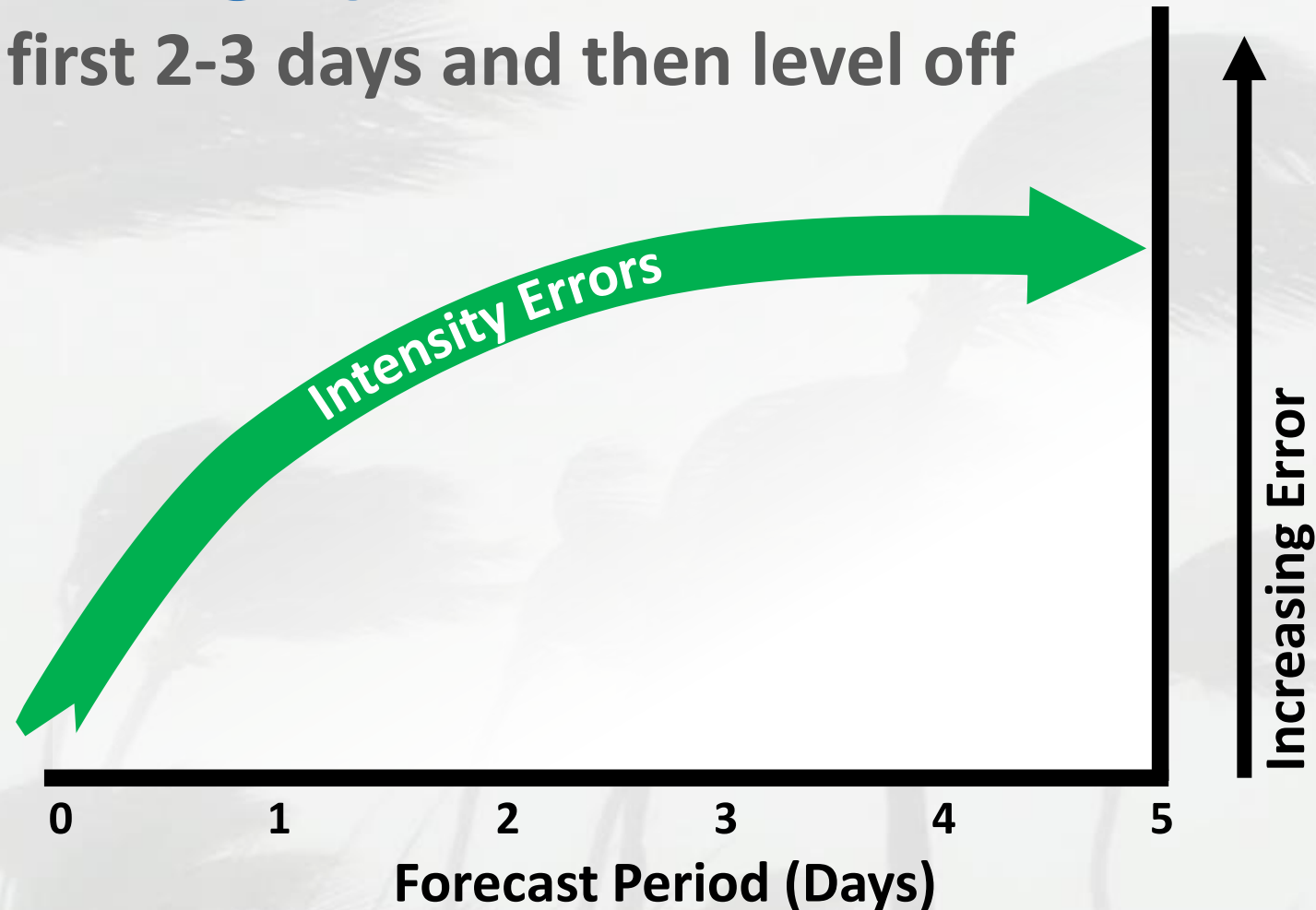


# FORECAST INTENSITY ERRORS

## *NHC 5-year Averages*

### INTENSITY ERRORS

Increase the first 2-3 days and then level off

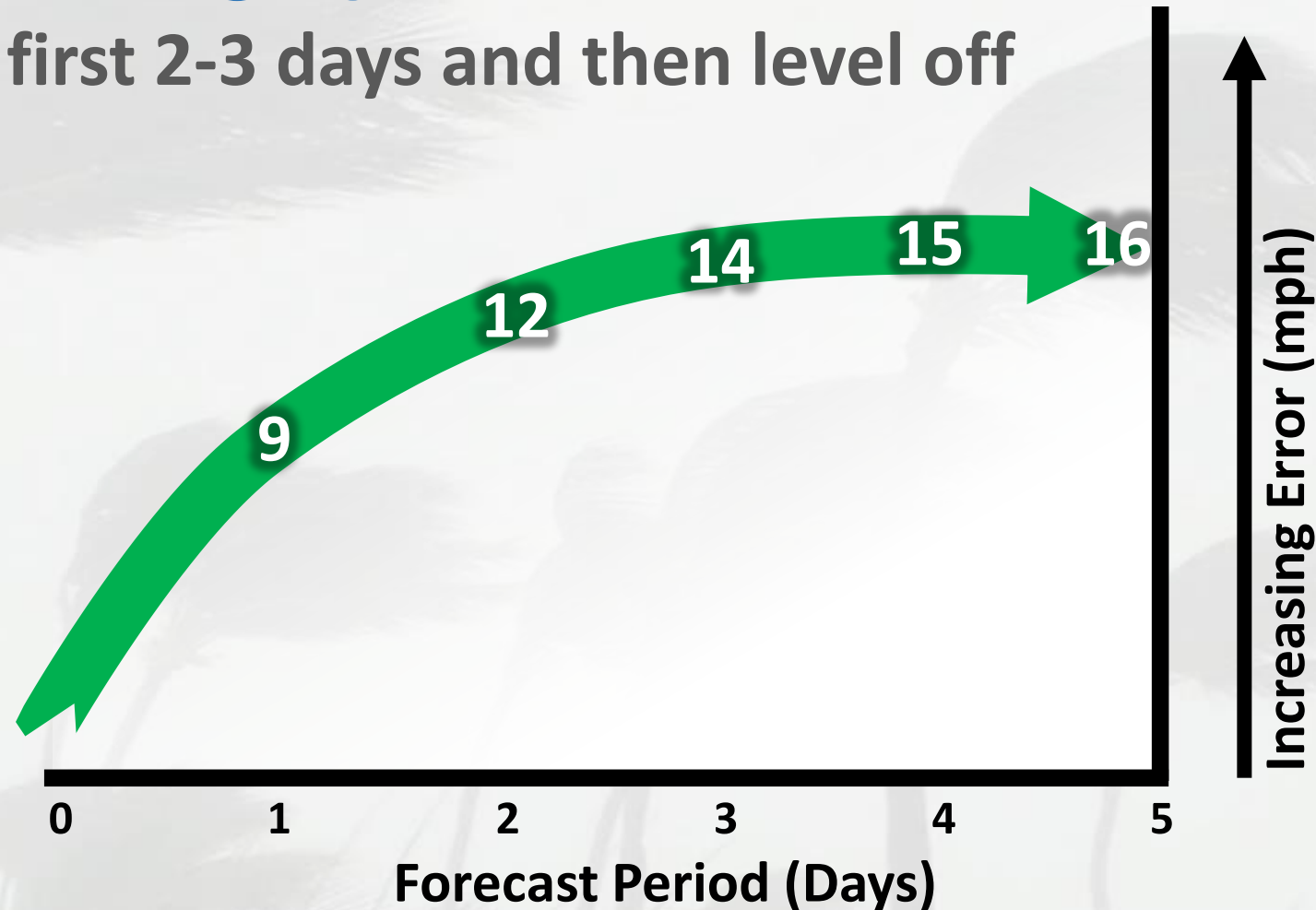


# FORECAST INTENSITY ERRORS

*NHC 5-year Averages*

## INTENSITY ERRORS

Increase the first 2-3 days and then level off



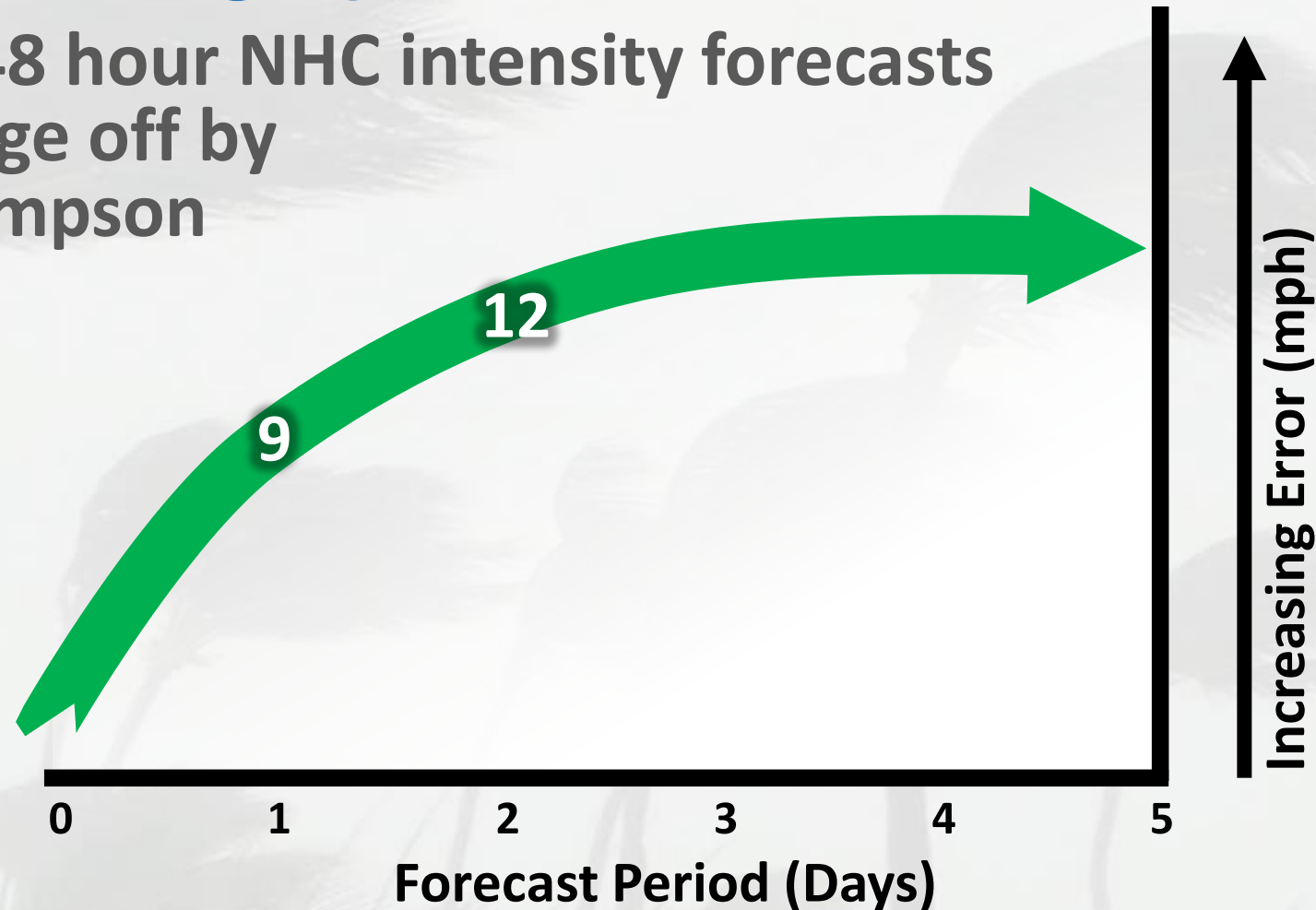


# FORECAST INTENSITY ERRORS

## *NHC 5-year Averages*

### INTENSITY ERRORS

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



# FORECAST INTENSITY ERRORS

## *Rapid Strengthening*

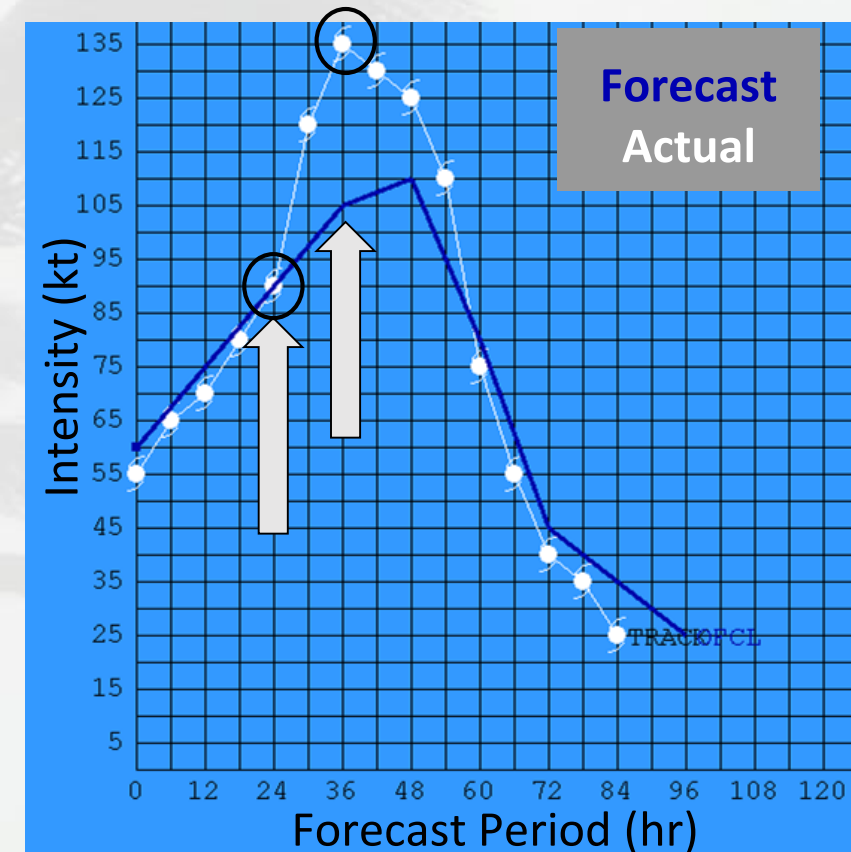
### RAPID INTENSIFICATION

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.

