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UNIT THREE
Forecast Uncertainty

FORECAST UNCERTAINTY
What, Me Worry?

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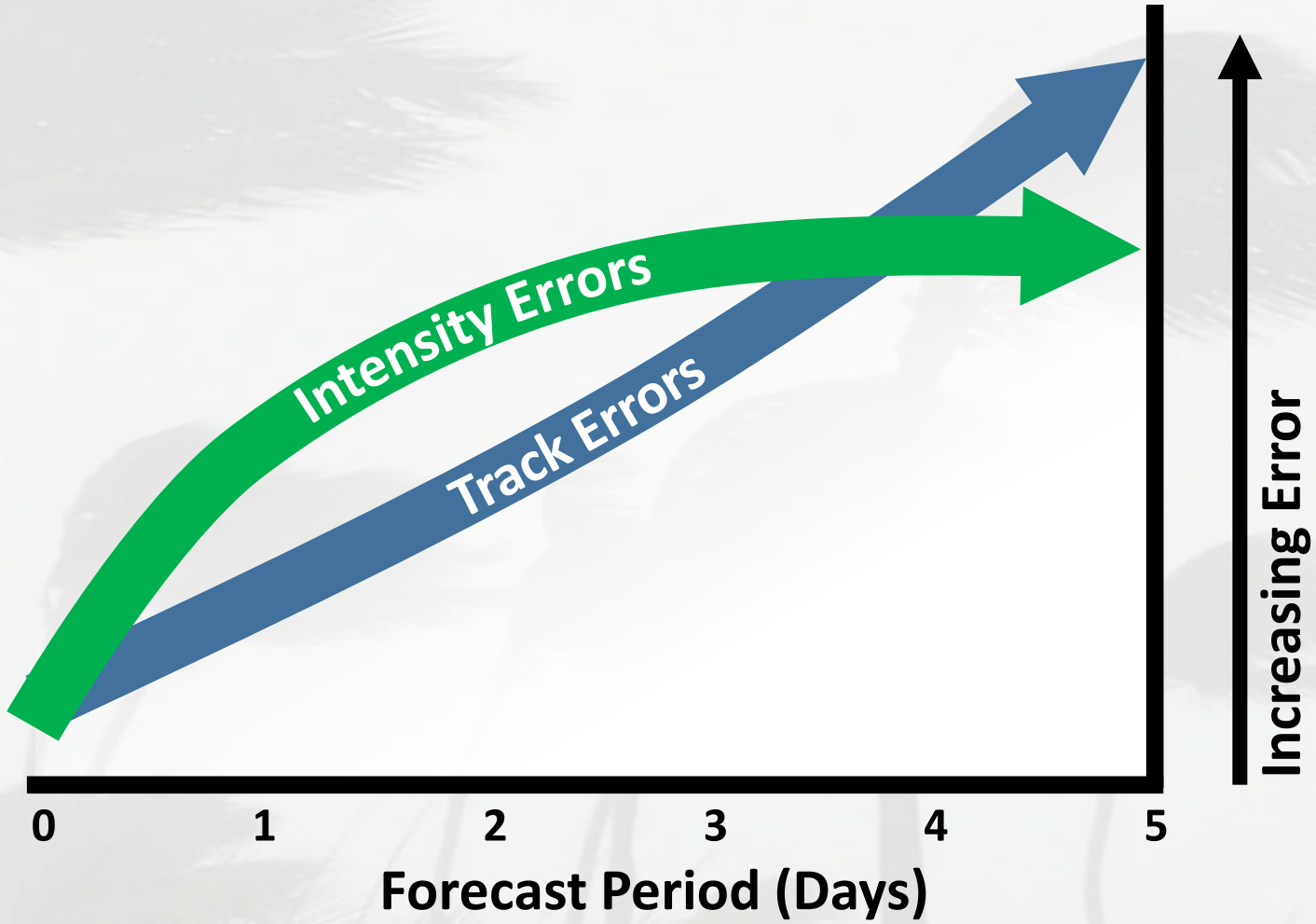

FORECAST TRACK ERRORS

Improving, but not perfect.

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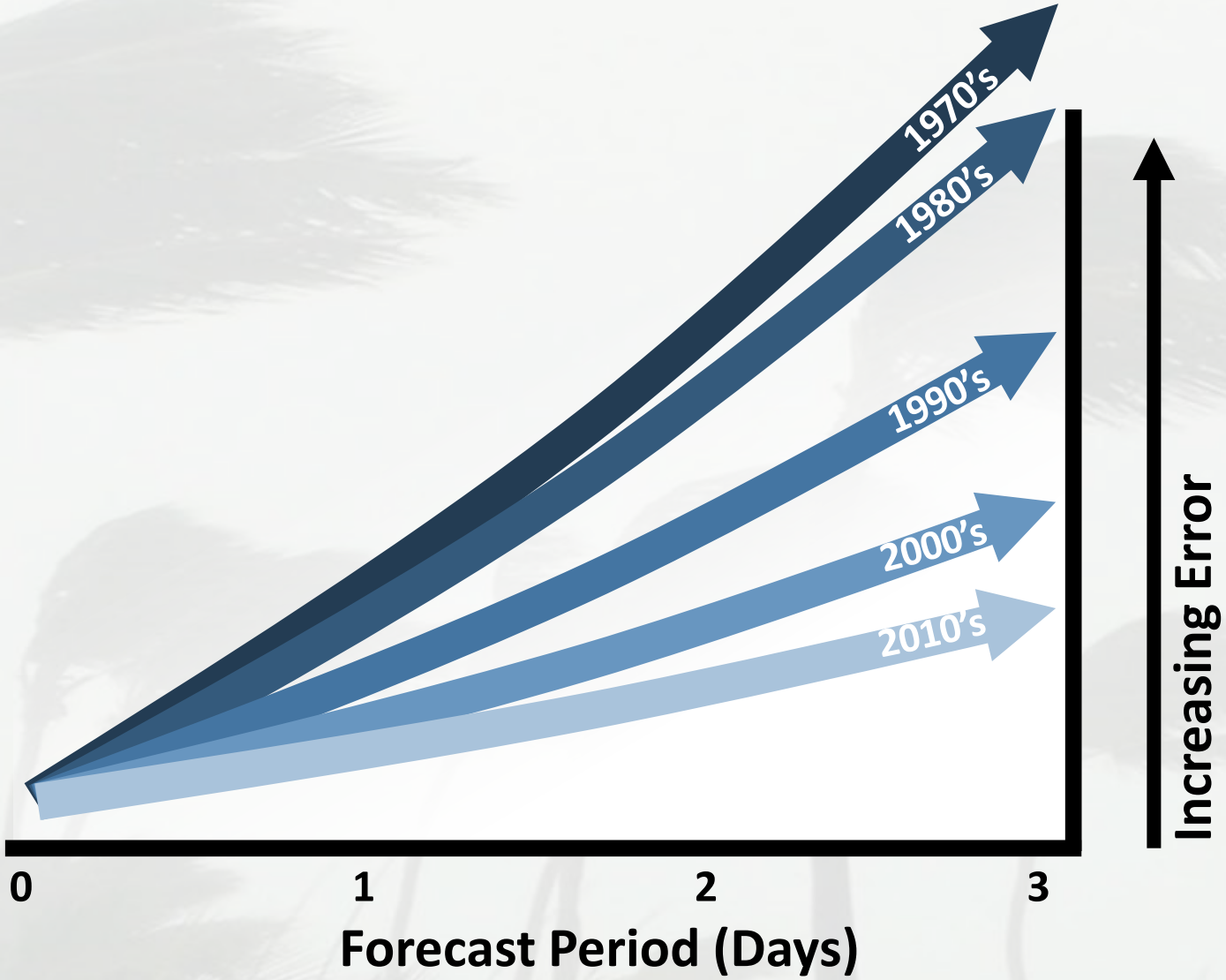
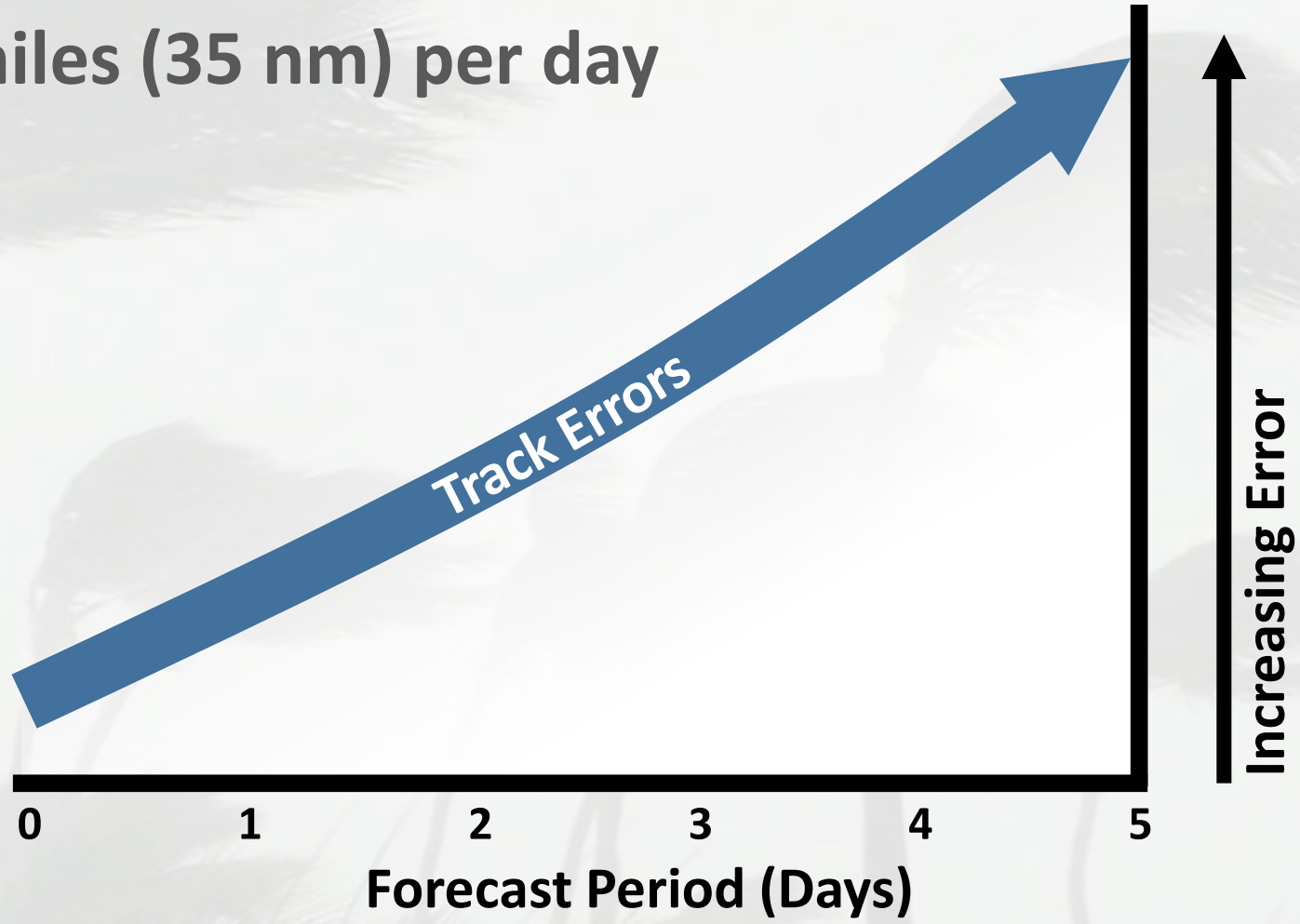


FORECAST TRACK ERRORS
NHC 5-year Averages

TRACK ERRORS

Increase 40 miles (35 nm) per day



FORECAST TRACK ERRORS
NHC 5-year Averages

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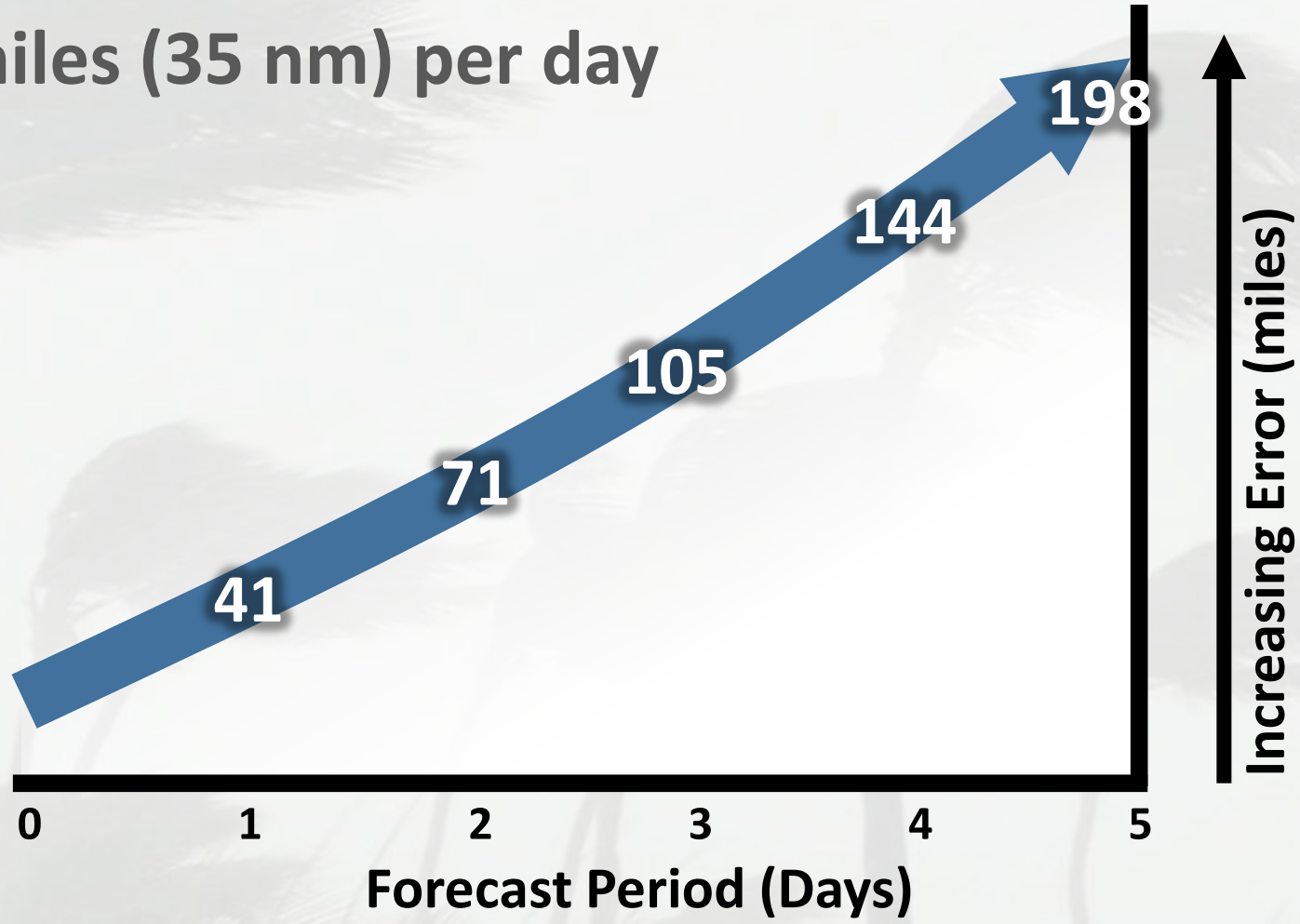
TRACK ERRORS