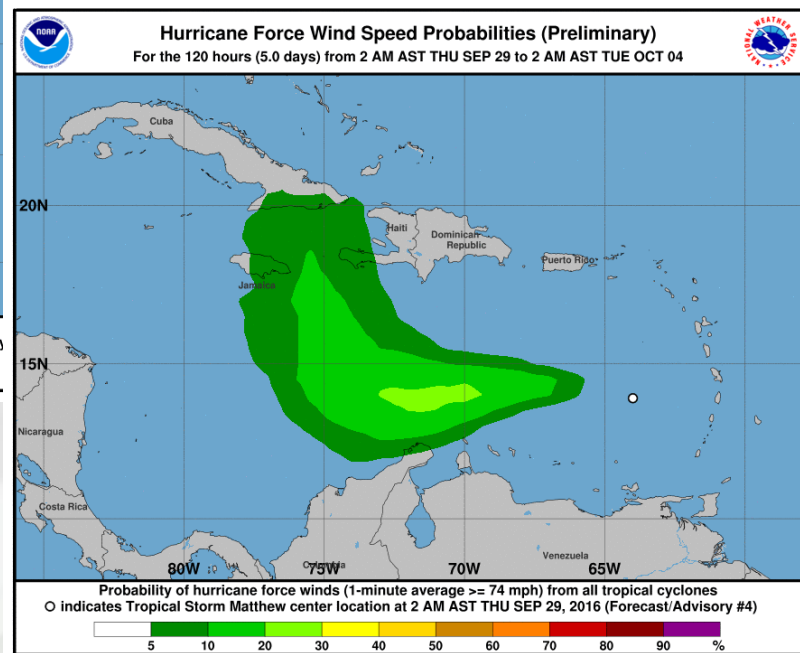
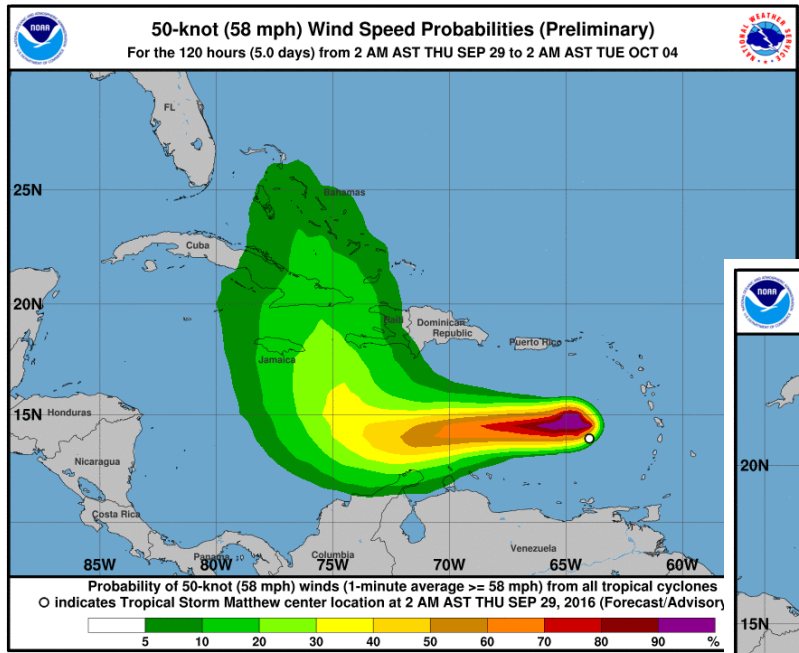
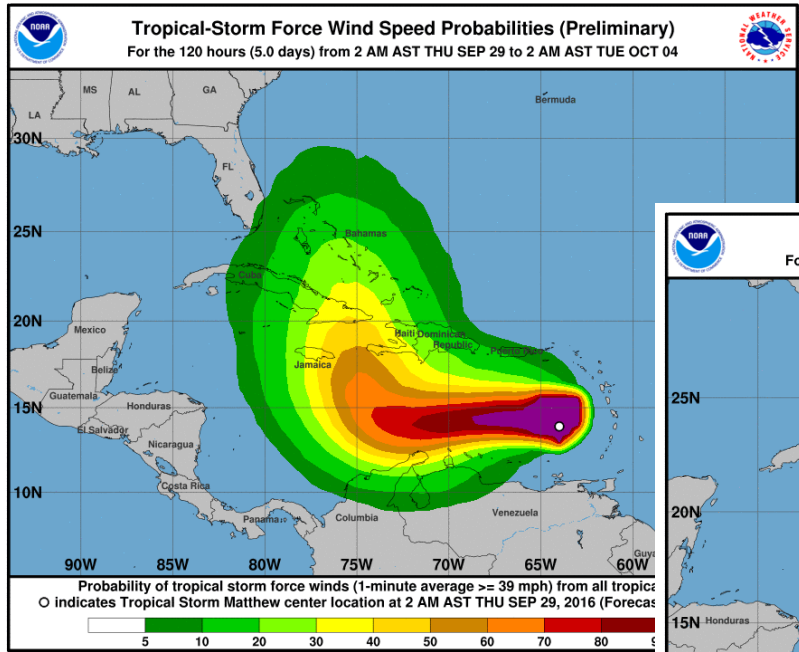
#### Example: Iota Advisory 7 (2020)

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



# Wind Speed Probabilities

*How Likely. Arrival Times. Inland Threat*



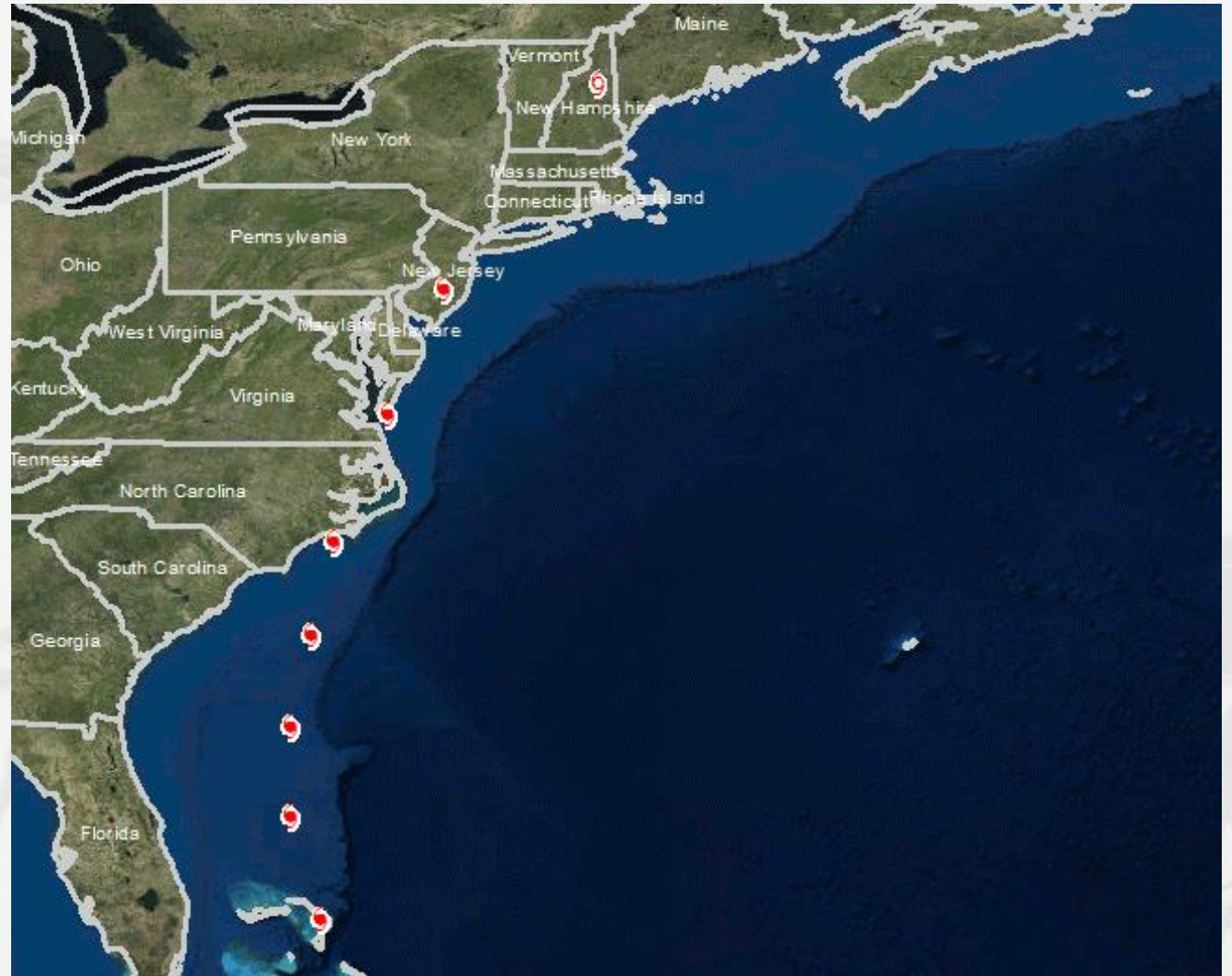
Graphics depicts location-specific cumulative probabilities of tropical-storm-force, 50-kt, and hurricane-force winds.

# WIND SPEED PROBABILITIES

*How are they generated?*

## MORE SCENARIOS

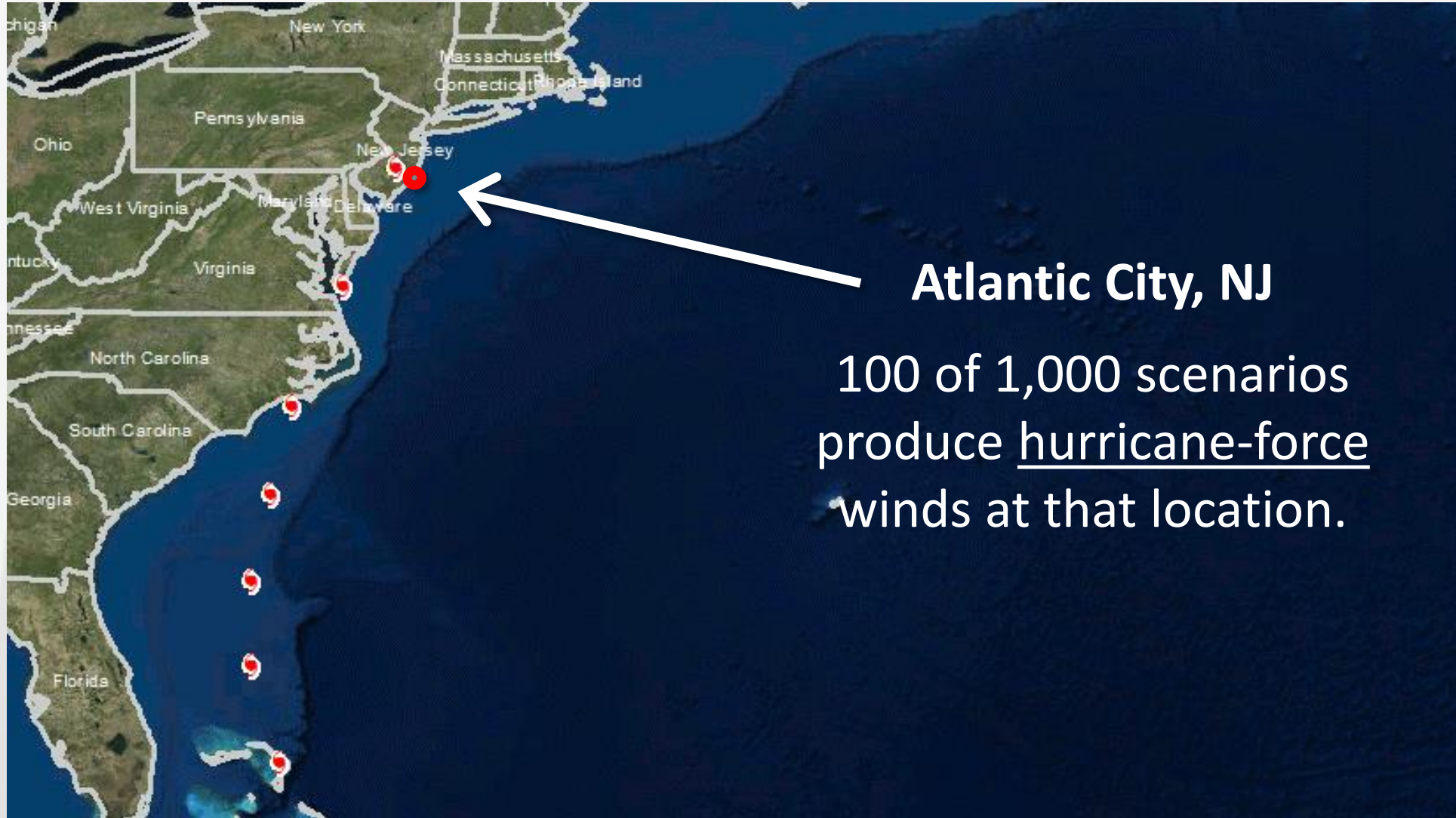
- **1,000 realistic alternative scenarios are generated**
  - Official NHC forecast
  - Historical track and intensity forecast errors
- **Weakening over land**
- **Track model spread**
  - Forecast track errors are correlated to the spread of model guidance





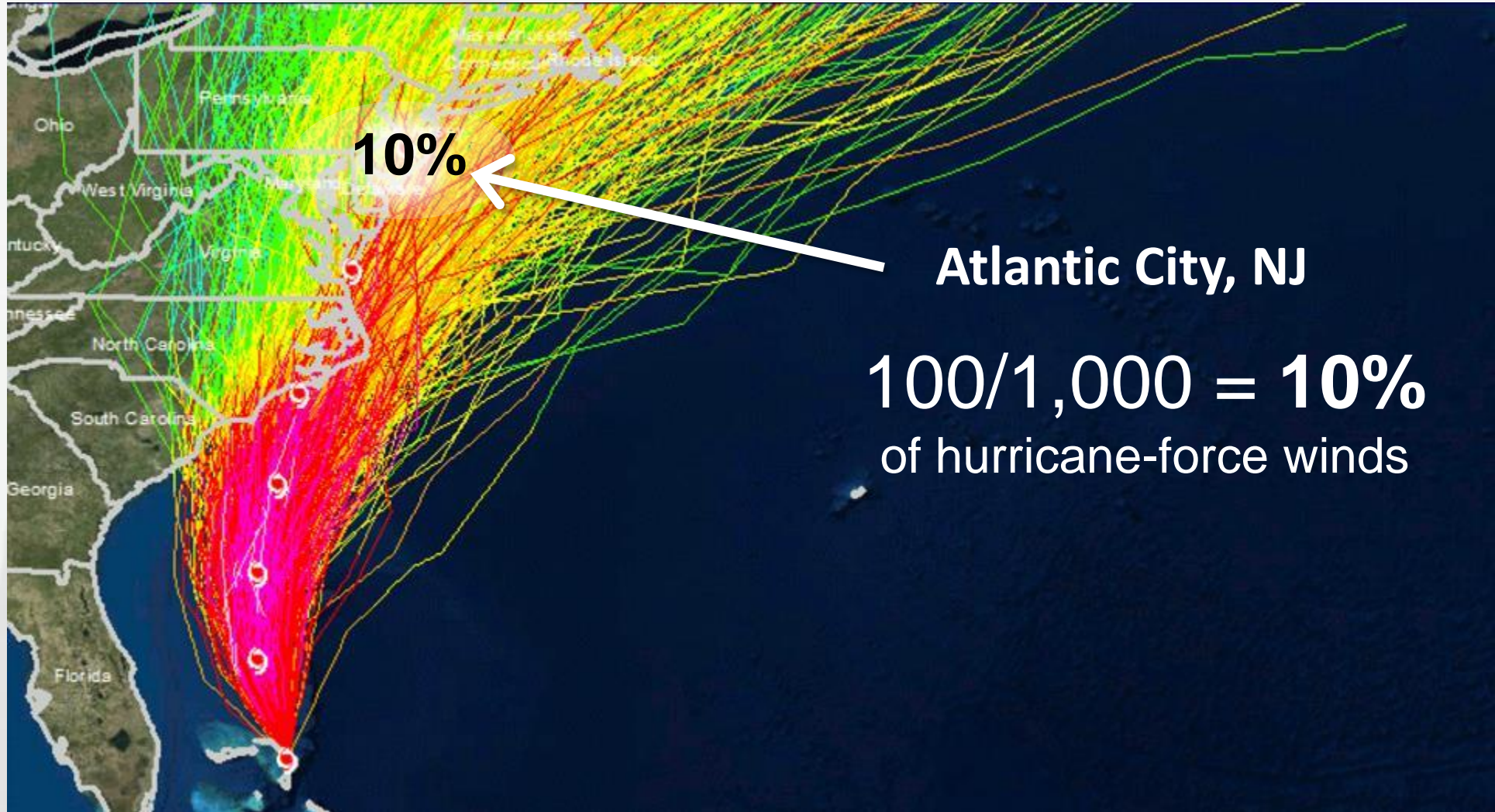
# WIND SPEED PROBABILITIES

*How are they generated?*



# WIND SPEED PROBABILITIES

*How are they generated?*

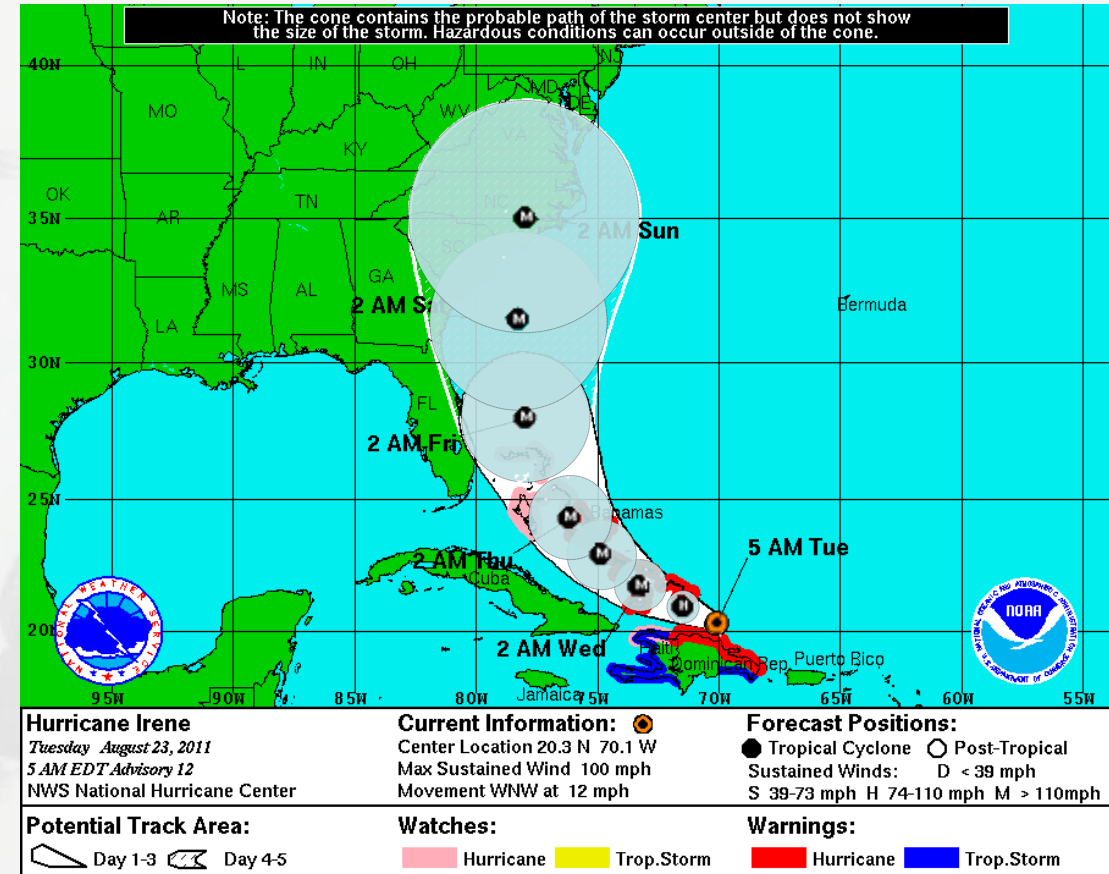




# NHC FORECAST CONE

## *The cure for the skinny black line?*

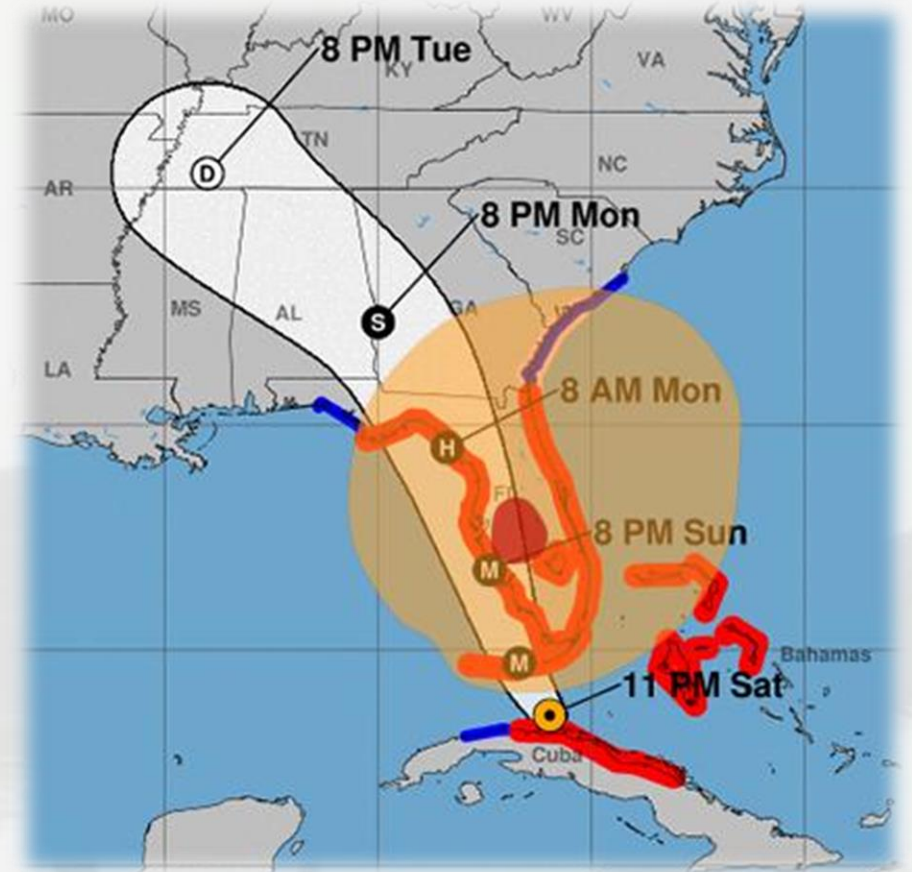
- Represents probable track of tropical cyclone center
- Formed by connecting circles centered on each forecast point
- The size of each circle is created using NHC track errors, so that the actual storm position will be within the circle 67% of the time.



# NHC FORECAST CONE

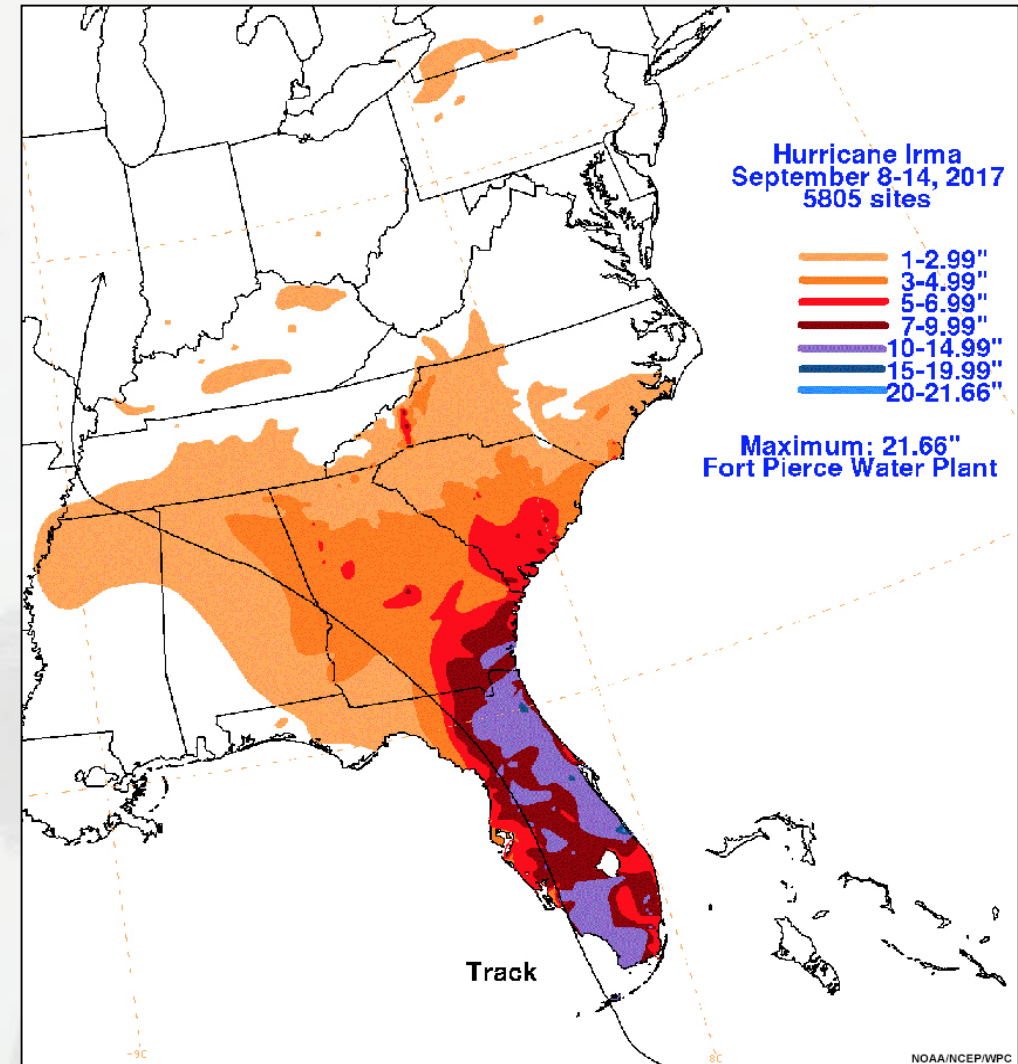
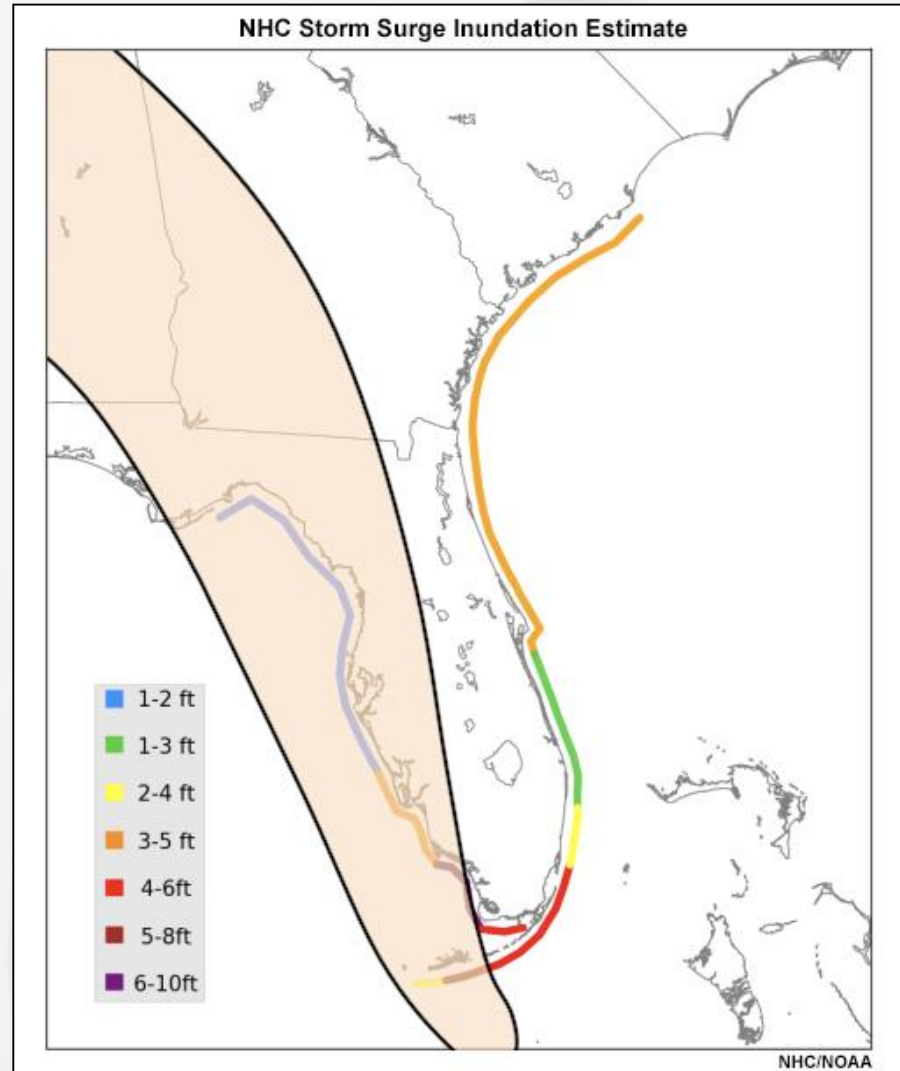
*No worries, not in the cone?*