Increase 40 miles (35 nm) per day



FORECAST TRACK ERRORS
Based on Initial Intensity

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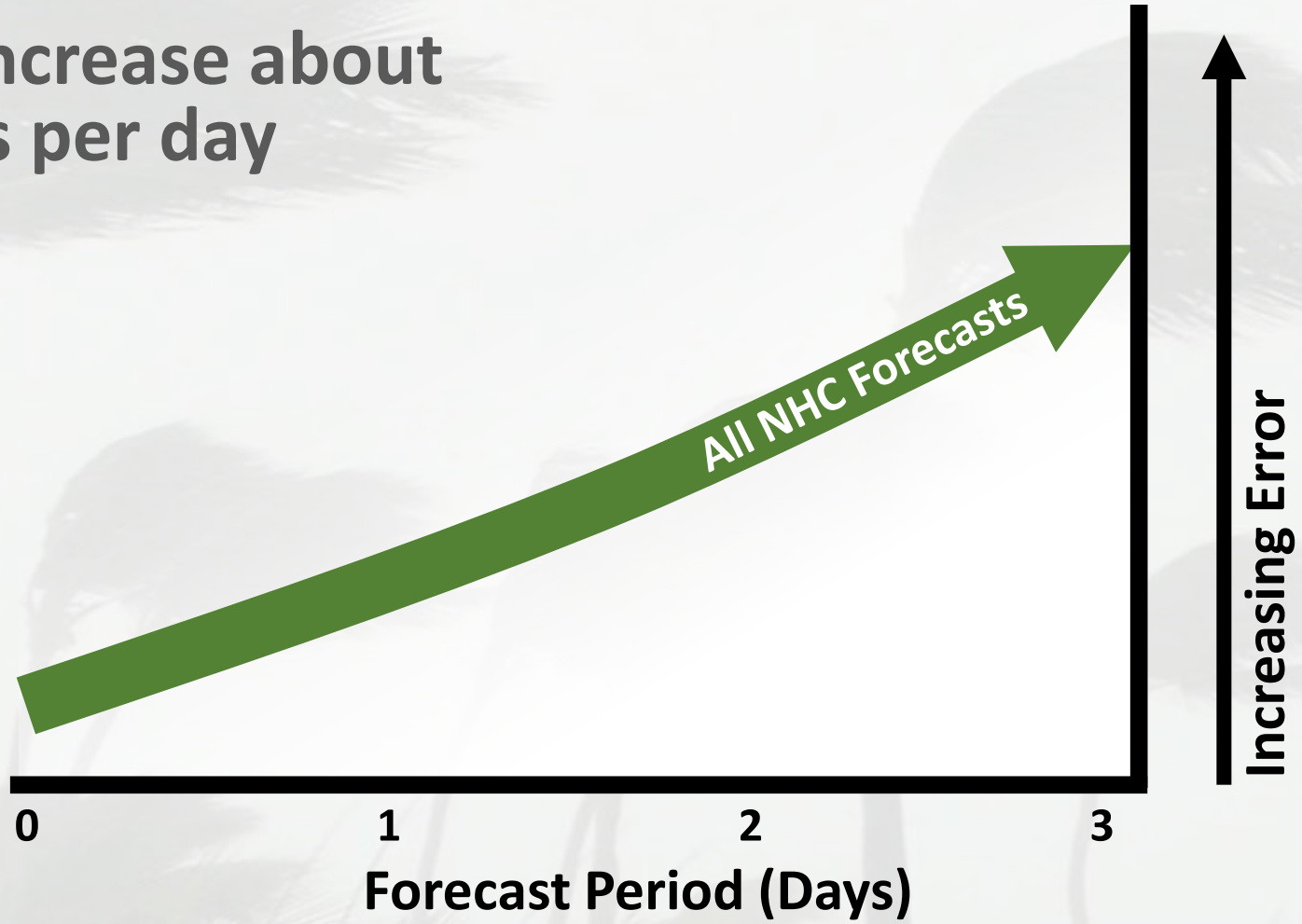
ALL NHC FORECASTS

Track errors increase about
35 to 40 miles per day



FORECAST TRACK ERRORS
Based on Initial Intensity

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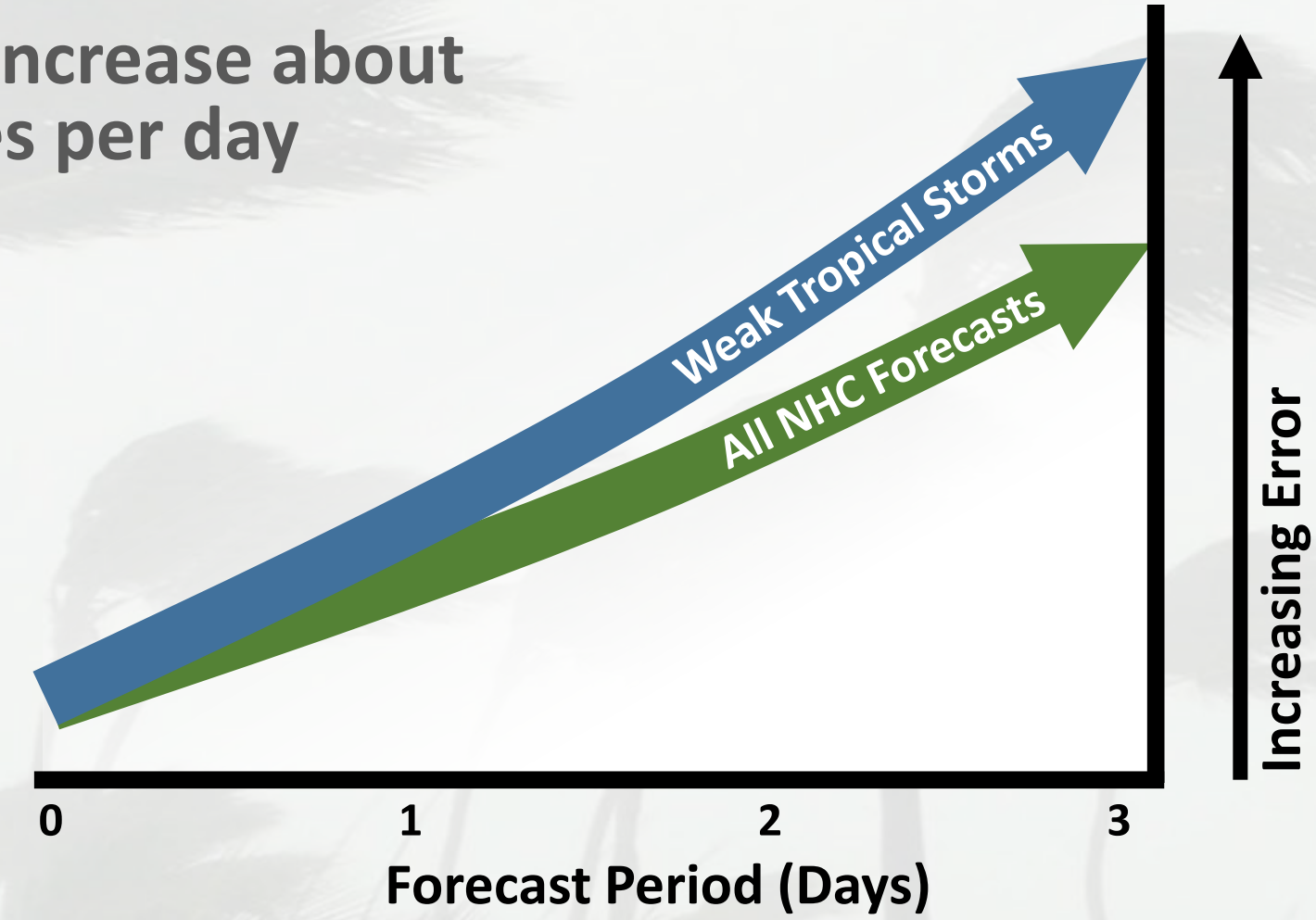
WEAK TROPICAL STORMS

Track errors increase about
40 to 45 miles per day



FORECAST TRACK ERRORS
Based on Initial Intensity

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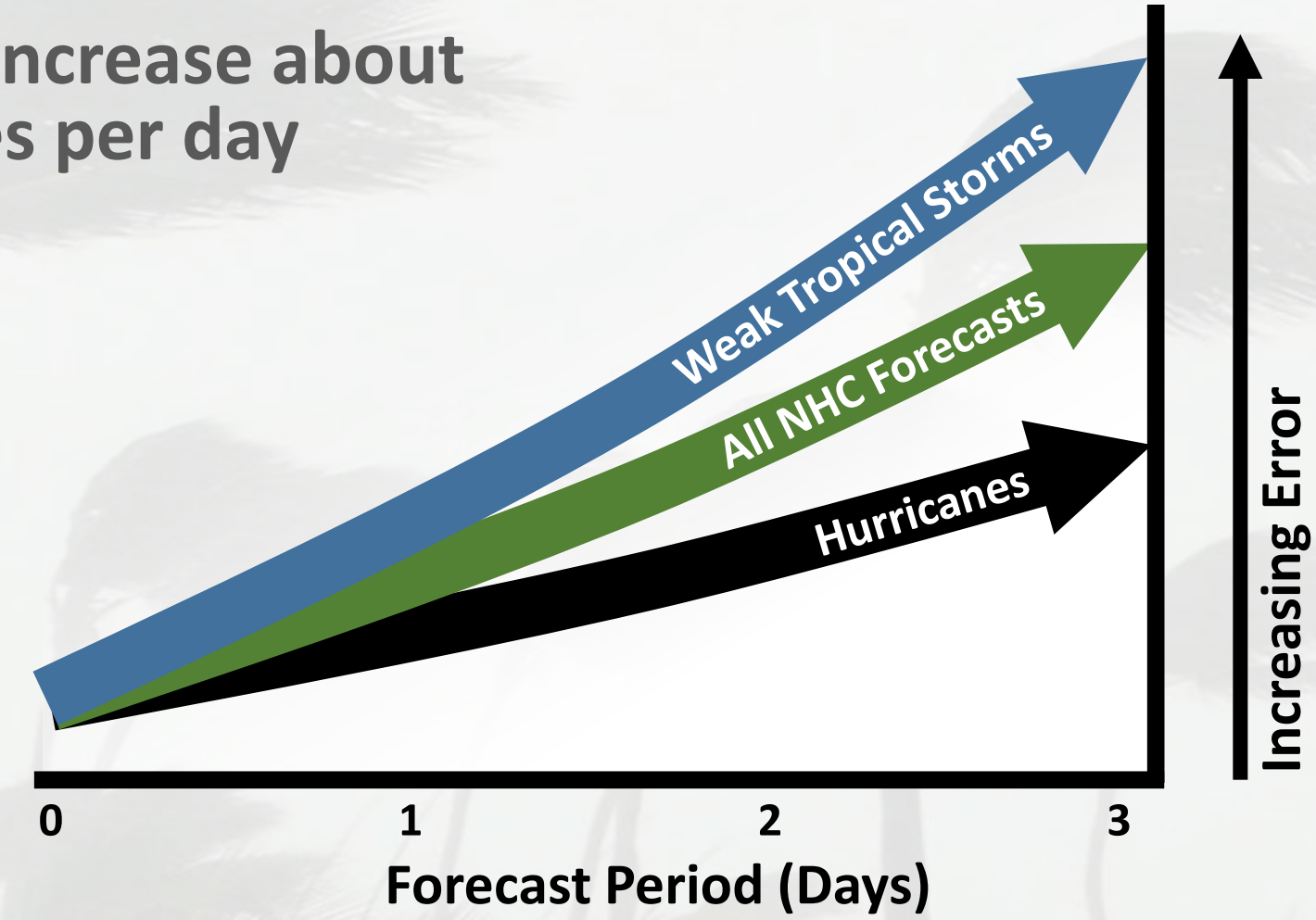
HURRICANES

Track errors increase about
25 to 30 miles per day



FORECAST INTENSITY ERRORS

Finally, signs of improvement!

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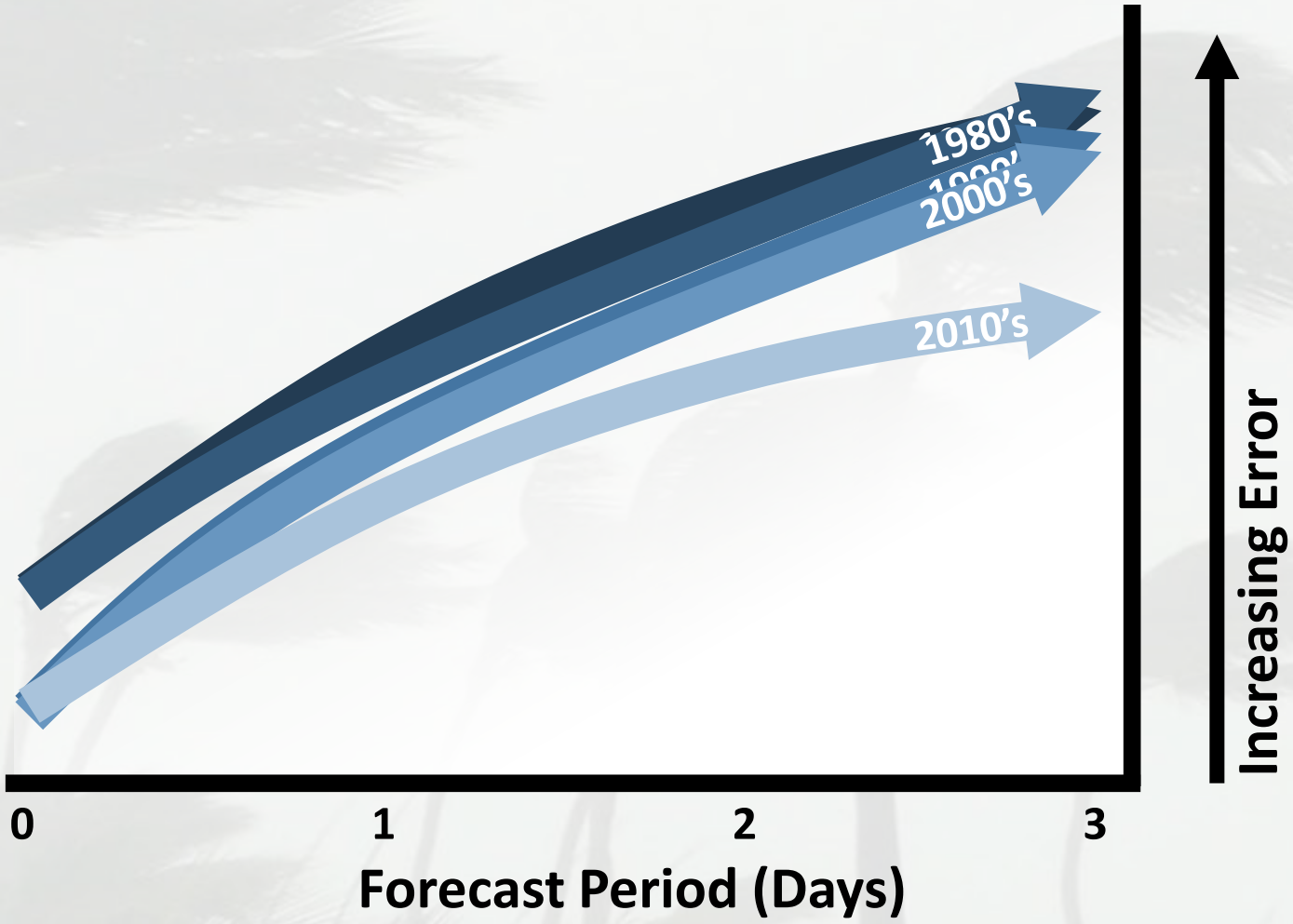