- 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



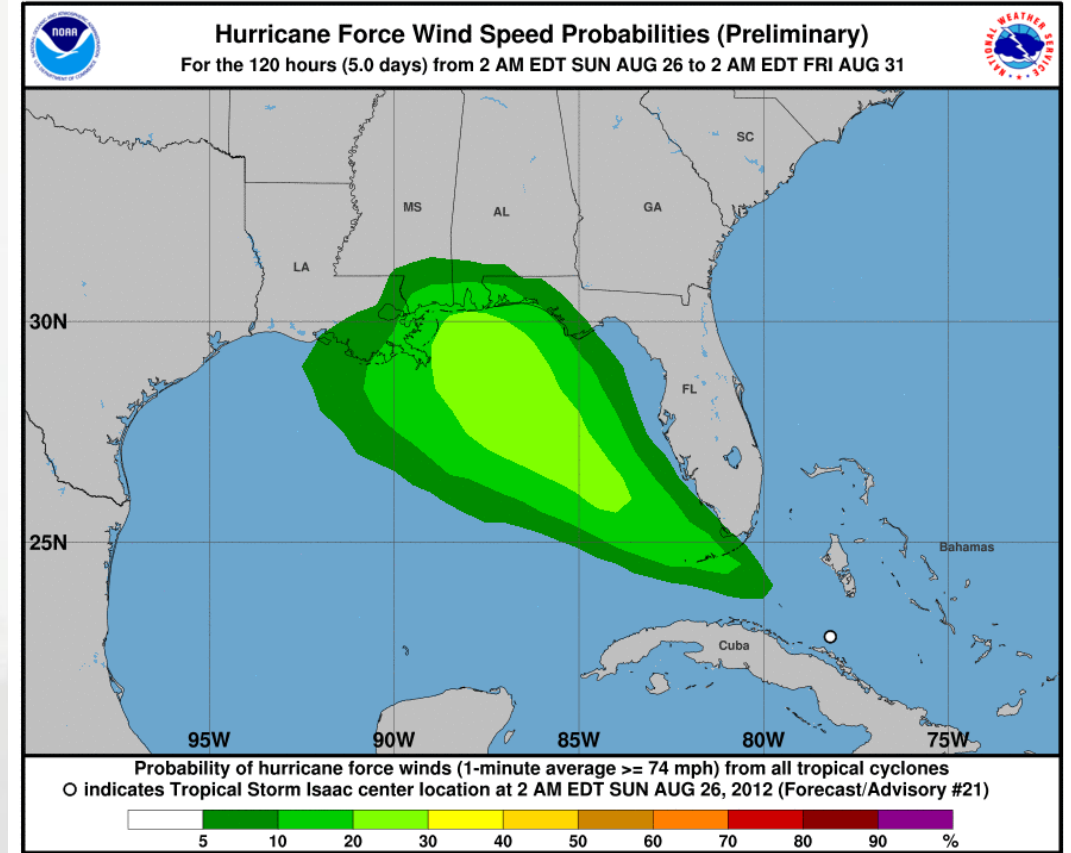
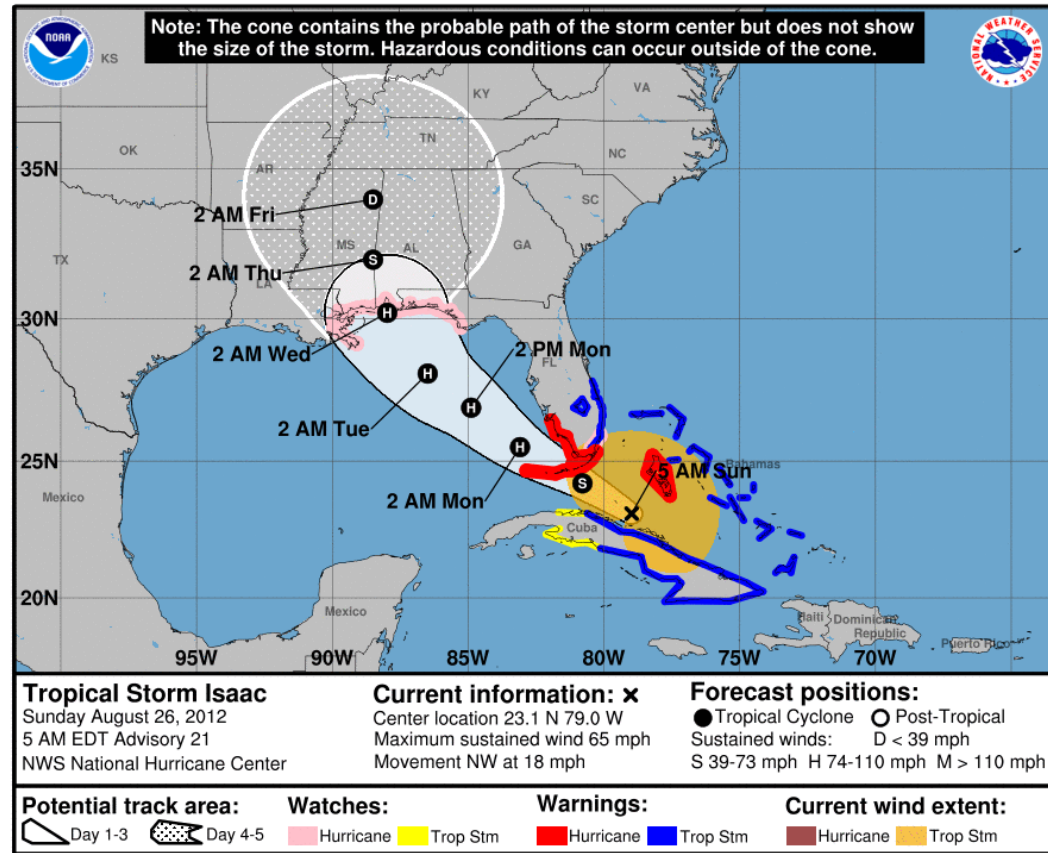
# NHC FORECAST CONE

*No worries, not in the cone?*



# WIND SPEED PROBABILITIES

## *Probabilities vs. The Cone?*



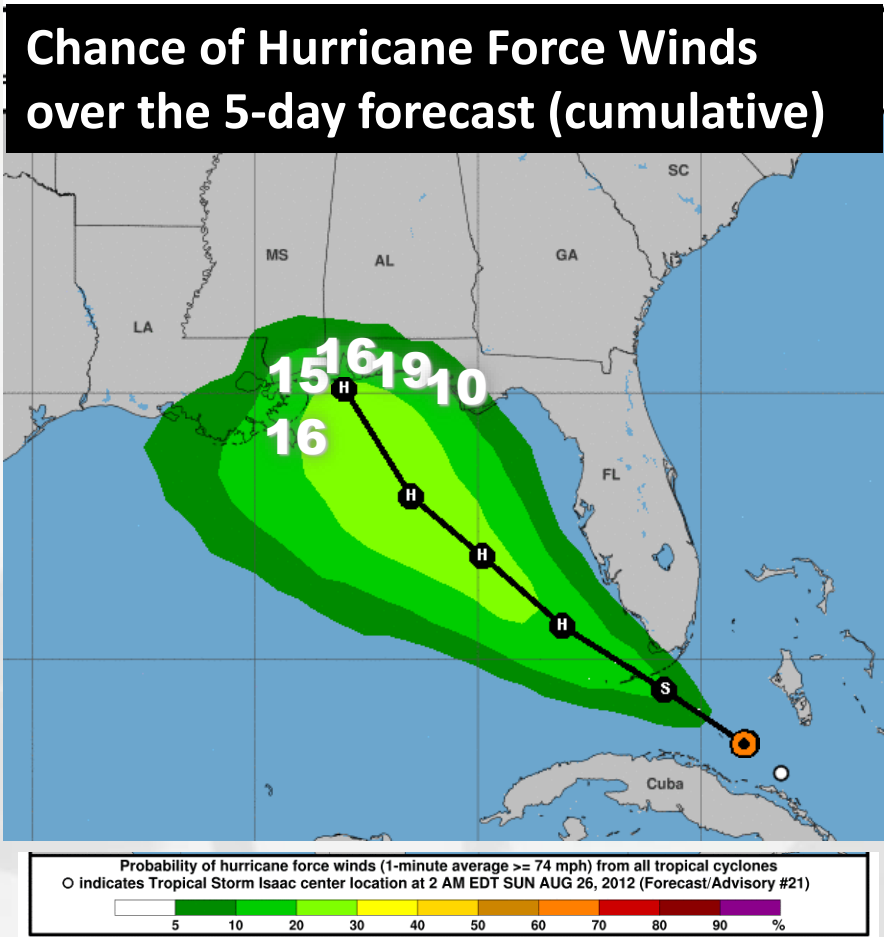
Tropical Storm Isaac Advisory 21  
5:00 AM EDT 26 Aug 2012



# WIND SPEED PROBABILITIES

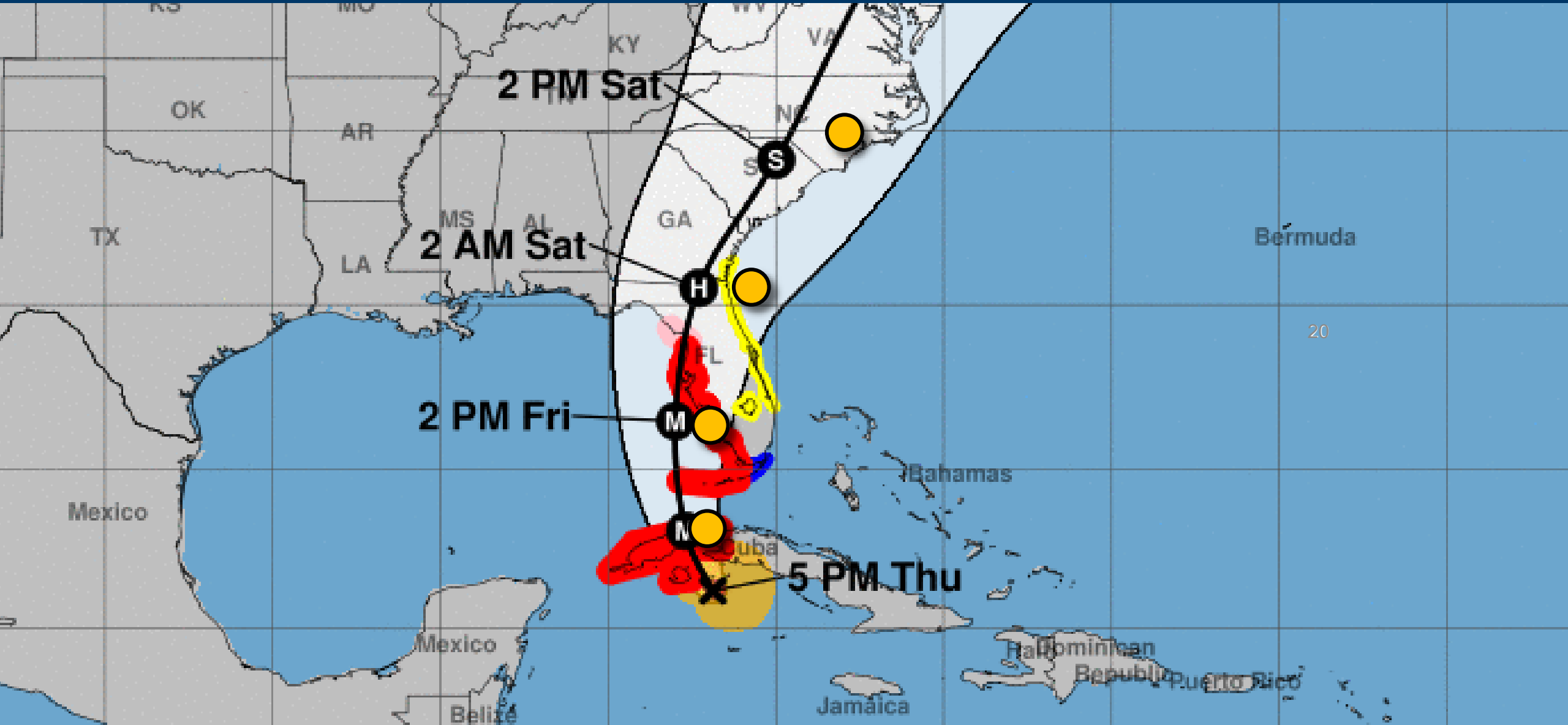
## Tropical Storm Isaac (2012)

TROPICAL STORM ISAAC WIND SPEED PROBABILITIES NUMBER 21									
NWS NATIONAL HURRICANE CENTER MIAMI FL AL092012									
0900 UTC SUN AUG 26 2012									
- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -									
TIME PERIODS	FROM 06Z SUN TO 18Z SUN	FROM 18Z SUN TO 06Z MON	FROM 06Z MON TO 18Z MON	FROM 18Z MON TO 06Z TUE	FROM 06Z TUE TO 06Z WED	FROM 06Z WED TO 06Z THU	FROM 06Z THU TO 06Z FRI		
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)		
LOCATION	KT								
PANAMA CITY FL 34	X	2 ( 2)	22 (24)	30 (54)	16 (70)	3 (73)	X (73)		
PANAMA CITY FL 50	X	X ( X)	1 ( 1)	10 (11)	13 (24)	2 (26)	1 (27)		
PANAMA CITY FL 64	X	X ( X)	X ( X)	2 ( 2)	6 ( 8)	1 ( 9)	1 (10)		
PENSACOLA FL 34	X	X ( X)	10 (10)	32 (42)	30 (72)	6 (78)	2 (80)		
PENSACOLA FL 50	X	X ( X)	X ( X)	6 ( 6)	27 (33)	5 (38)	2 (40)		
PENSACOLA FL 64	X	X ( X)	X ( X)	2 ( 2)	13 (15)	3 (18)	1 (19)		
MOBILE AL 34	X	X ( X)	5 ( 5)	24 (29)	36 (65)	8 (73)	2 (75)		
MOBILE AL 50	X	X ( X)	X ( X)	3 ( 3)	23 (26)	8 (34)	2 (36)		
MOBILE AL 64	X	X ( X)	X ( X)	1 ( 1)	10 (11)	4 (15)	1 (16)		
GULFPORT MS 34	X	X ( X)	3 ( 3)	22 (25)	35 (60)	9 (69)	3 (72)		
GULFPORT MS 50	X	X ( X)	X ( X)	3 ( 3)	21 (24)	8 (32)	2 (34)		
GULFPORT MS 64	X	X ( X)	X ( X)	X ( X)	9 ( 9)	5 (14)	1 (15)		
BURAS LA 34	X	X ( X)	4 ( 4)	22 (26)	30 (56)	8 (64)	2 (66)		
BURAS LA 50	X	X ( X)	X ( X)	3 ( 3)	21 (24)	6 (30)	3 (33)		
BURAS LA 64	X	X ( X)	X ( X)	X ( X)	11 (11)	4 (15)	1 (16)		



# HURRICANE CHARLEY

*Don't focus on the skinny black line.*





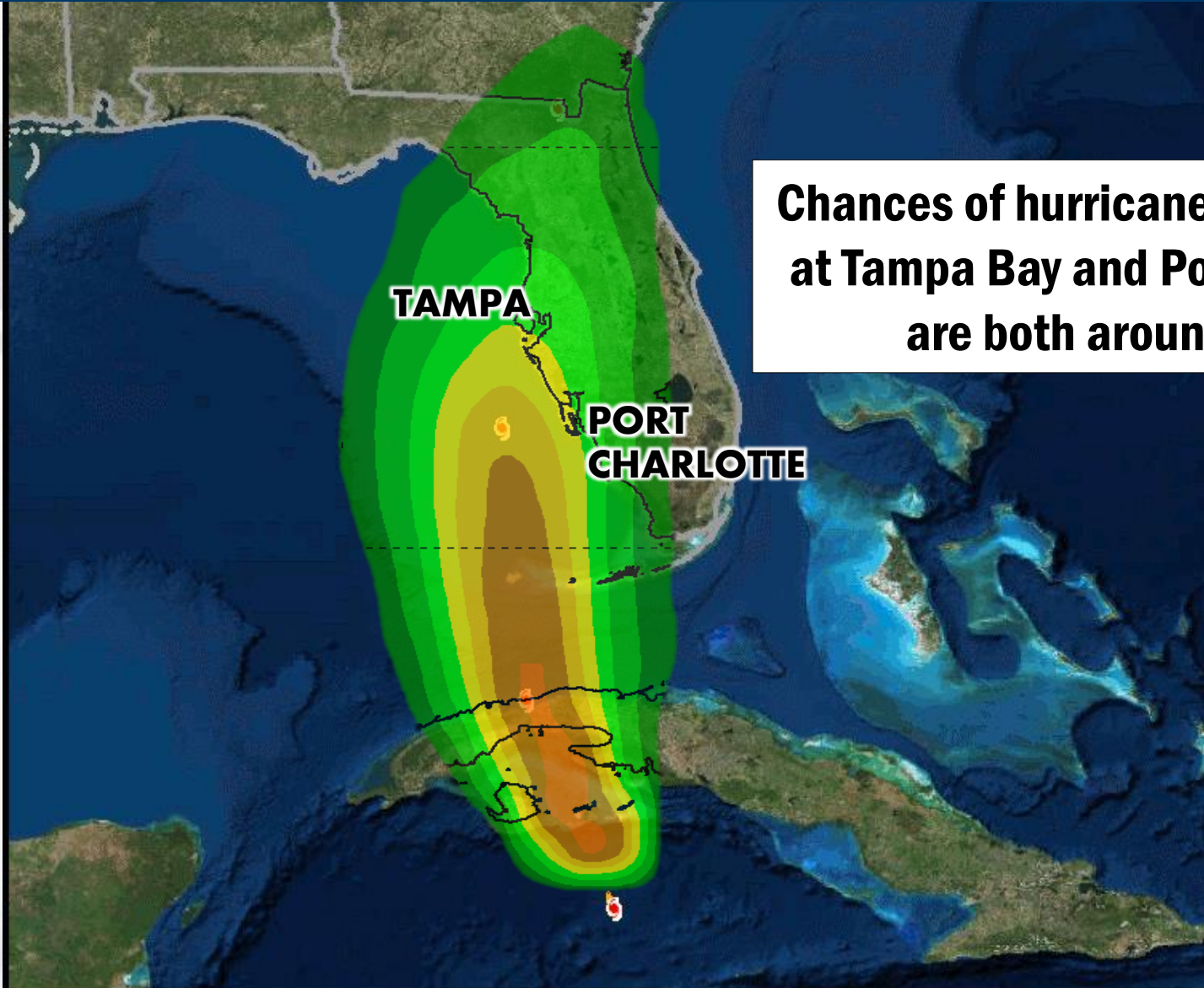
# HURRICANE CHARLEY

*Would alternate scenarios help?*



# HURRICANE CHARLEY


*Would alternate scenarios help?*



**Chances of hurricane-force winds  
at Tampa Bay and Port Charlotte  
are both around 30%**

# WIND SPEED PROBABILITIES

## Text Product



NATIONAL HURRICANE CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER7

NWS NATIONAL HURRICANE CENTER MIAMI FLAL142018

0900 UTC MON OCT 08 2018

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -



TIME PERIODS	FROM 06Z MON TO 18Z MON	FROM 18Z MON TO 06Z TUE	FROM 06Z TUE TO 18Z TUE	FROM 18Z TUE TO 06Z WED	FROM 06Z WED TO 06Z THU	FROM 06Z THU TO 06Z FRI	FROM 06Z FRI TO 06Z SAT
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
LOCATION	KT						
TALLAHASSEE FL 34	X	X ( X )	1 ( 1 )	6 ( 7 )	68 (75)	6 (81)	X (81)
TALLAHASSEE FL 50	X	X ( X )	X ( X )	1 ( 1 )	41 (42)	6 (48)	X (48)
TALLAHASSEE FL 64	X	X ( X )	X ( X )	X ( X )	20 (20)	4 (24)	X (24)
APALACHICOLA 34	X	X ( X )	5 ( 5 )	29 (34)	57 (91)	1 (92)	X (92)
APALACHICOLA 50	X	X ( X )	X ( X )	6 ( 6 )	59 (65)	2 (67)	X (67)
APALACHICOLA 64	X	X ( X )	X ( X )	1 ( 1 )	39 (40)	1 (41)	X (41)
PANAMA CITY FL 34	X	X ( X )	4 ( 4 )	26 (30)	60 (90)	1 (91)	X (91)
PANAMA CITY FL 50	X	X ( X )	X ( X )	6 ( 6 )	57 (63)	1 (64)	X (64)
PANAMA CITY FL 64	X	X ( X )	X ( X )	1 ( 1 )	37 (38)	X (38)	X (38)

**Location-Specific Probabilities**

- Tropical-Storm-Force
- 58 mph
- Hurricane-Force


# WIND SPEED PROBABILITIES

## Text Product



# NATIONAL HURRICANE CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER7

NWS NATIONAL HURRICANE CENTER MIAMI FLAL142018

0900 UTC MON OCT 08 2018

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -

TIME PERIODS	FROM 06Z MON TO 18Z MON	FROM 18Z MON TO 06Z TUE	FROM 06Z TUE TO 18Z TUE	FROM 18Z TUE TO 06Z WED	FROM 06Z WED TO 06Z THU	FROM 06Z THU TO 06Z FRI	FROM 06Z FRI TO 06Z SAT
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
TALLAHASSEE FL 34	X	X ( X )	1 ( 1 )	6 ( 7 )	68 ( 75 )	6 ( 81 )	X ( 81 )
TALLAHASSEE FL 50	X	X ( X )	X ( X )	1 ( 1 )	41 ( 42 )	6 ( 48 )	X ( 48 )
TALLAHASSEE FL 64	X	X ( X )	X ( X )	X ( X )	20 ( 20 )	4 ( 24 )	X ( 24 )
APALACHICOLA 34	X	X ( X )	5 ( 5 )	29 ( 34 )	57 ( 91 )	1 ( 92 )	X ( 92 )
APALACHICOLA 50	X	X ( X )	X ( X )	6 ( 6 )	59 ( 65 )	2 ( 67 )	X ( 67 )
APALACHICOLA 64	X	X ( X )	X ( X )	1 ( 1 )	39 ( 40 )	1 ( 41 )	X ( 41 )
PANAMA CITY FL 34	X	X ( X )	4 ( 4 )	26 ( 30 )	60 ( 90 )	1 ( 91 )	X ( 91 )
PANAMA CITY FL 50	X	X ( X )	X ( X )	6 ( 6 )	57 ( 63 )	1 ( 64 )	X ( 64 )
PANAMA CITY FL 64	X	X ( X )	X ( X )	1 ( 1 )	37 ( 38 )	X ( 38 )	X ( 38 )


**Location-Specific Probabilities**

- Tropical-Storm-Force
- 58 mph
- Hurricane-Force



# WIND SPEED PROBABILITIES

## Text Product



NATIONAL HURRICANE CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER 7

NWS NATIONAL HURRICANE CENTER MIAMI FL AL142018

0900 UTC MON OCT 08 2018

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -



TIME PERIODS	FROM 06Z MON TO 18Z MON	FROM 18Z MON TO 06Z TUE	FROM 06Z TUE TO 18Z TUE	FROM 18Z TUE TO 06Z WED	FROM 06Z WED TO 06Z THU	FROM 06Z THU TO 06Z FRI	FROM 06Z FRI TO 06Z SAT
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
TALLAHASSEE FL 34	X	X ( X )	1 ( 1 )	6 ( 7 )	68 (75)	6 (81)	X (81)
TALLAHASSEE FL 50	X	X ( X )	X ( X )	1 ( 1 )	41 (42)	6 (48)	X (48)
TALLAHASSEE FL 64	X	X ( X )	X ( X )	X ( X )	20 (20)	4 (24)	X (24)
APALACHICOLA 34	X	X ( X )	5 ( 5 )	29 (34)	57 (91)	1 (92)	X (92)
APALACHICOLA 50	X	X ( X )	X ( X )	6 ( 6 )	59 (65)	2 (67)	X (67)
APALACHICOLA 64	X	X ( X )	X ( X )	1 ( 1 )	39 (40)	1 (41)	X (41)
PANAMA CITY FL 34	X	X ( X )	4 ( 4 )	26 (30)	60 (90)	1 (91)	X (91)
PANAMA CITY FL 50	X	X ( X )	X ( X )	6 ( 6 )	57 (63)	1 (64)	X (64)
PANAMA CITY FL 64	X	X ( X )	X ( X )	1 ( 1 )	37 (38)	X (38)	X (38)

**Location-Specific Probabilities**

- Tropical-Storm-Force
- 58 mph
- Hurricane-Force

# WIND SPEED PROBABILITIES

## Text Product



<div><div><div></div><div><div>NATIONAL HURRICANE CENTER</div><div>NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION</div></div></div></div>								
TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER 7								
NWS NATIONAL HURRICANE CENTER MIAMI FL AL142018								
0900 UTC MON OCT 08 2018								
- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -								
TIME	FROM	FROM	FROM	FROM	FROM	FROM	FROM	
PERIODS	06Z MON	18Z MON	06Z TUE	18Z TUE	06Z WED	06Z THU	06Z FRI	
	TO	TO	TO	TO	TO	TO	TO	
	18Z MON	06Z TUE	18Z TUE	06Z WED	06Z THU	06Z FRI	06Z SAT	
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)	
- - - - -								
LOCATION	KT							
TALLAHASSEE FL 34	X	X ( X )	1 ( 1 )	6 ( 7 )	68 (75)	6 (81)	X (81)	
TALLAHASSEE FL 50	X	X ( X )	X ( X )	1 ( 1 )	41 (42)	6 (48)	X (48)	
TALLAHASSEE FL 64	X	X ( X )	X ( X )	X ( X )	20 (20)	4 (24)	X (24)	
APALACHICOLA 34	X	X ( X )	5 ( 5 )	29 (34)	57 (91)	1 (92)	X (92)	
APALACHICOLA 50	X	X ( X )	X ( X )	6 ( 6 )	59 (65)	2 (67)	X (67)	
APALACHICOLA 64	X	X ( X )	X ( X )	1 ( 1 )	39 (40)	1 (41)	X (41)	
PANAMA CITY FL 34	X	X ( X )	4 ( 4 )	26 (30)	60 (90)	1 (91)	X (91)	
PANAMA CITY FL 50	X	X ( X )	X ( X )	6 ( 6 )	57 (63)	1 (64)	X (64)	
PANAMA CITY FL 64	X	X ( X )	X ( X )	1 ( 1 )	37 (38)	X (38)	X (38)	