FORECAST INTENSITY ERRORS
NHC 5-year Averages

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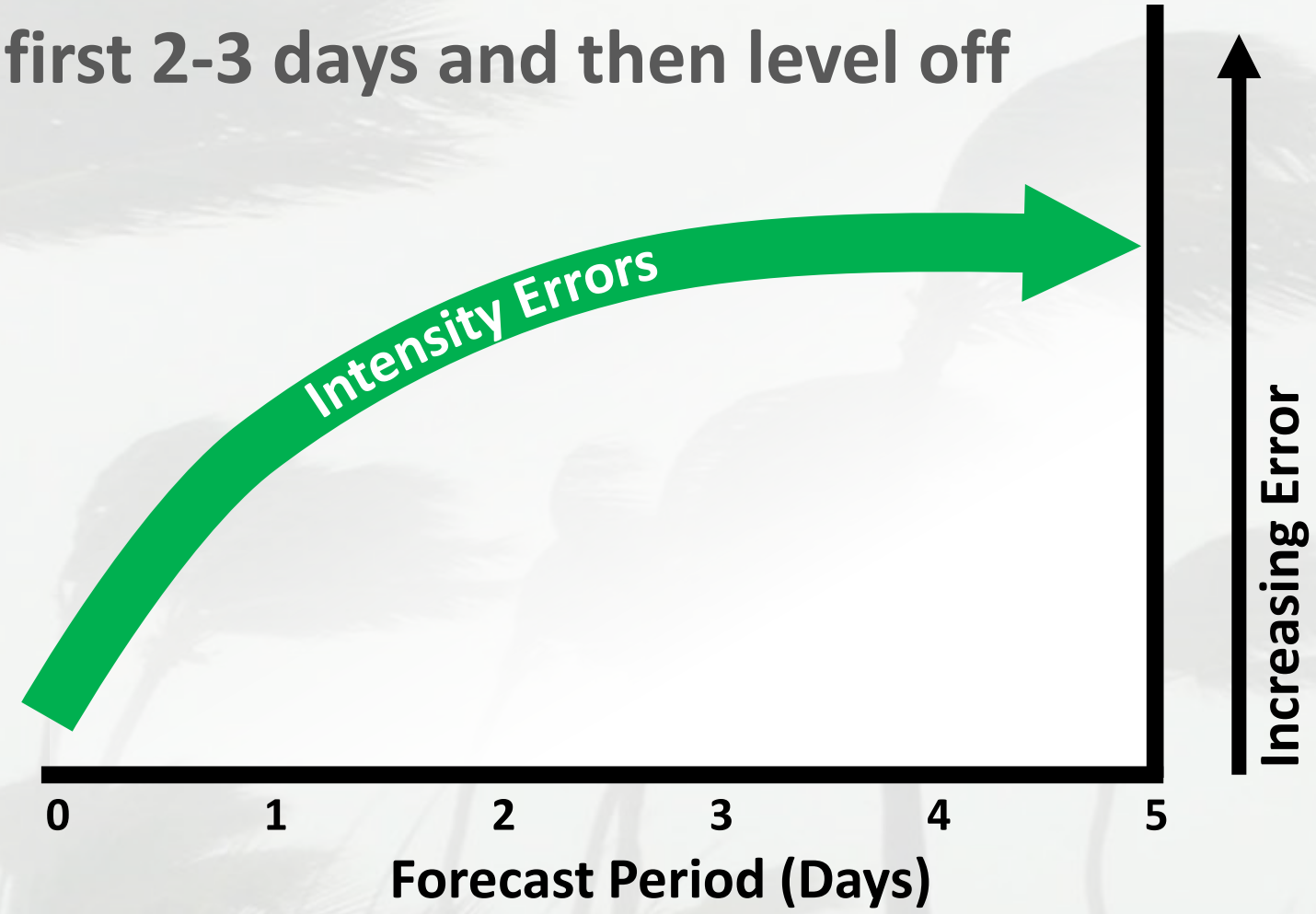
INTENSITY ERRORS

Increase the first 2-3 days and then level off



FORECAST INTENSITY ERRORS
NHC 5-year Averages

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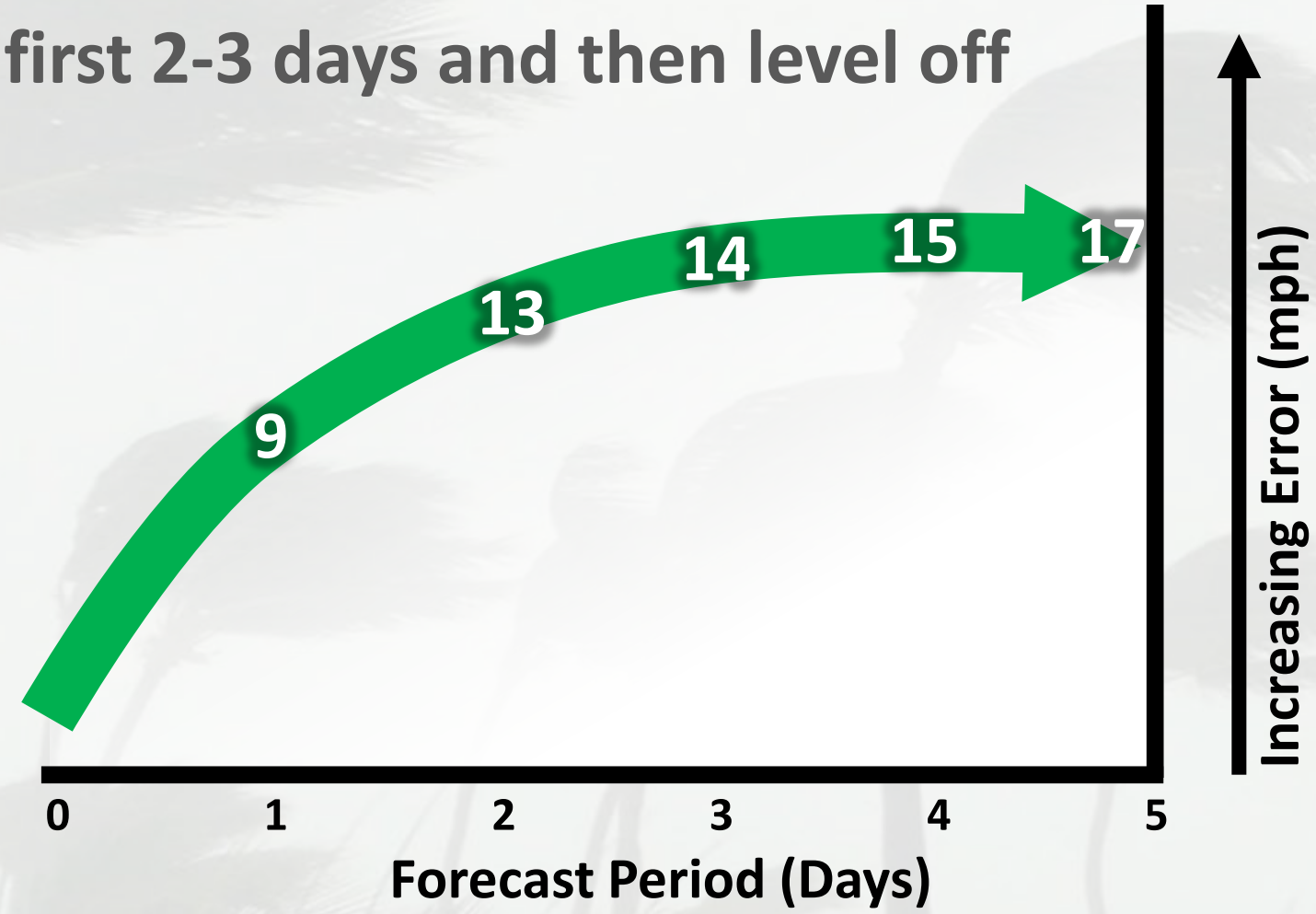
INTENSITY ERRORS

Increase the first 2-3 days and then level off



FORECAST INTENSITY ERRORS
NHC 5-year Averages

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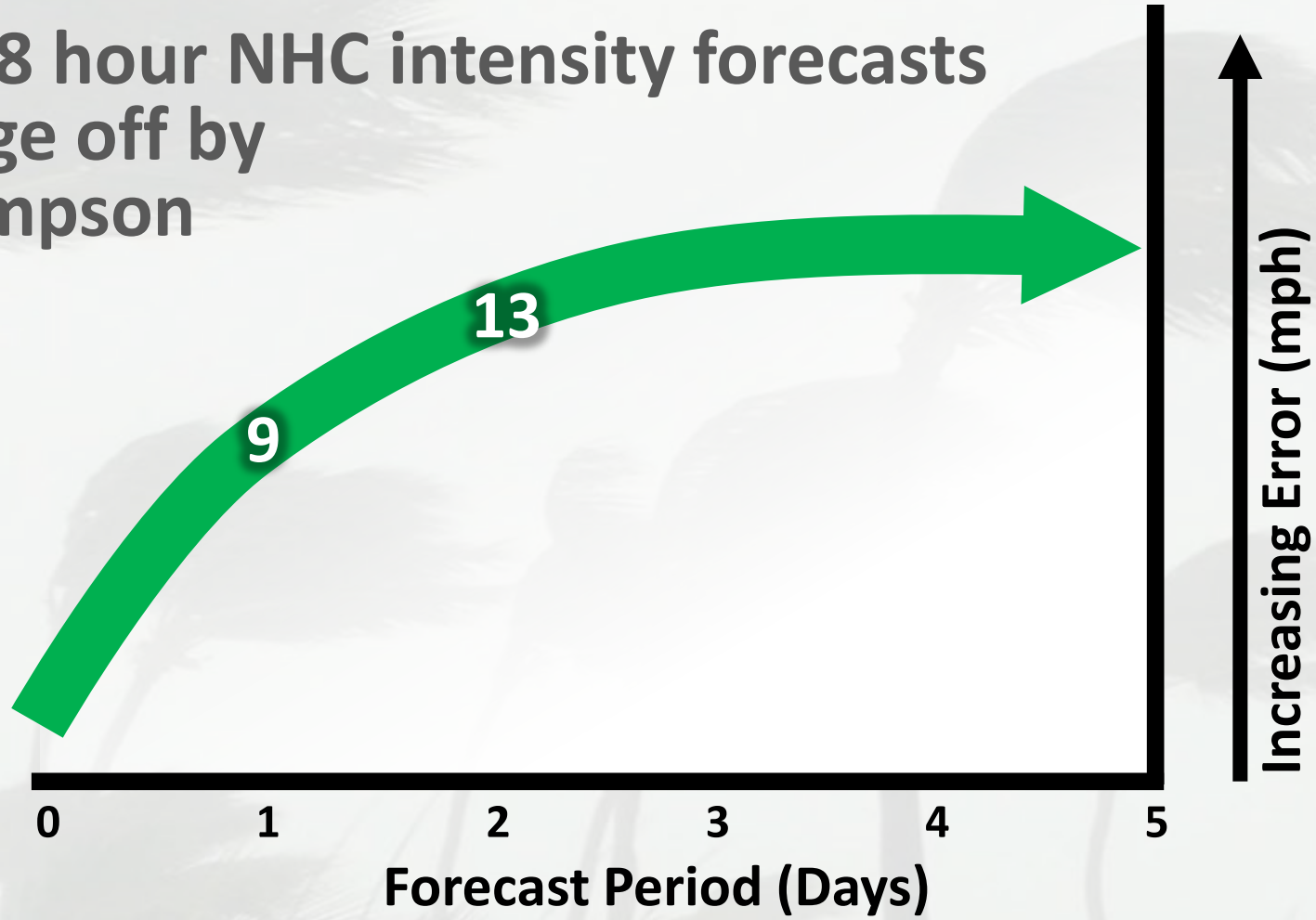
INTENSITY ERRORS

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



FORECAST INTENSITY ERRORS
Rapid Strengthening

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RAPID INTENSIFICATION

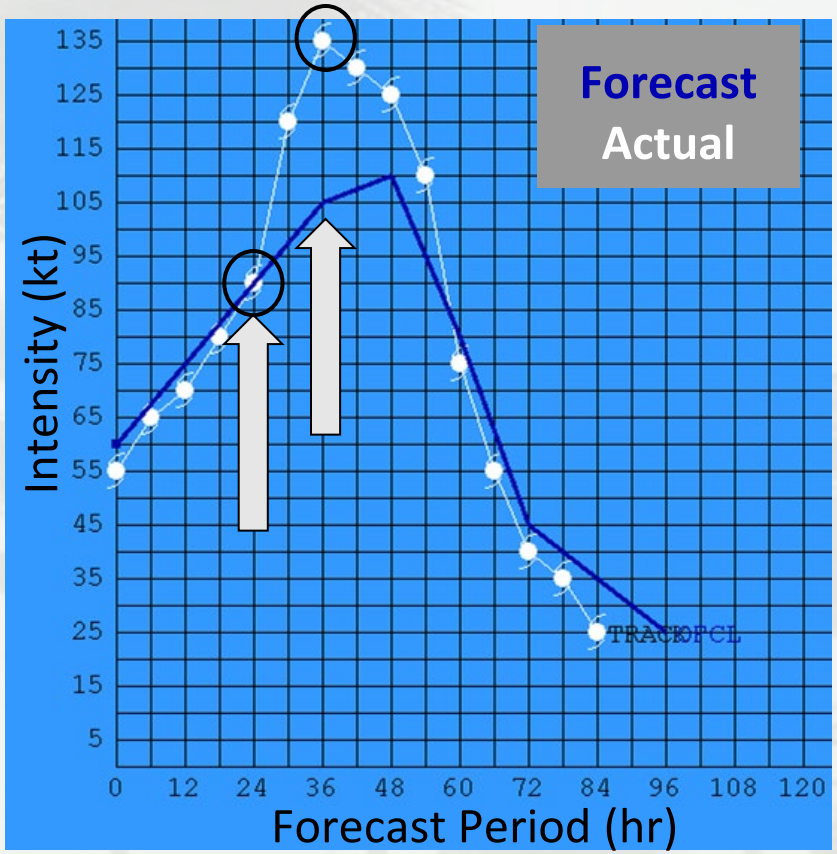
Rapid intensification remains a forecast challenge and often results in very large errors

- 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:	65 mph
24h Forecast:	105 mph
Actual Intensity:	105 mph
24 h Error:	**0 mph**

Initial Intensity:	65 mph
36h Forecast:	120 mph
Actual Intensity:	155 mph
36 h Error:	**35 mph**



HURRICANE CHARLEY

Don't focus on the skinny black line.