**Onset Probabilities**  
•Timing information



# WIND SPEED PROBABILITIES

## Text Product



<div><div><div></div><div><div>NATIONAL HURRICANE CENTER</div><div>NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION</div></div></div></div>								
TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER 7								
NWS NATIONAL HURRICANE CENTER MIAMI FL AL142018								
0900 UTC MON OCT 08 2018								
- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -								
TIME PERIODS	FROM	FROM	FROM	FROM	FROM	FROM	FROM	
	06Z MON	18Z MON	06Z TUE	18Z TUE	06Z WED	06Z THU	06Z FRI	
	TO	TO	TO	TO	TO	TO	TO	
	18Z MON	06Z TUE	18Z TUE	06Z WED	06Z THU	06Z FRI	06Z SAT	
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)	
- - - - -								
LOCATION	KT							
TALLAHASSEE FL 34	X	X (X)	1 (1)	6 (7)	68 (75)	6 (81)	X (81)	
TALLAHASSEE FL 50	X	X (X)	X (X)	1 (1)	41 (42)	6 (48)	X (48)	
TALLAHASSEE FL 64	X	X (X)	X (X)	X (X)	20 (20)	4 (24)	X (24)	
APALACHICOLA 34	X	X (X)	5 (5)	29 (34)	57 (91)	1 (92)	X (92)	
APALACHICOLA 50	X	X (X)	X (X)	6 (6)	59 (65)	2 (67)	X (67)	
APALACHICOLA 64	X	X (X)	X (X)	1 (1)	39 (40)	1 (41)	X (41)	
PANAMA CITY FL 34	X	X (X)	4 (4)	26 (30)	60 (90)	1 (91)	X (91)	
PANAMA CITY FL 50	X	X (X)	X (X)	6 (6)	57 (63)	1 (64)	X (64)	
PANAMA CITY FL 64	X	X (X)	X (X)	1 (1)	37 (38)	X (38)	X (38)	

### Cumulative Probabilities

•Total chance through the time period

# WIND SPEED PROBABILITIES

## 5-Day Cumulative Graphic

<div><div></div><div>NATIONAL HURRICANE CENTER</div><div>NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION</div></div>								
TIME PERIODS	FROM 06Z MON TO 18Z MON	FROM 18Z MON TO 06Z TUE	FROM 06Z TUE TO 18Z TUE	FROM 18Z TUE TO 06Z WED	FROM 06Z WED TO 06Z THU	FROM 06Z THU TO 06Z FRI	FROM 06Z FRI TO 06Z SAT	
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)	
LOCATION	KT							
CEDAR KEY FL	34	X	X ( X )	3 ( 3 )	15 ( 18 )	43 ( 61 )	2 ( 63 )	X ( 63 )
CEDAR KEY FL	50	X	X ( X )	X ( X )	1 ( 1 )	20 ( 21 )	1 ( 22 )	X ( 22 )
CEDAR KEY FL	64	X	X ( X )	X ( X )	X ( X )	7 ( 7 )	1 ( 8 )	X ( 8 )
TALLAHASSEE FL	34	X	X ( X )	1 ( 1 )	6 ( 7 )	68 ( 75 )	6 ( 81 )	X ( 81 )
TALLAHASSEE FL	50	X	X ( X )	X ( X )	1 ( 1 )	41 ( 42 )	6 ( 48 )	X ( 48 )
TALLAHASSEE FL	64	X	X ( X )	X ( X )	X ( X )	20 ( 20 )	4 ( 24 )	X ( 24 )
APALACHICOLA	34	X	X ( X )	5 ( 5 )	29 ( 34 )	57 ( 91 )	1 ( 92 )	X ( 92 )
APALACHICOLA	50	X	X ( X )	X ( X )	6 ( 6 )	59 ( 65 )	2 ( 67 )	X ( 67 )
APALACHICOLA	64	X	X ( X )	X ( X )	1 ( 1 )	39 ( 40 )	1 ( 41 )	X ( 41 )
PANAMA CITY FL	34	X	X ( X )	4 ( 4 )	26 ( 30 )	60 ( 90 )	1 ( 91 )	X ( 91 )
PANAMA CITY FL	50	X	X ( X )	X ( X )	6 ( 6 )	57 ( 63 )	1 ( 64 )	X ( 64 )
PANAMA CITY FL	64	X	X ( X )	X ( X )	1 ( 1 )	37 ( 38 )	X ( 38 )	X ( 38 )
PENSACOLA FL	34	X	X ( X )	1 ( 1 )	8 ( 9 )	43 ( 52 )	2 ( 54 )	X ( 54 )
PENSACOLA FL	50	X	X ( X )	X ( X )	1 ( 1 )	20 ( 21 )	1 ( 22 )	X ( 22 )
PENSACOLA FL	64	X	X ( X )	X ( X )	X ( X )	9 ( 9 )	X ( 9 )	X ( 9 )

### Location-Specific Probabilities

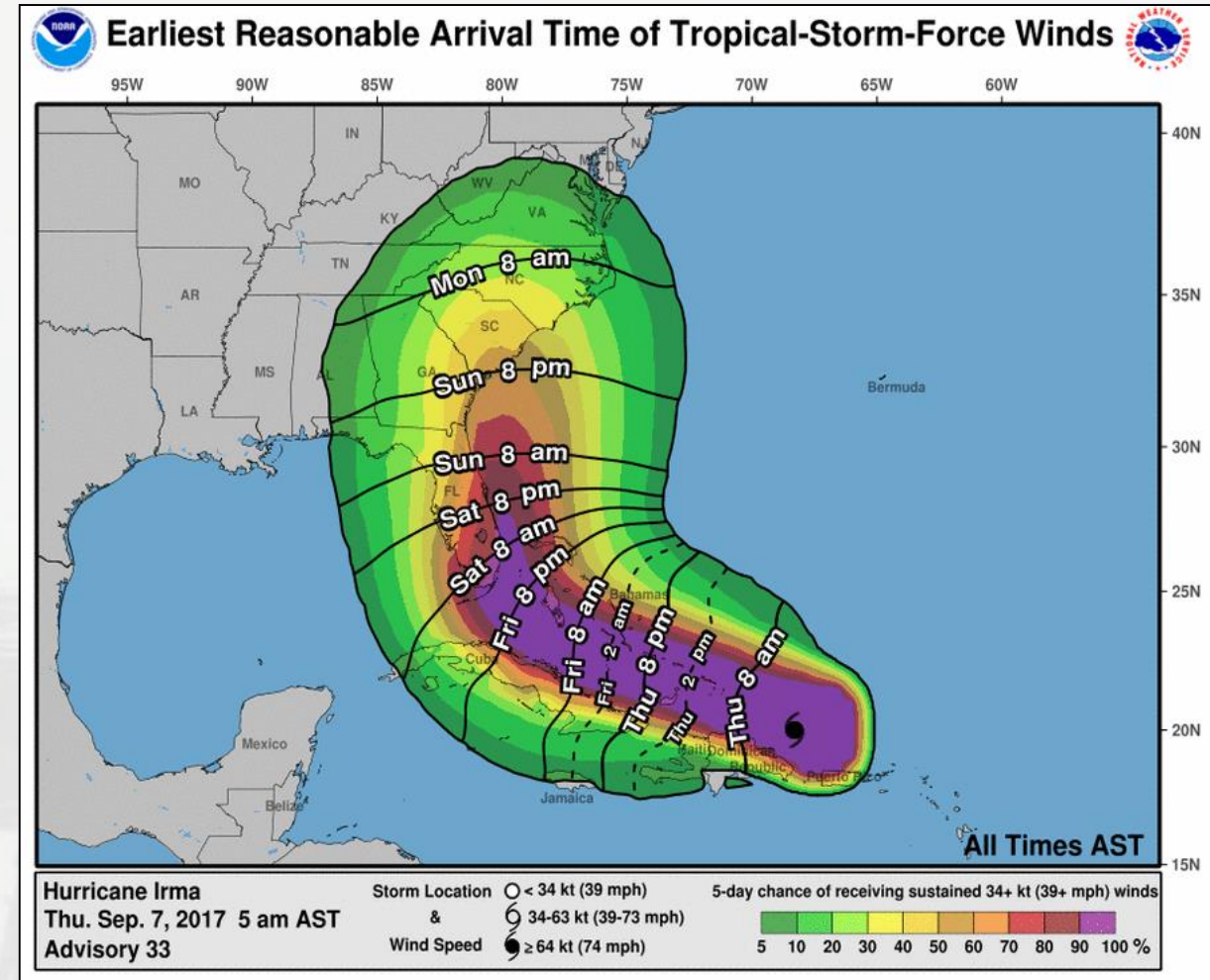
- Tropical-Storm-Force
- 58 mph
- Hurricane-Force

9 38 24 41 8

# TIME OF ARRIVAL OF TS-FORCE WINDS

## *Earliest Reasonable Time of Arrival*

- Shows earliest reasonable arrival time of TS winds (black contours) and cumulative TS wind speed probabilities (colors)
- Identifies the time window that users at individual locations can safely assume will be free from TS winds
  - Based on the time that has  $\leq 10\%$  chance of seeing sustained TS winds before the indicated time
- Best for users with low tolerance for risk

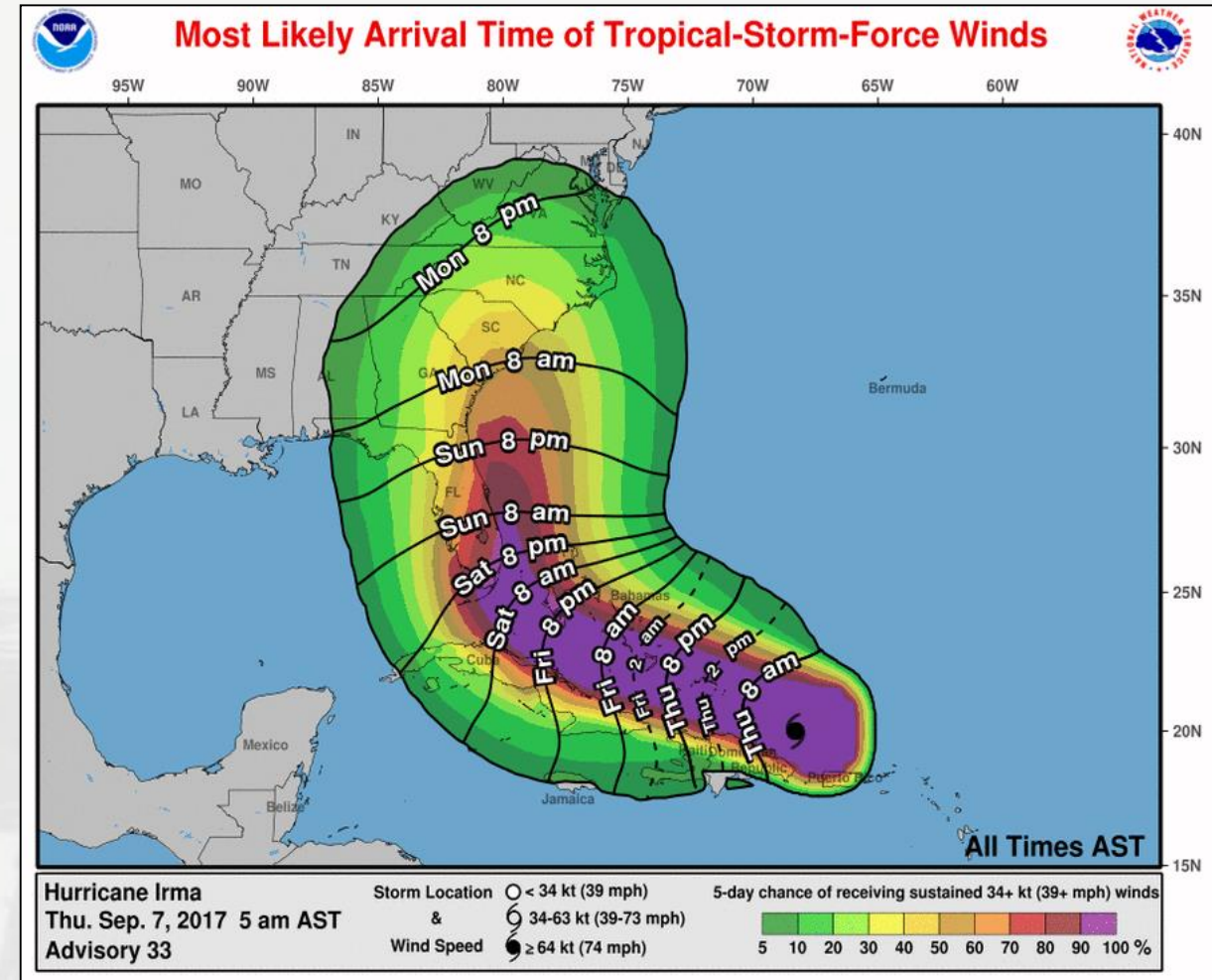


Earliest Reasonable Time of Arrival

# TIME OF ARRIVAL OF TS-FORCE WINDS

## *Most Likely Time of Arrival*

- Shows most likely arrival time of TS winds (black contours) and cumulative TS wind speed probabilities (colors)
- Shows the time before or after which the onset of sustained TS winds is equally likely
- Best for users that are willing to risk not having completed preparations before TS winds arrive

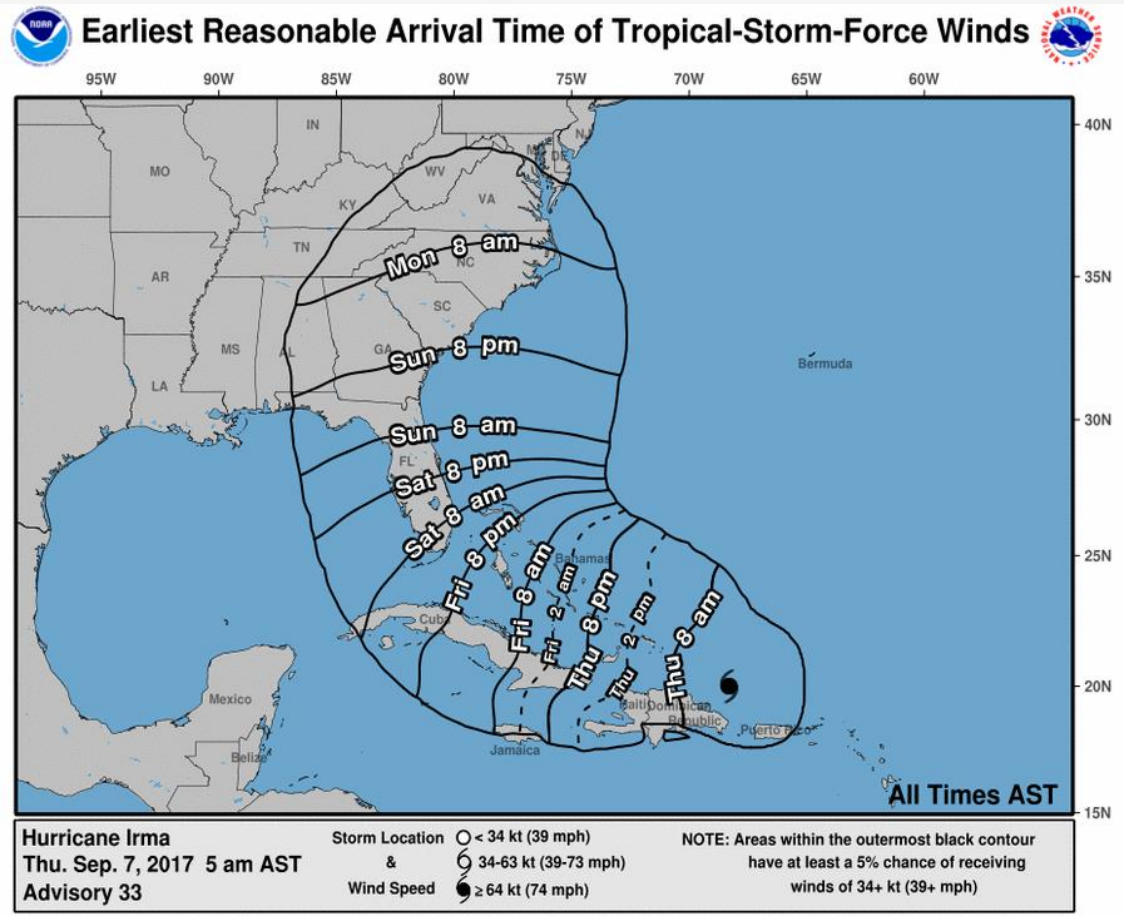
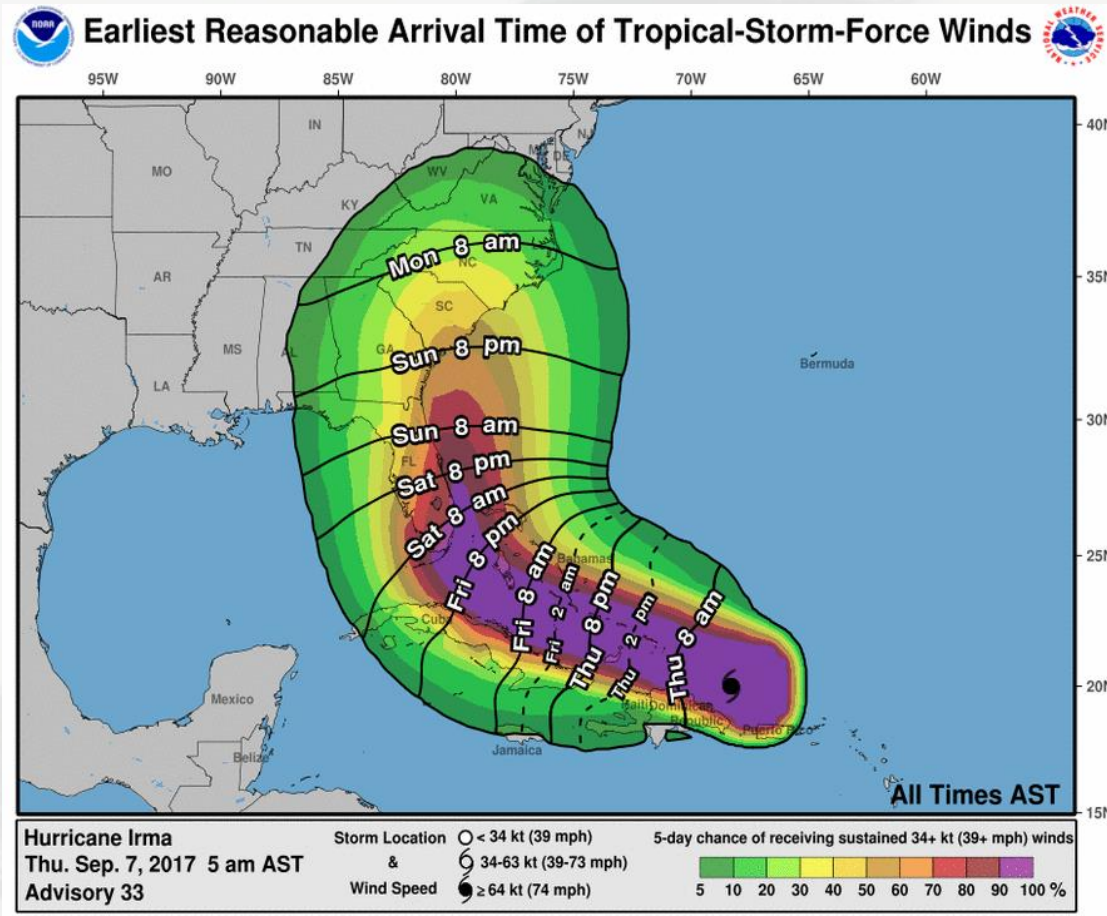


Most Likely Time of Arrival



# 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

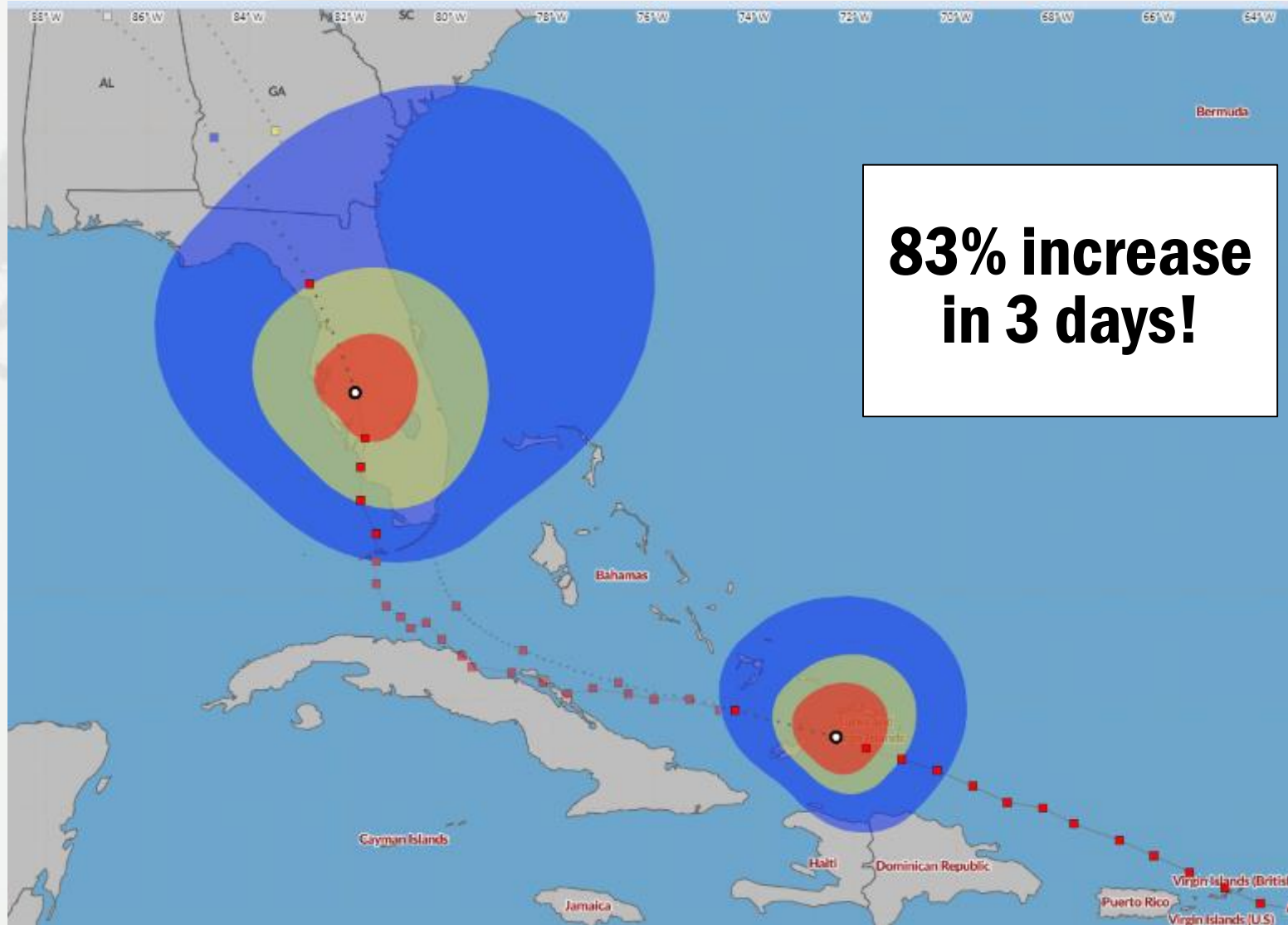
- **Major sources of uncertainty in wind timing:**
  - **Track** – Forward speed, direction of motion, and location of center relative to given location
  - **Storm Size** – How far will TS winds extend from the center? Difficult to forecast and highly variable
- **Time of Arrival graphics designed to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

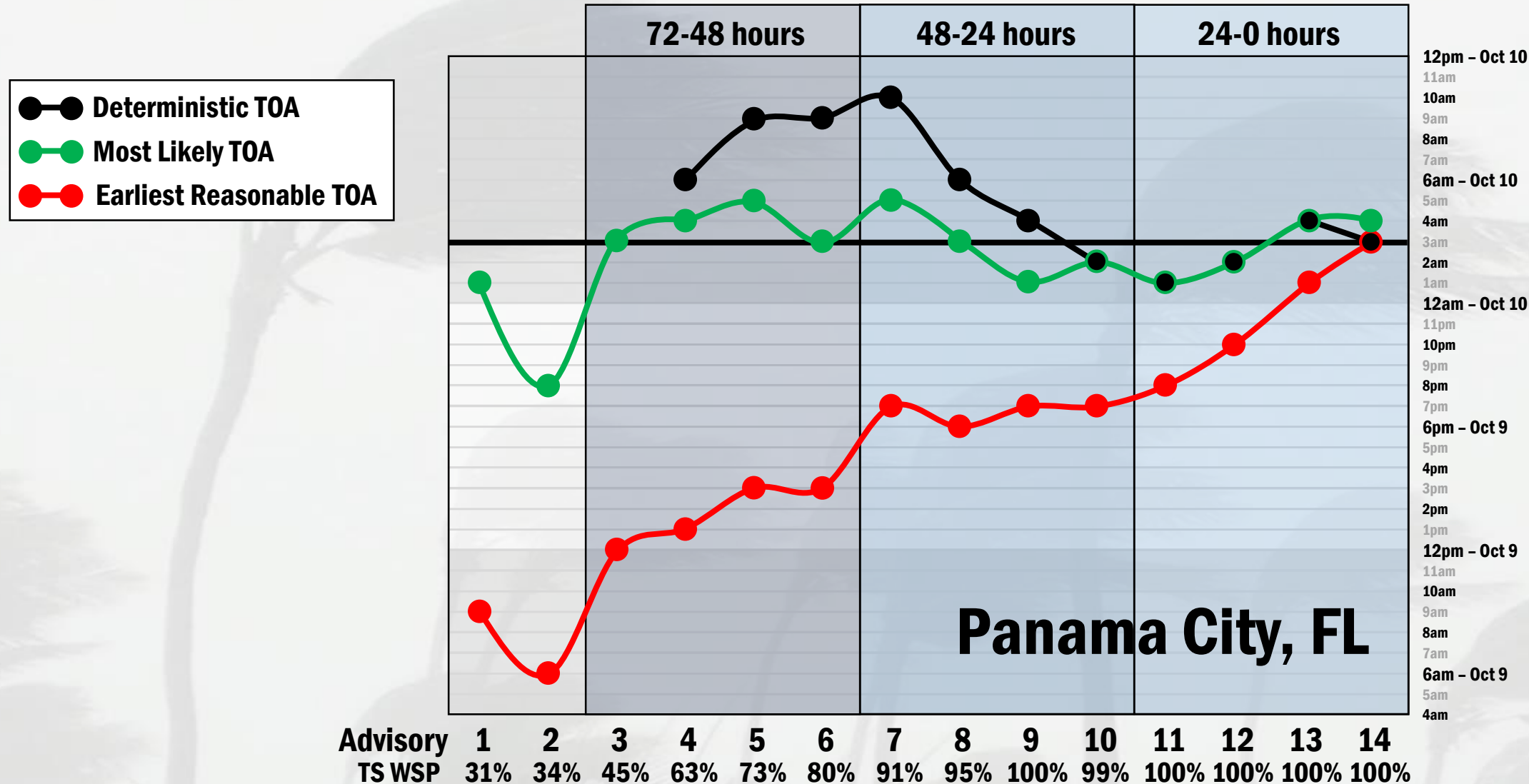
### TIME OF ARRIVAL

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

- **Storms that stall or move very slowly (<5 mph)**
  - 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.