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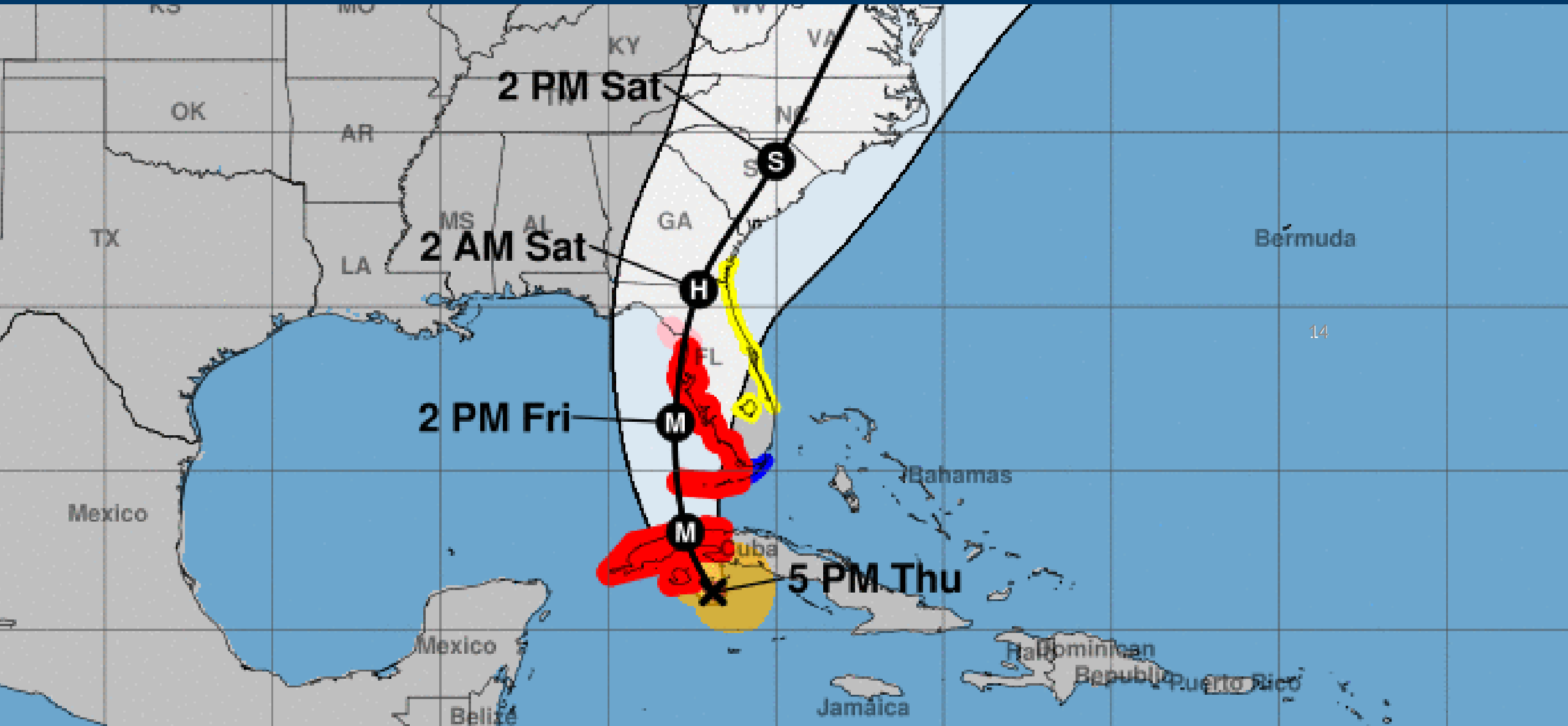

HURRICANE CHARLEY

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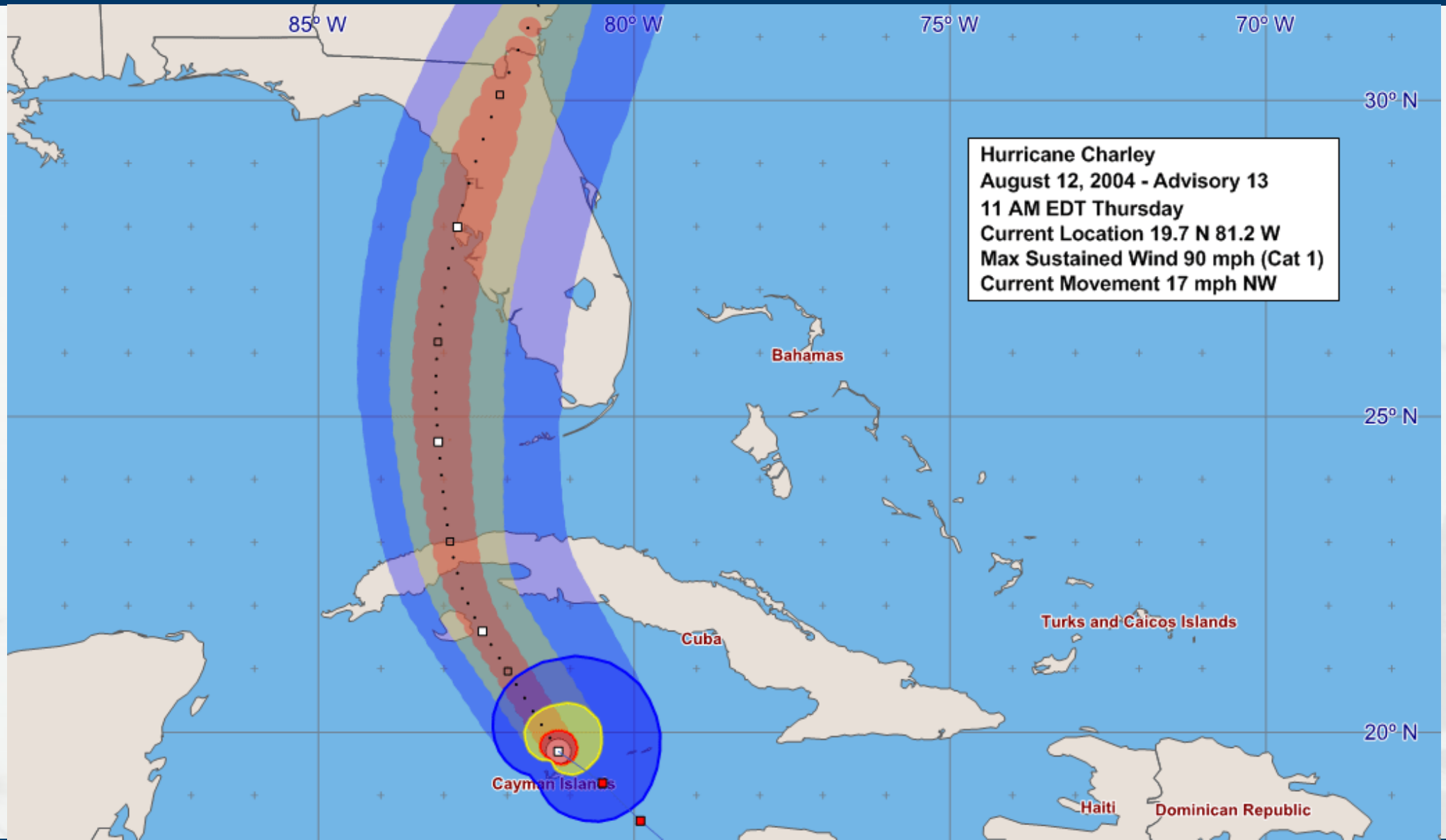

HURRICANE CHARLEY

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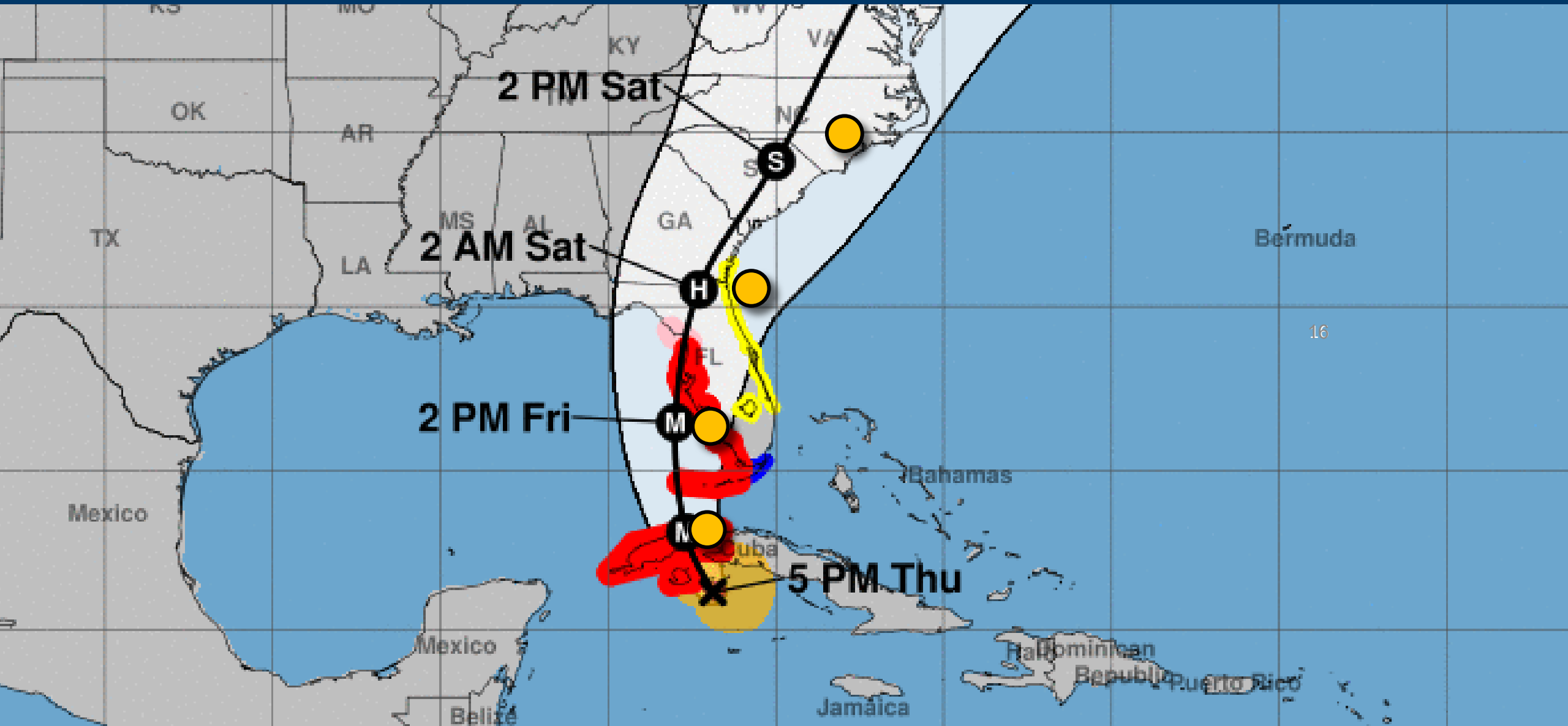

HURRICANE CHARLEY

Would alternate scenarios help?

WIND SPEED PROBABILITIES

How Likely. Arrival Times. Inland Threat.

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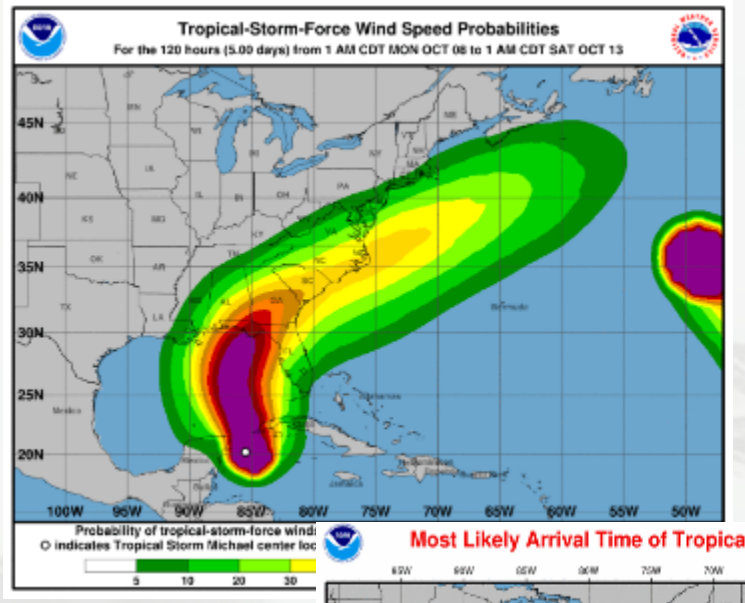
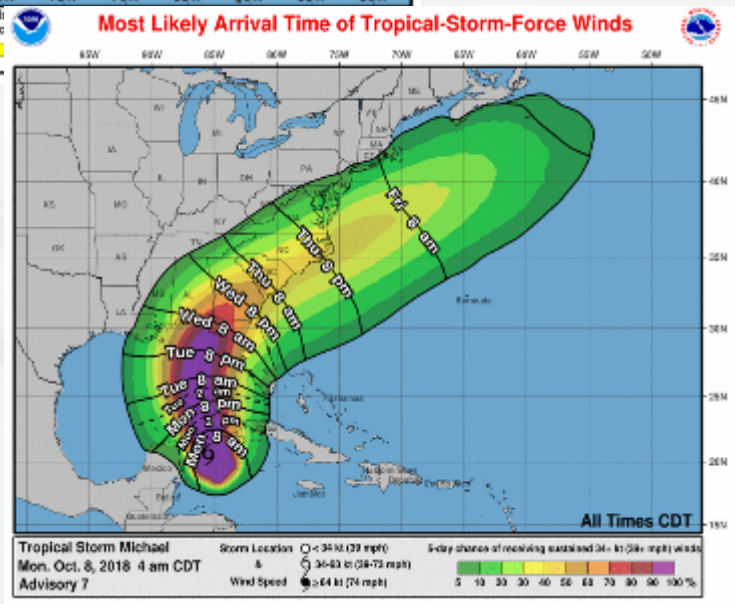
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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)





WIND SPEED PROBABILITIES
Question

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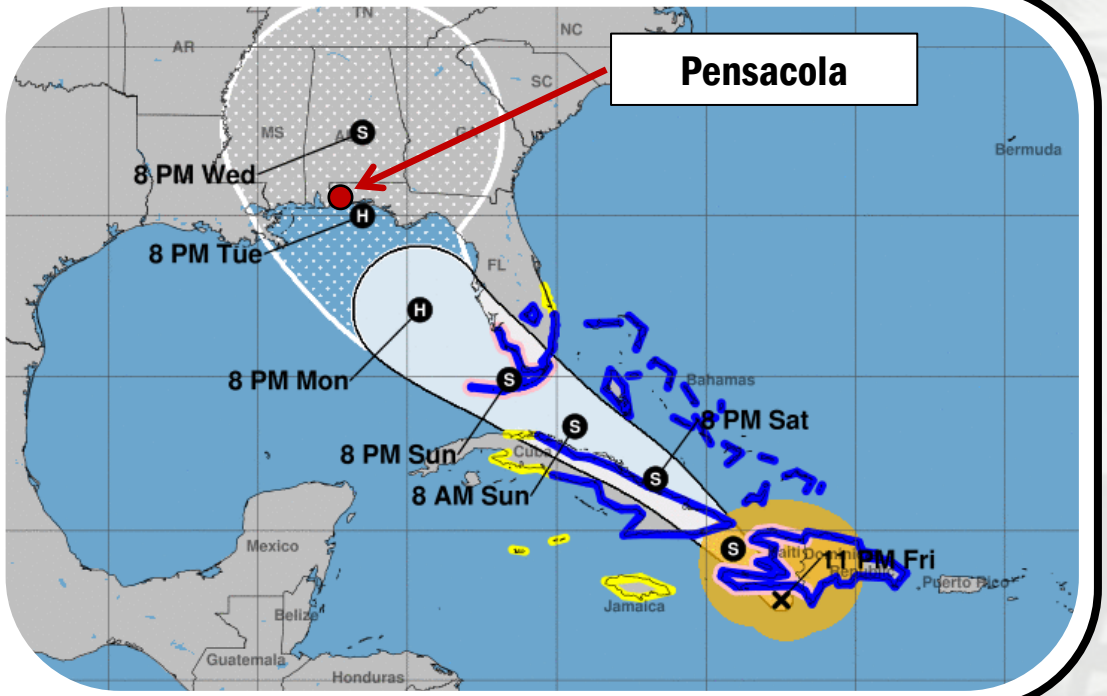
QUESTION

The chance of hurricane force winds occurring at Pensacola during the next 5 days is between_____.

A. 1% to 10%
B. 10% to 20%
C. 20% to 30%
D. 30% to 40%
E. 40% to 50%



WIND SPEED PROBABILITIES
How are they generated?