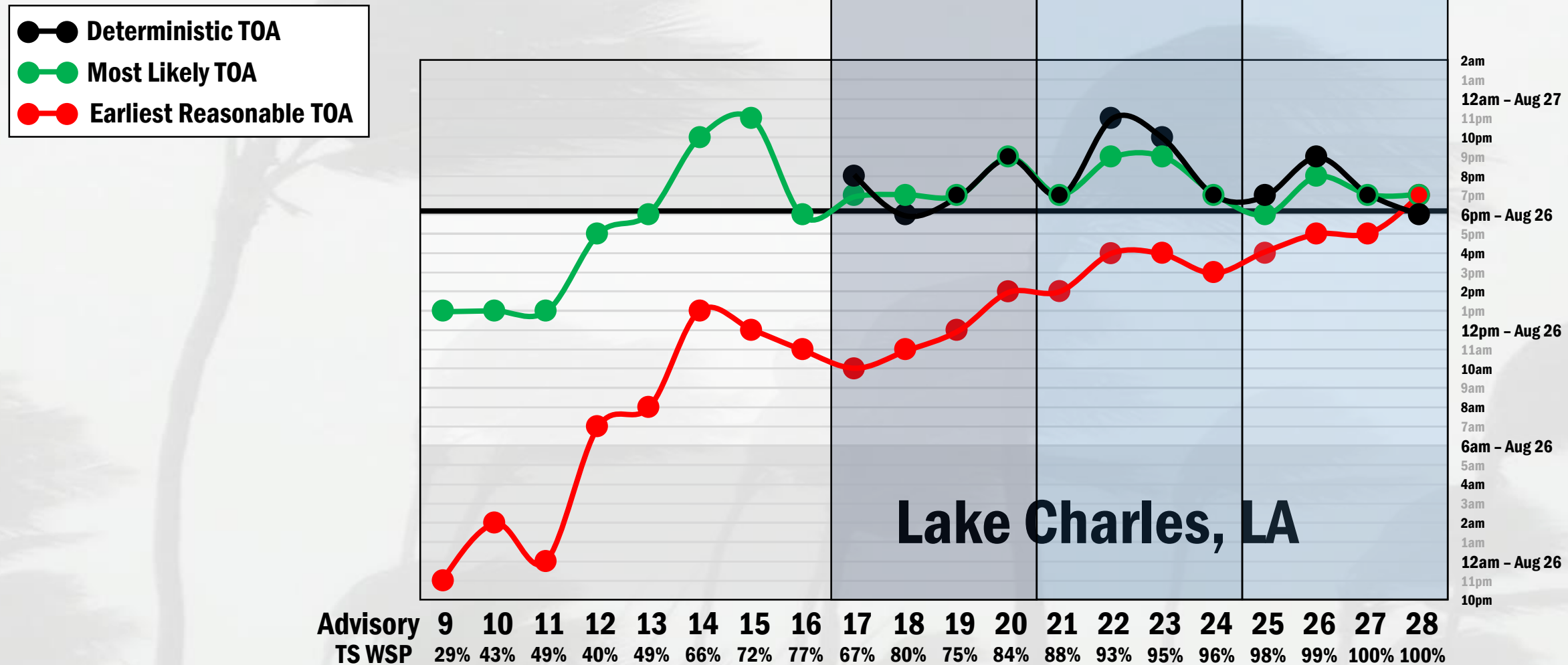
# TIME OF ARRIVAL OF TS WINDS

## Hurricane Michael (2018)



# TIME OF ARRIVAL OF TS WINDS

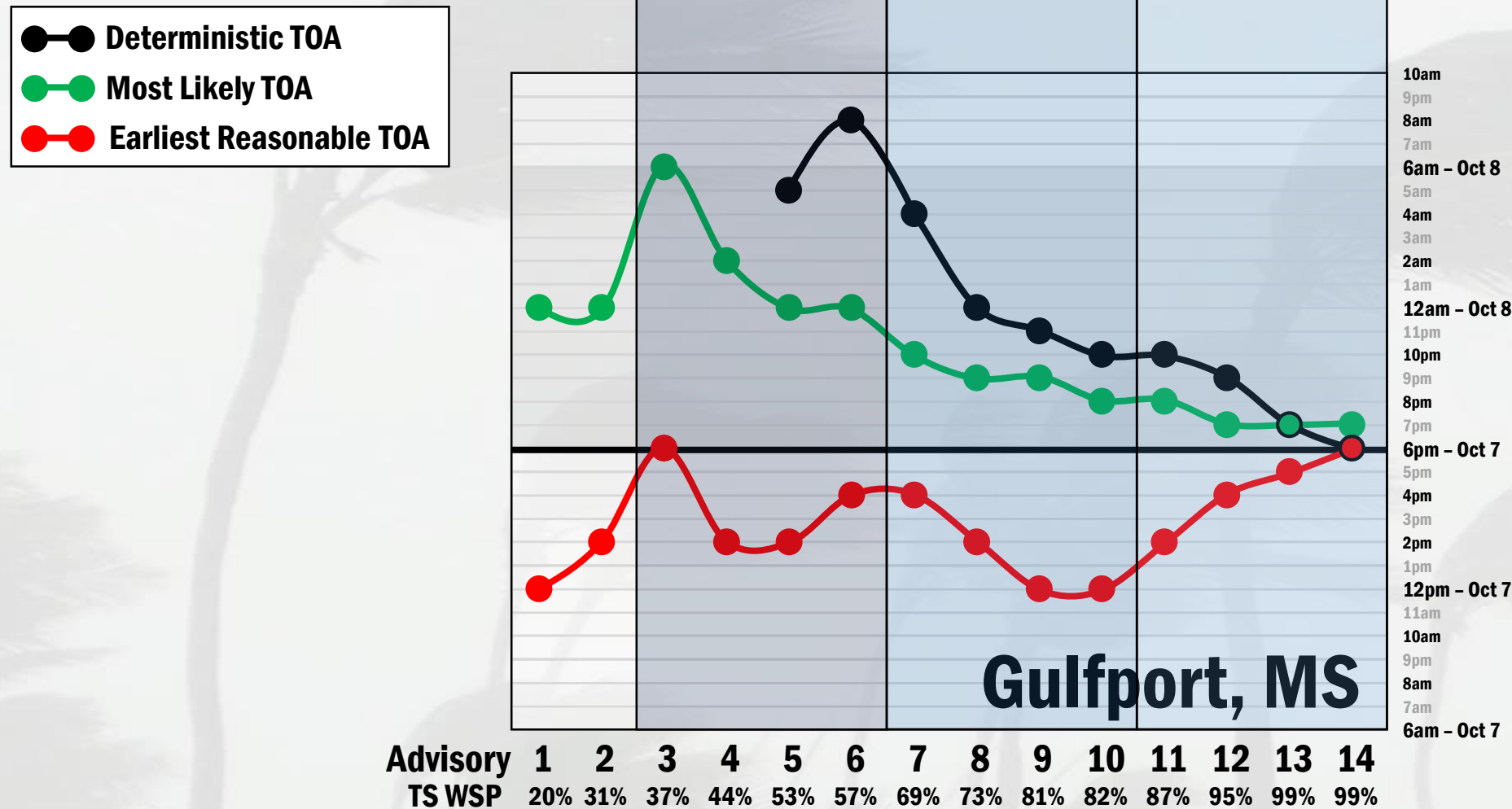
## Hurricane Laura (2020)





# TIME OF ARRIVAL OF TS WINDS

## Hurricane Nate (2017)



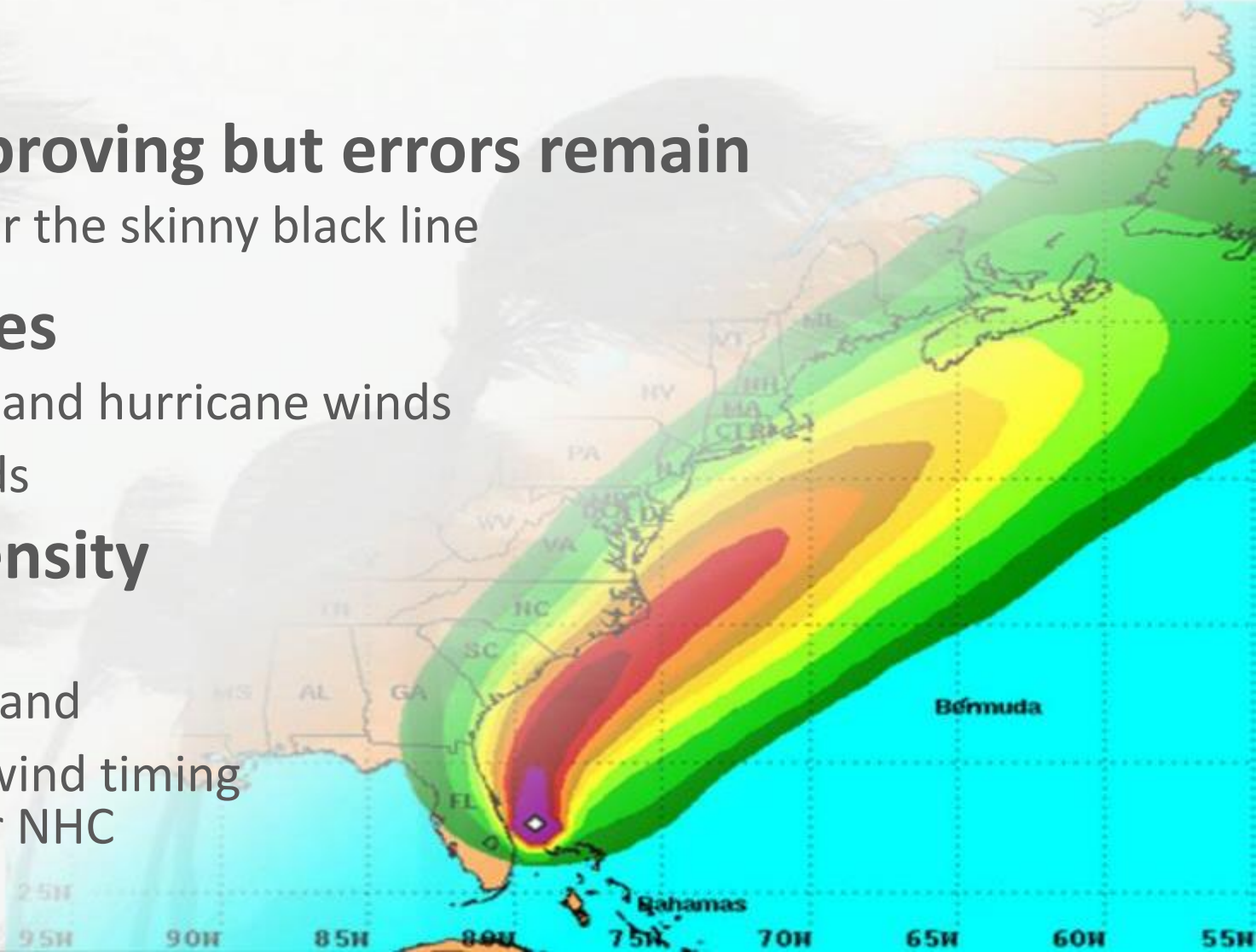
# WIND SPEED PROBABILITIES

## Summary



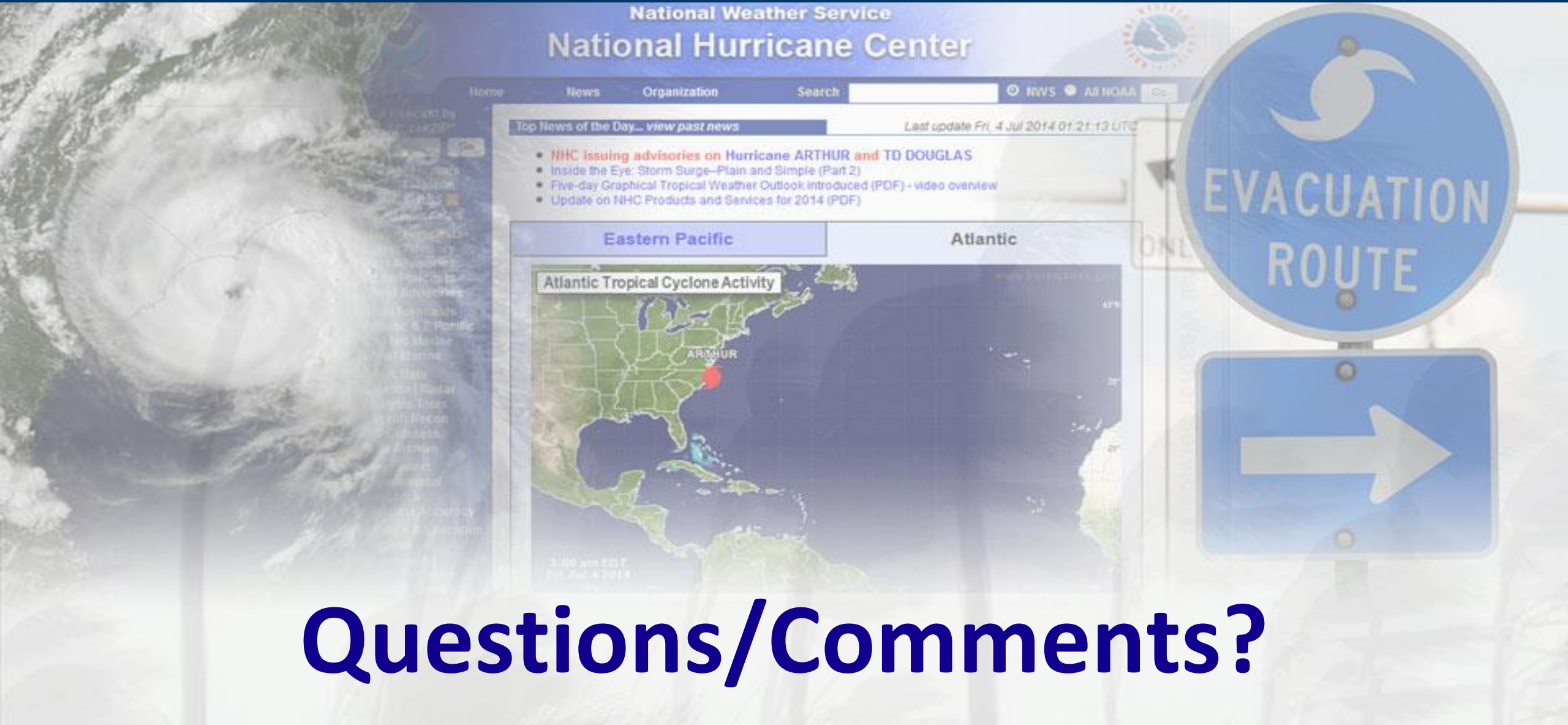
## SUMMARY

- **NHC's forecasts are improving but errors remain**
  - 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



# HURRICANE READINESS

## *A Short Course*



# Questions/Comments?