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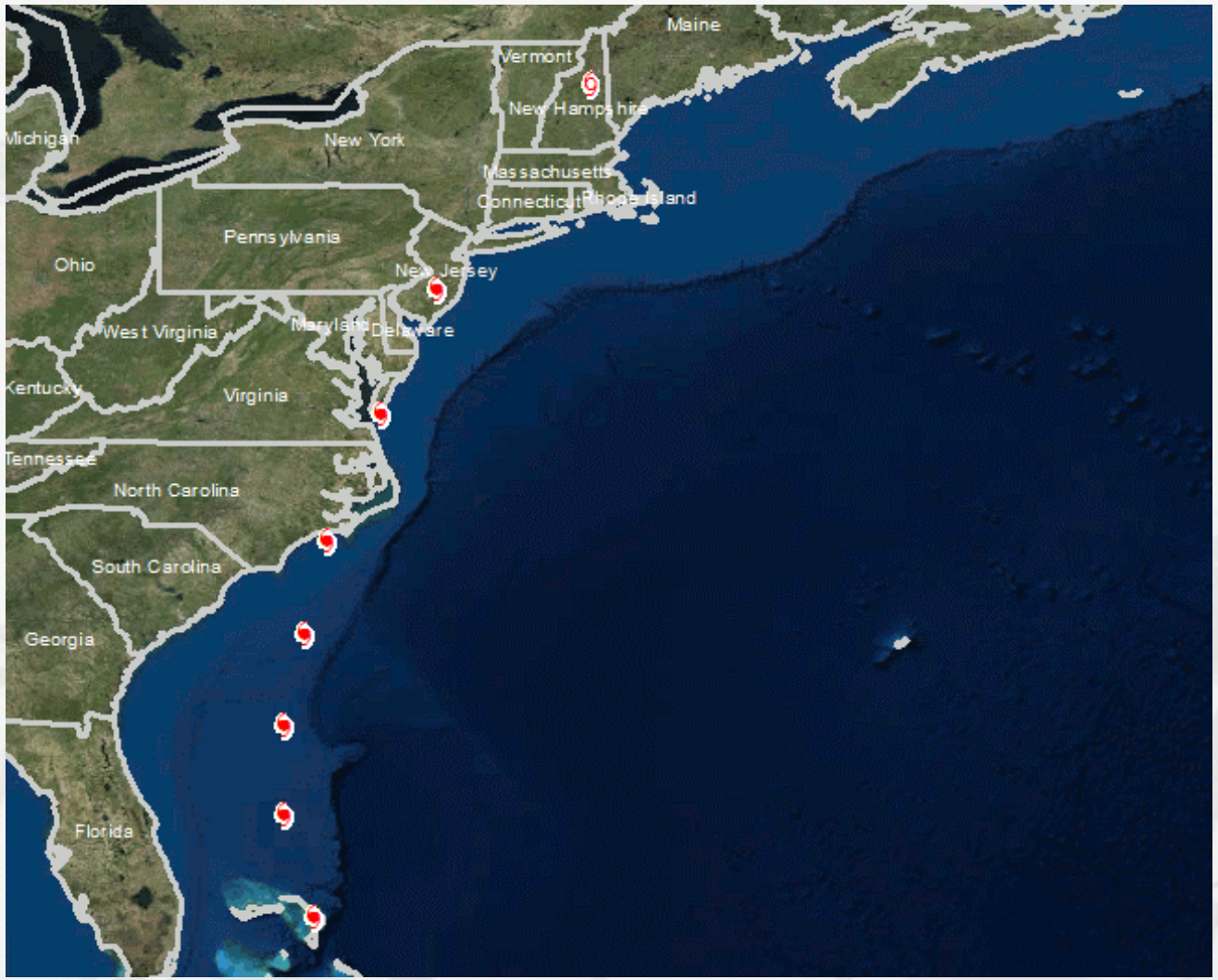
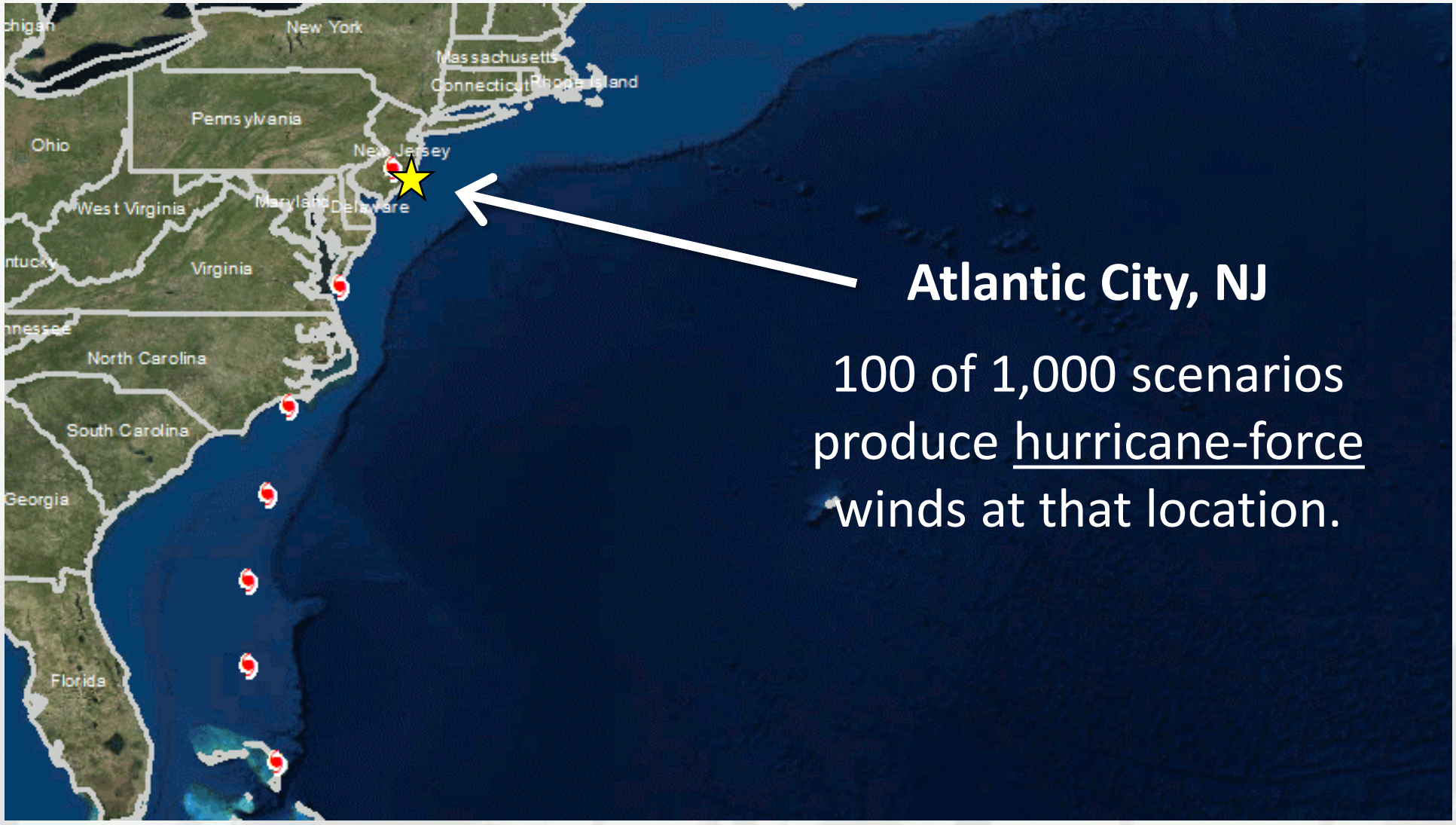
MORE SCENARIOS

- **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?

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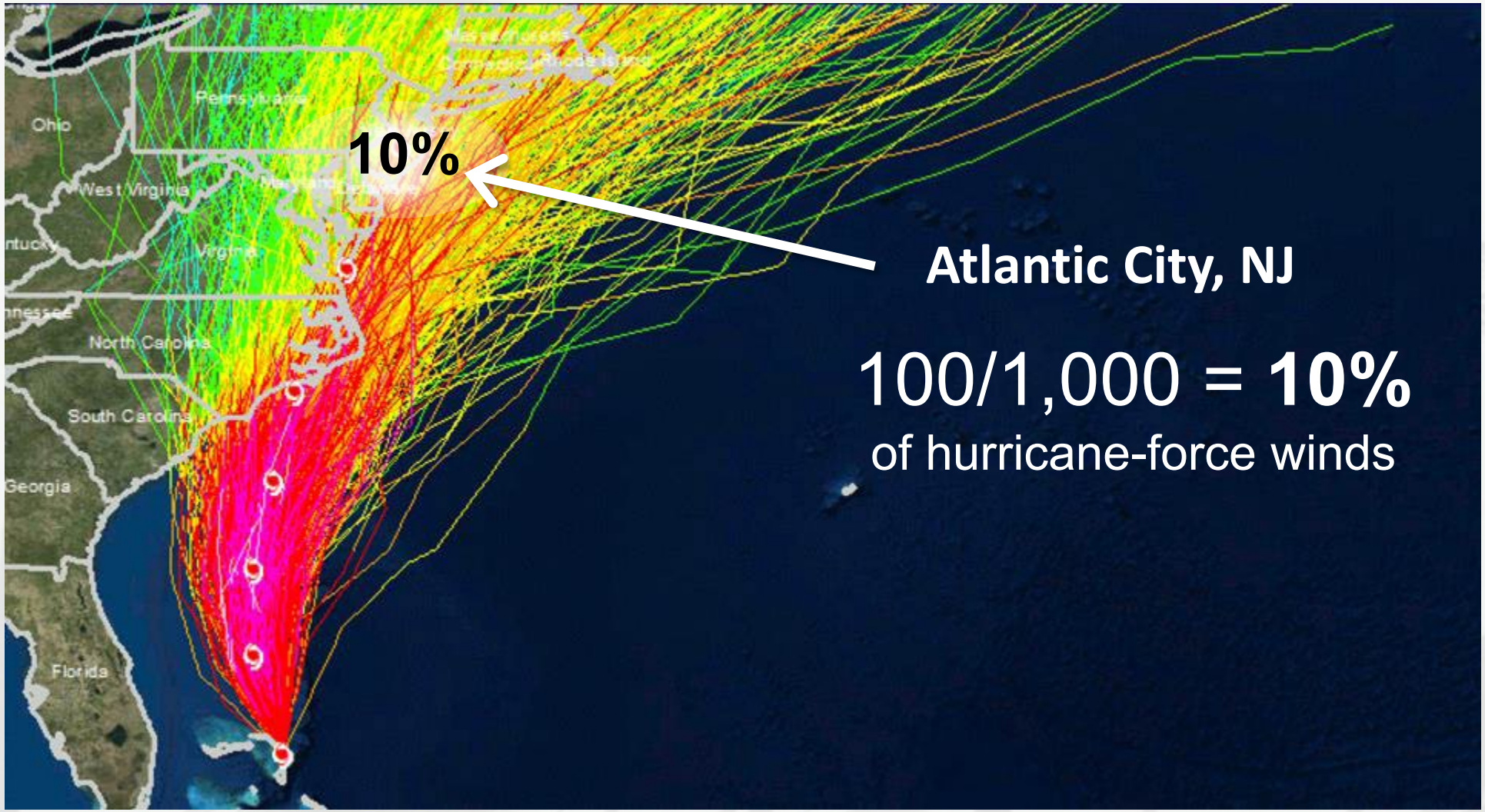

WIND SPEED PROBABILITIES

What does 10% chance mean?

WIND SPEED PROBABILITIES
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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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 - - - -

                FROM     FROM     FROM     FROM     FROM     FROM     FROM
  TIME        06Z MON  18Z MON  06Z TUE  18Z TUE  06Z WED  06Z THU  06Z FRI
PERIODS          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)
```

Location-Specific Probabilities

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

WIND SPEED PROBABILITIES
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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 - - - -

                FROM     FROM     FROM     FROM     FROM     FROM     FROM
  TIME        06Z MON  18Z MON  06Z TUE  18Z TUE  06Z WED  06Z THU  06Z FRI
PERIODS          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)
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WIND SPEED PROBABILITIES
Text Product

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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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 - - - -

                FROM     FROM     FROM     FROM     FROM     FROM     FROM
  TIME        06Z MON  18Z MON  06Z TUE  18Z TUE  06Z WED  06Z THU  06Z FRI
PERIODS          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)
```

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- 58 mph
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WIND SPEED PROBABILITIES
Text Product

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TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER 7
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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)
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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
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NWS NATIONAL HURRICANE CENTER MIAMI FL AL142018
0900 UTC MON OCT 08 2018

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FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION KT							
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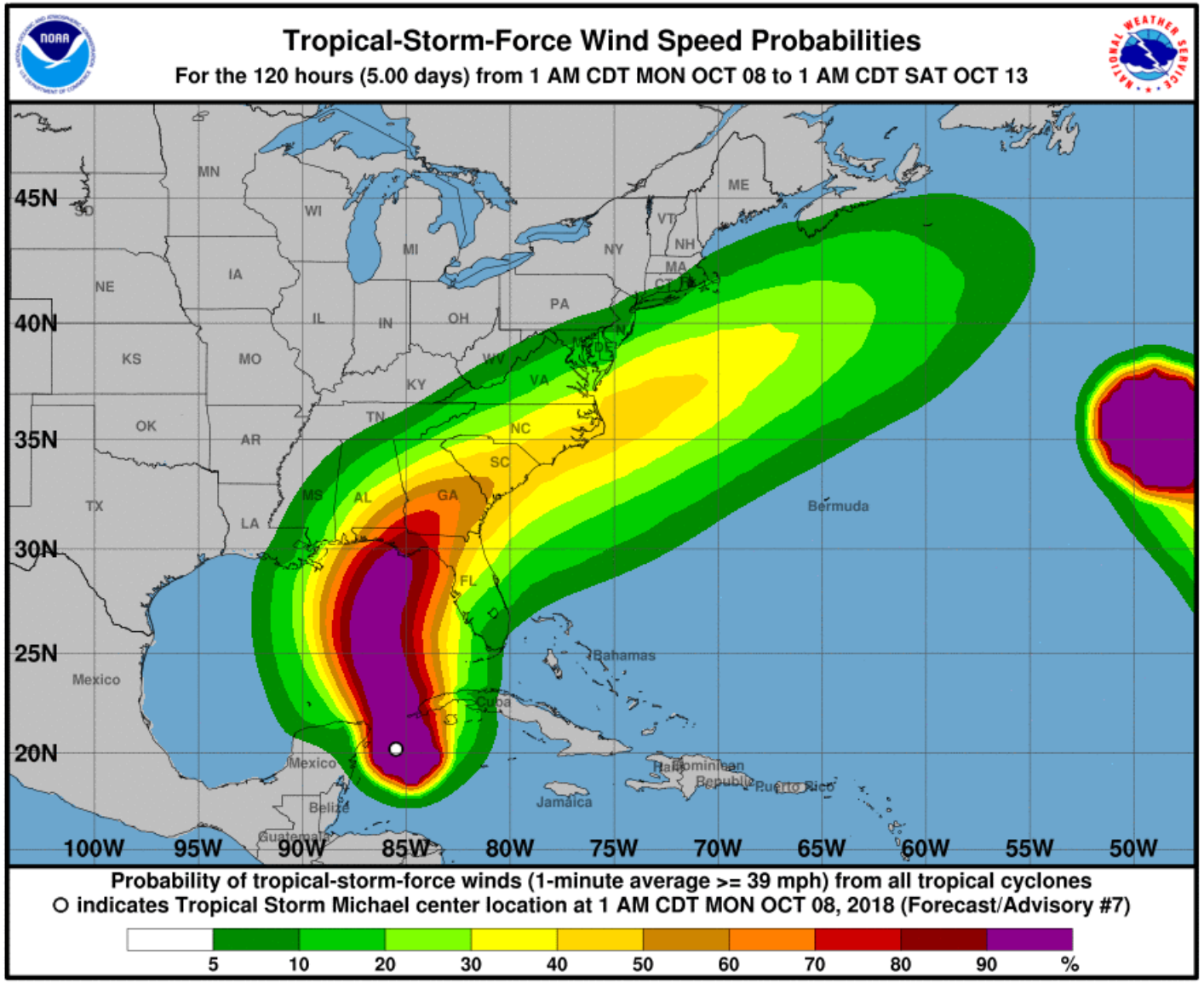
TALLAHASSEE FL 50	X	X(X)	X(X)	1(1)	41(42)	6(48)	X(48)
TALLAHASSEE FL 64	X	X(X)	X(X)	X(X)	20(20)	4(24)	X(24)
APALACHICOLA 34	X	X(X)	5(5)	29(34)	57(91)	1(92)	X(92)
APALACHICOLA 50	X	X(X)	X(X)	6(6)	59(65)	2(67)	X(67)
APALACHICOLA 64	X	X(X)	X(X)	1(1)	39(40)	1(41)	X(41)
PANAMA CITY FL 34	X	X(X)	4(4)	26(30)	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



Location-Specific Probabilities

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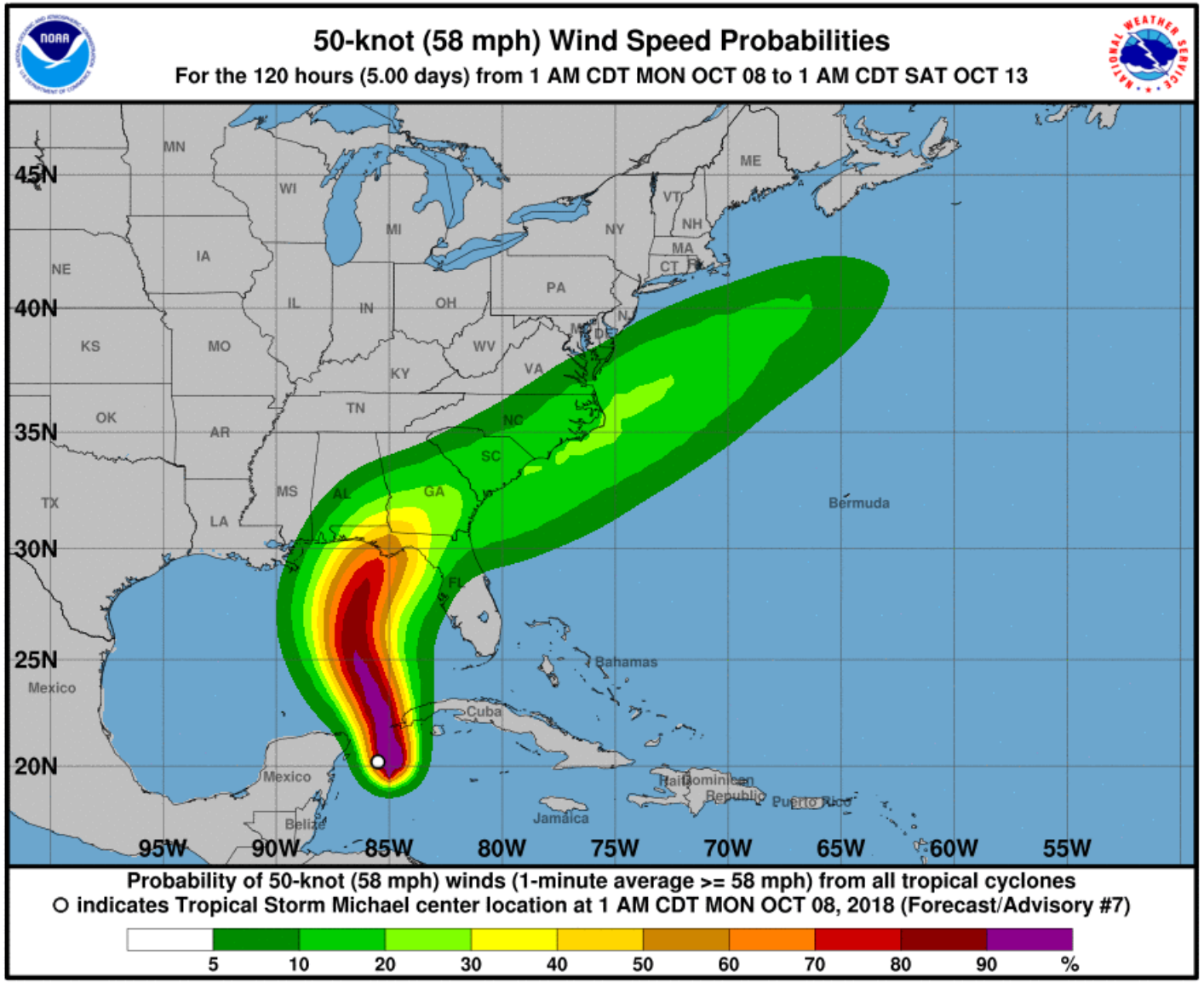
WIND SPEED PROBABILITIES
5-Day Cumulative Graphic



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WIND SPEED PROBABILITIES
5-Day Cumulative Graphic

Location-Specific Probabilities

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WIND SPEED PROBABILITIES
5-Day Cumulative Graphic

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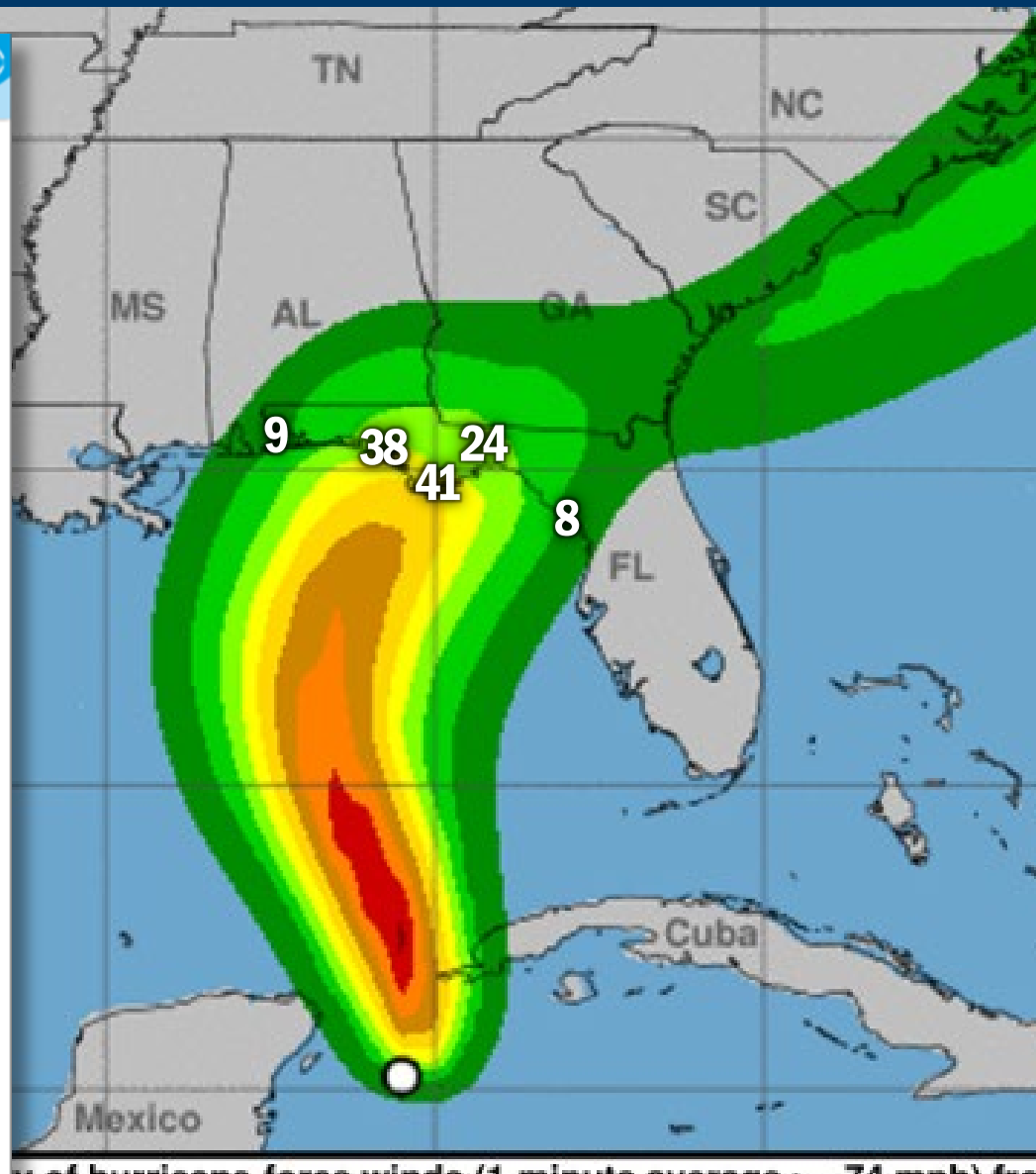
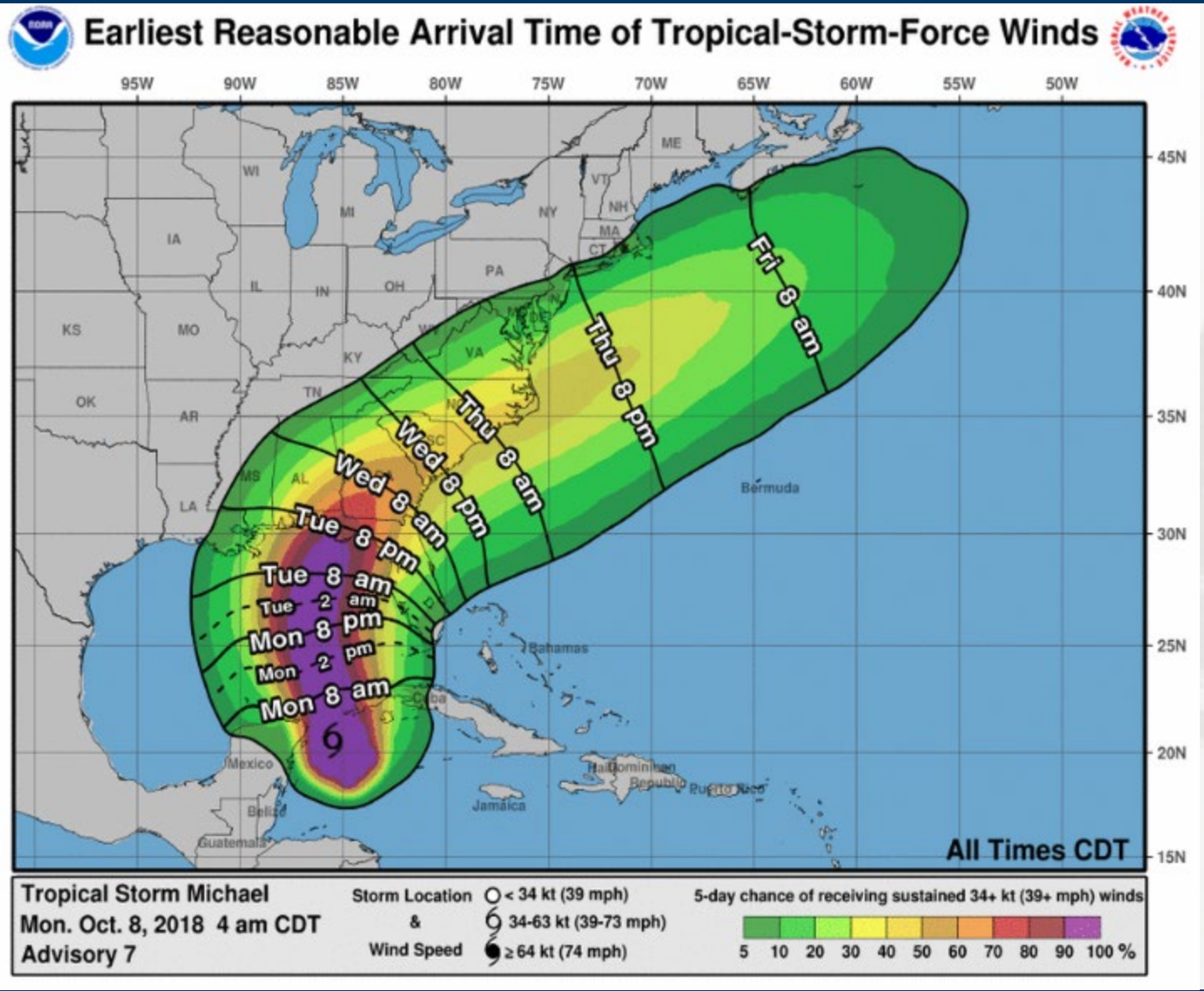
NATIONAL HURRICANE CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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)



WIND SPEED PROBABILITIES
Time of Arrival of TS Winds

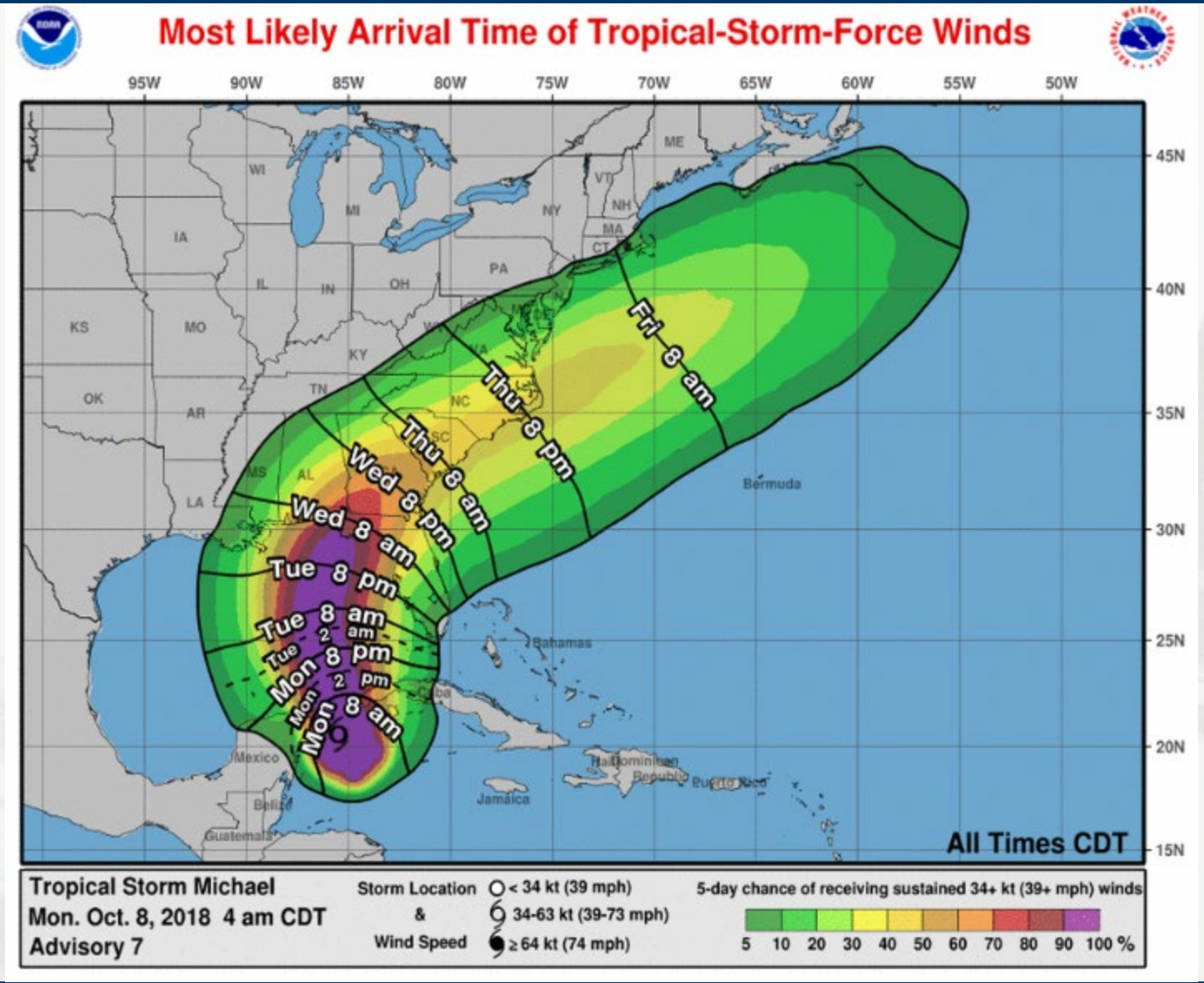
FEMA



Time of Arrival of TS Winds

- Earliest Reasonable
- Most Likely

WIND SPEED PROBABILITIES
Time of Arrival of TS Winds



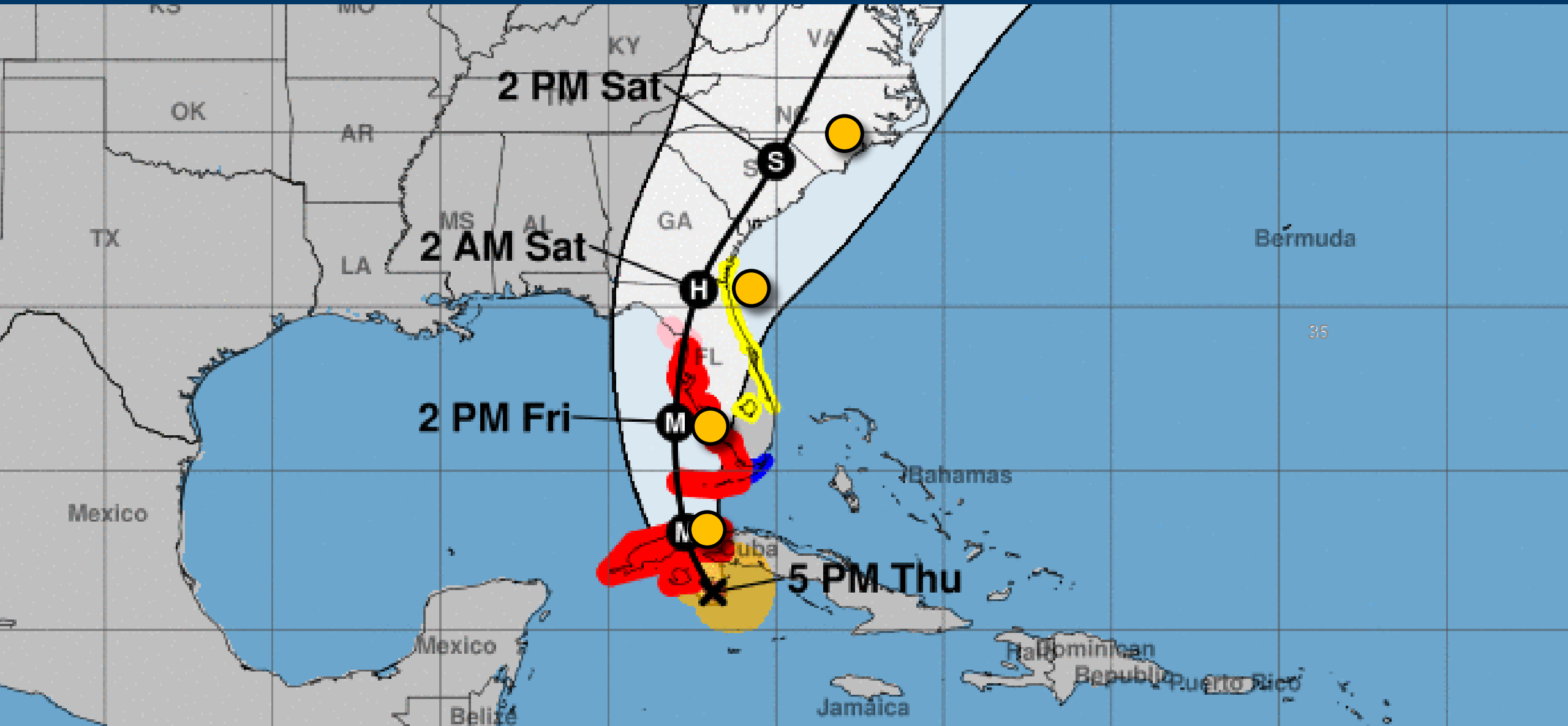
Time of Arrival of TS Winds

- Earliest Reasonable
- Most Likely

HURRICANE CHARLEY

Don't focus on the skinny black line.

FEMA



HURRICANE CHARLEY

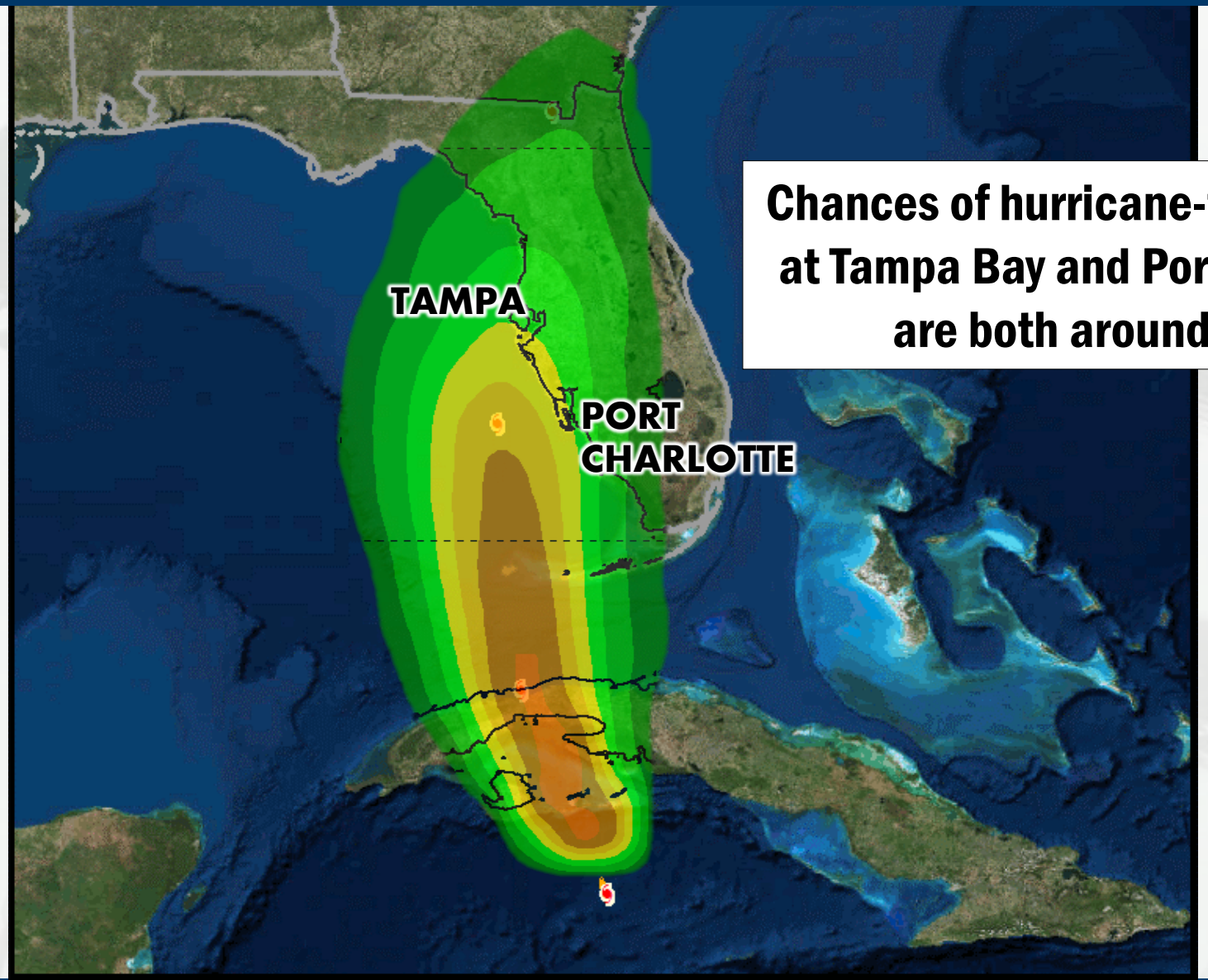
Would alternate scenarios help?

FEMA

HURRICANE CHARLEY

Would alternate scenarios help?

FEMA



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

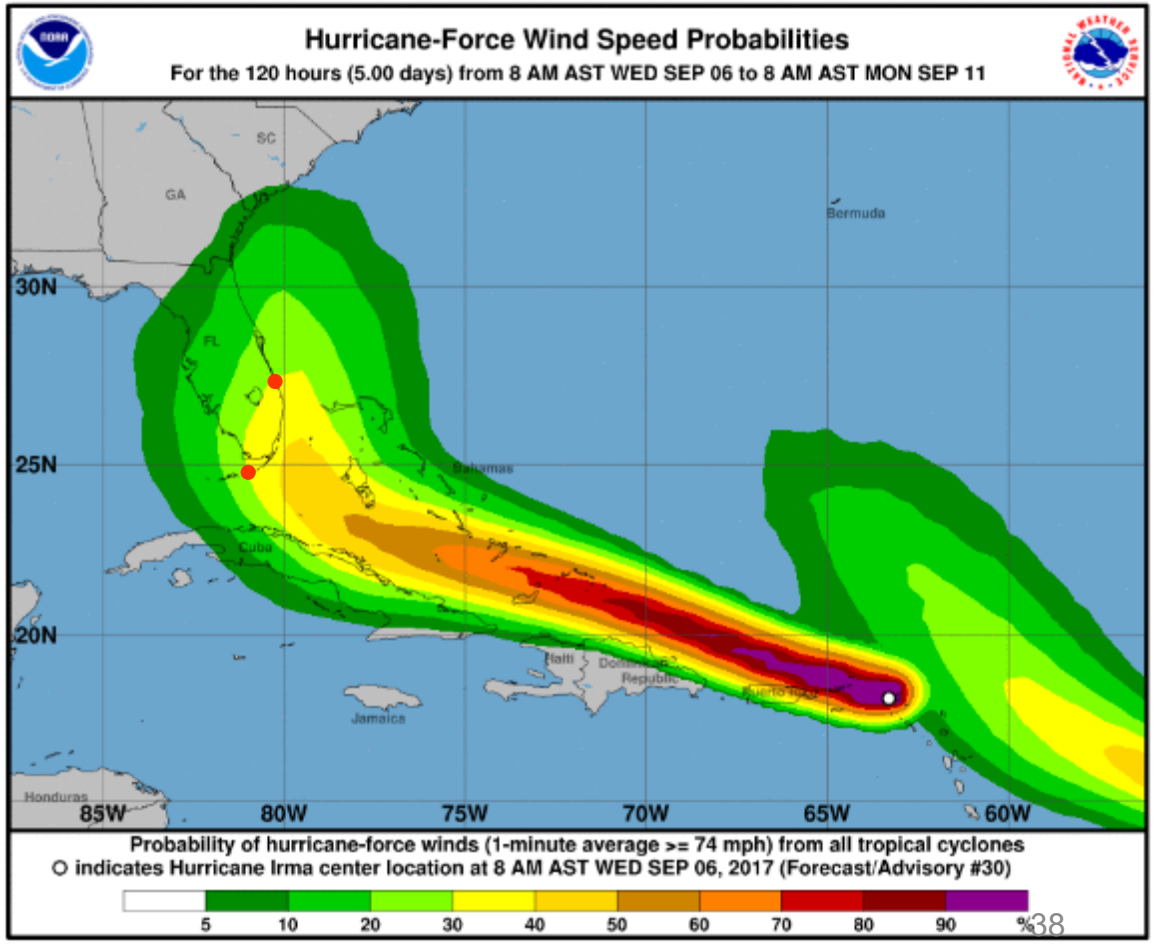
WIND SPEED PROBABILITIES
A Tool to Deal with Uncertainty

FEMA

HURRICANE IRMA

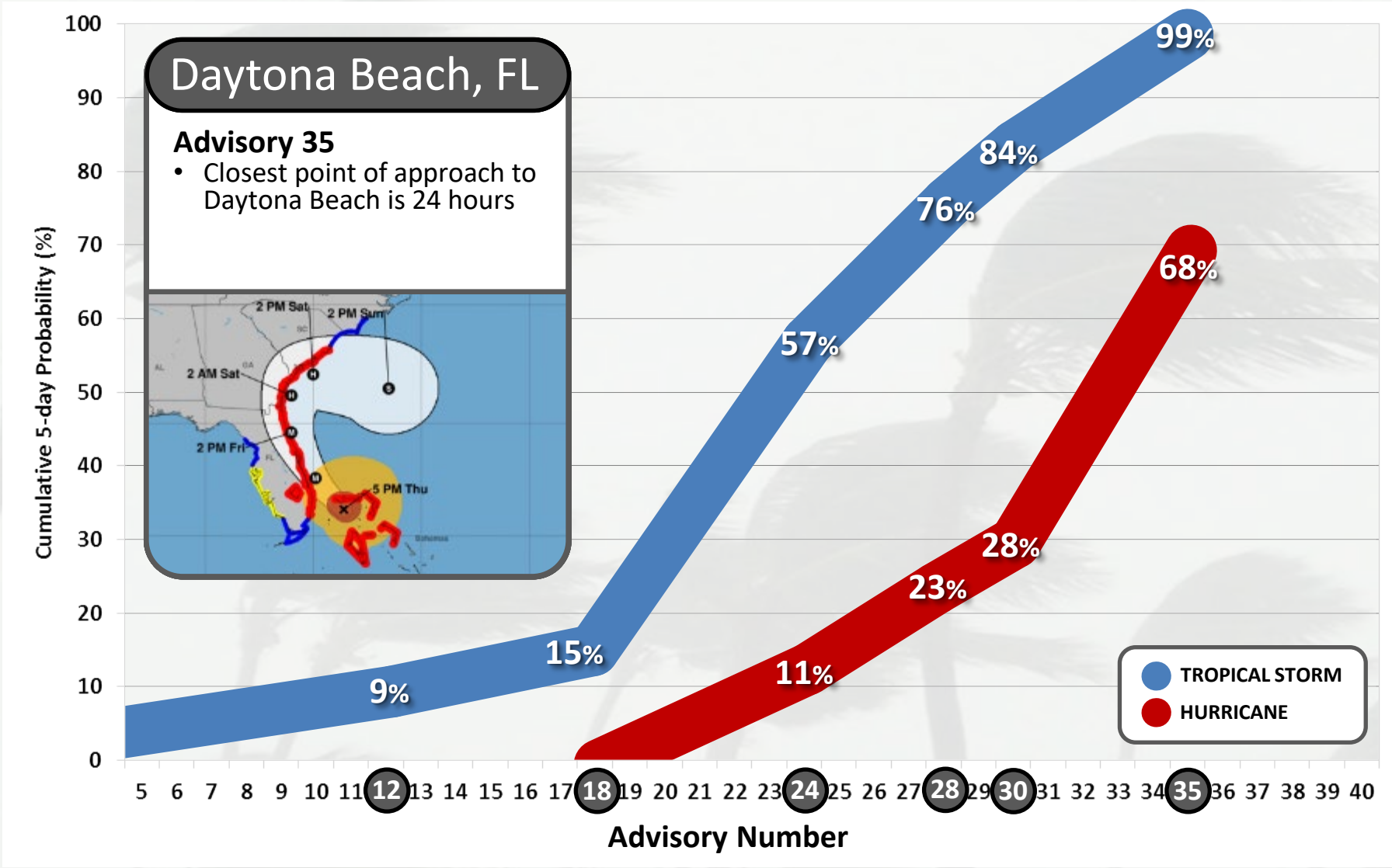
- **Advisory 30 – 11am EDT**
  - 6 September 2017

- **4-day position error 'only' ~100 miles**
  - Equal chances of hurricane-force winds at Marathon and Fort Pierce



WIND SPEED PROBABILITIES
Hurricane Matthew (2016)

FEMA



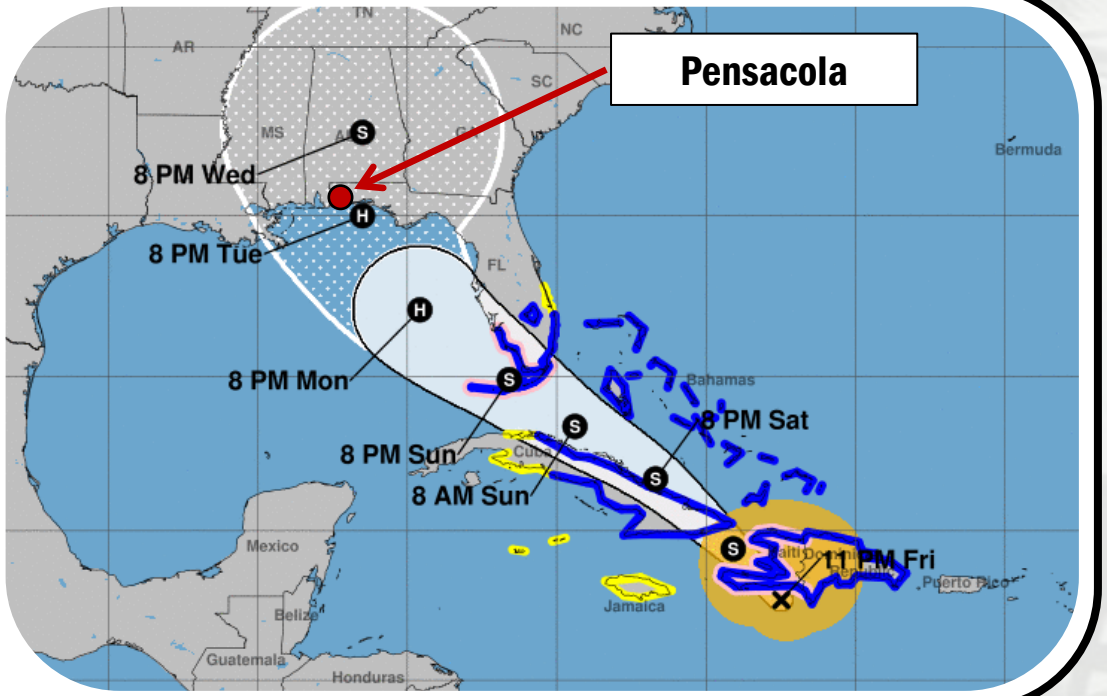
WIND SPEED PROBABILITIES
Question

FEMA

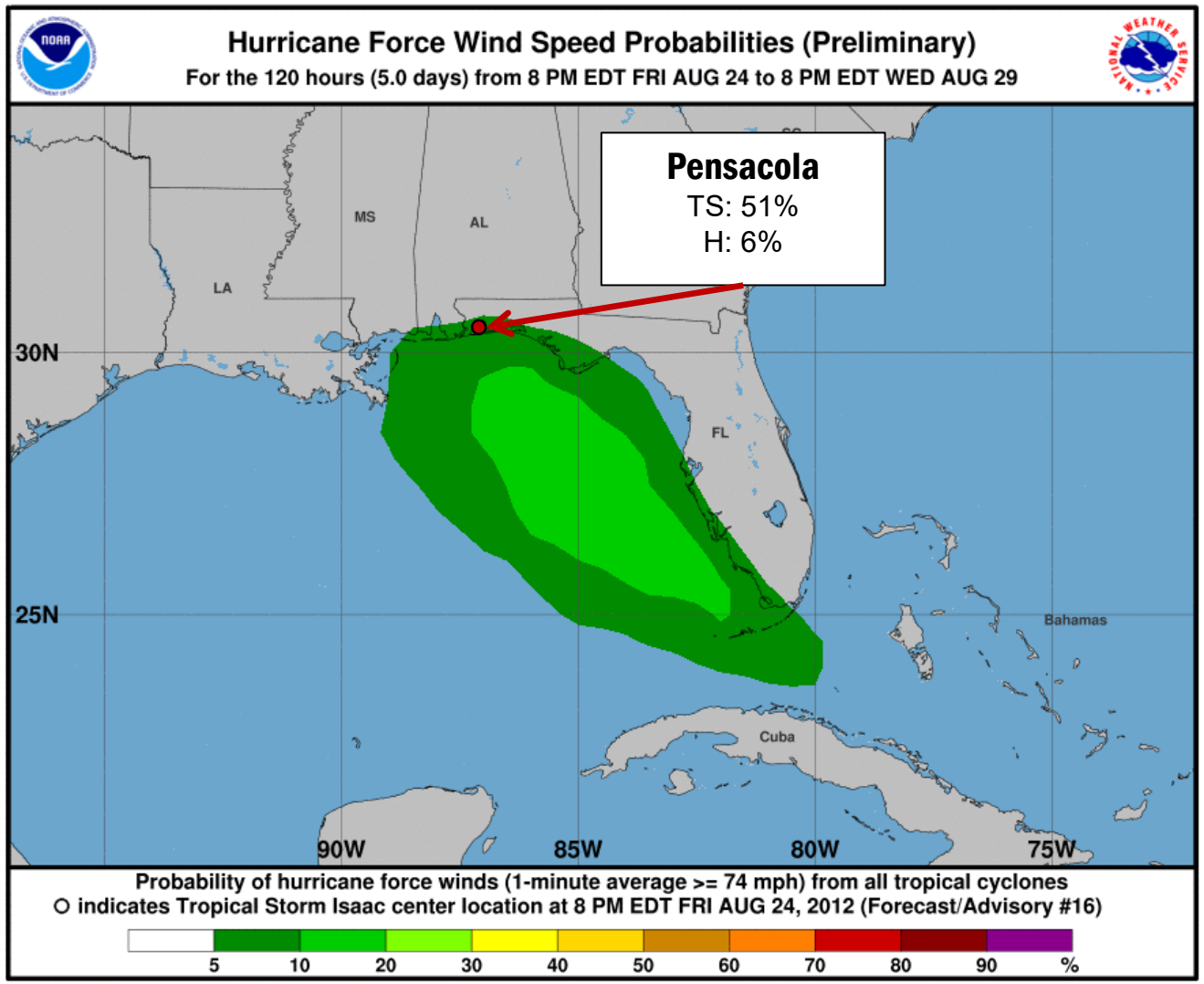
QUESTION

The chance of hurricane force winds occurring at Pensacola during the next 5 days is between_____.

A. 1% to 10%
B. 10% to 20%
C. 20% to 30%
D. 30% to 40%
E. 40% to 50%

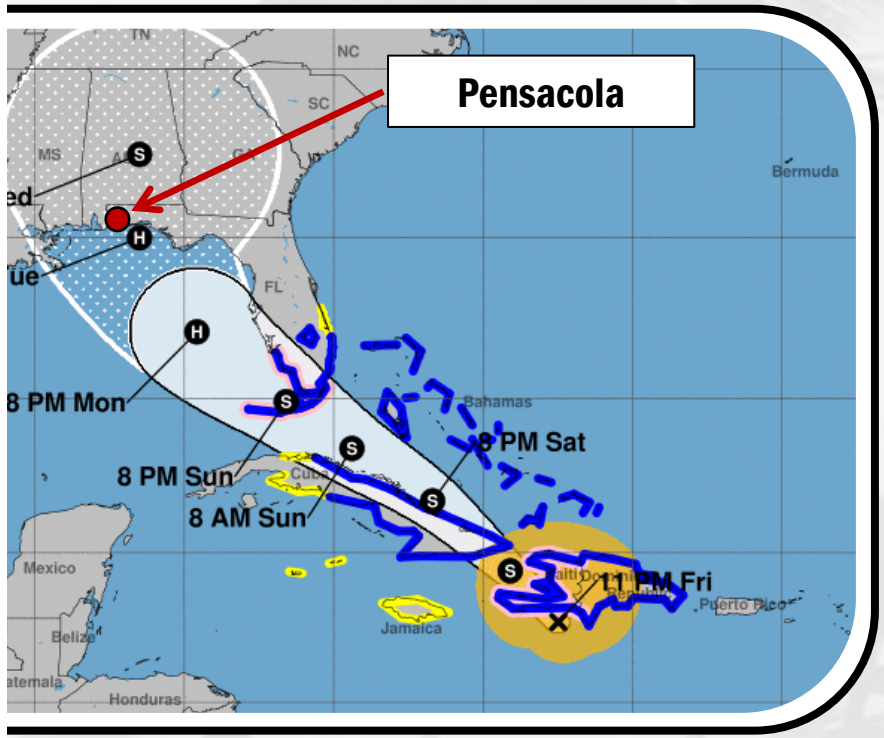


WIND SPEED PROBABILITIES
Question



ds occurring at Pensacola

_____.



WIND TIMING UNCERTAINTY
Importance and Causes

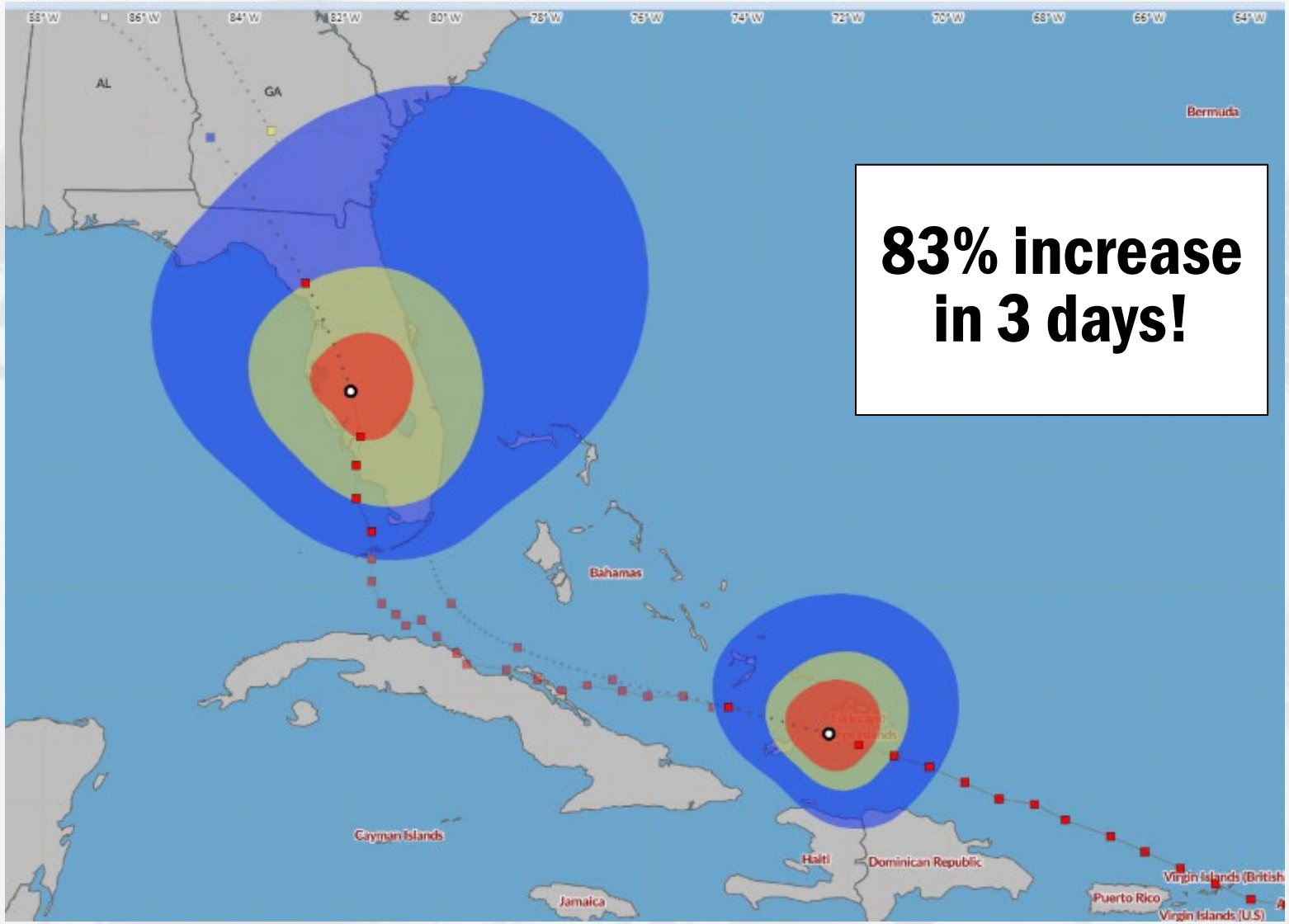
FEMA

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

FEMA

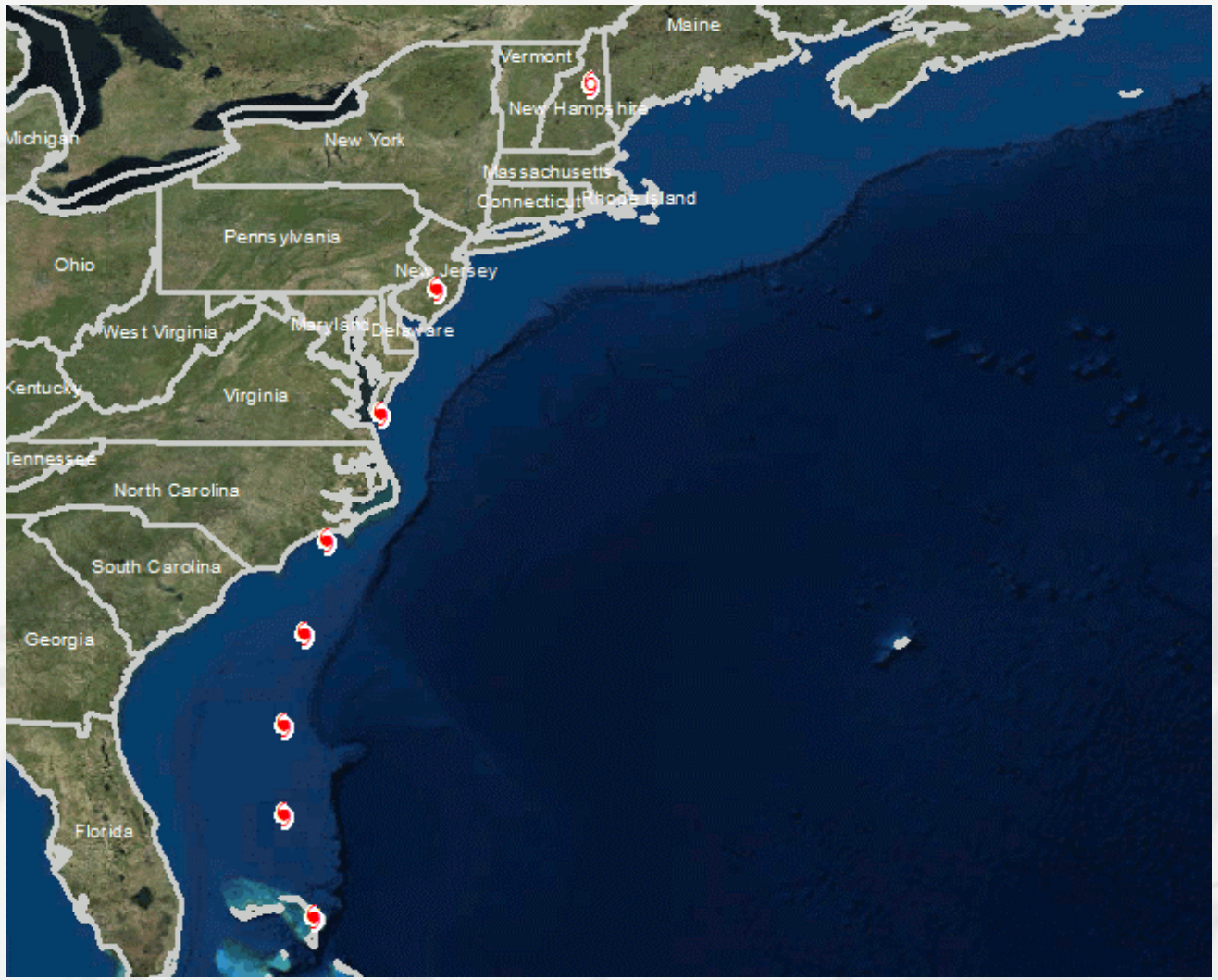


TIME OF ARRIVAL GRAPHIC
How are they generated?

FEMA

MORE SCENARIOS

- **1,000 realistic alternative scenarios are generated**
  - Official NHC forecast and historical errors
  - Weakening over land
  - Track model spread
- **Produce information about:**
  - Chance of wind occurring
  - Probabilistic onset timing



TIME OF ARRIVAL GRAPHIC
Earliest Reasonable Onset of TS Winds

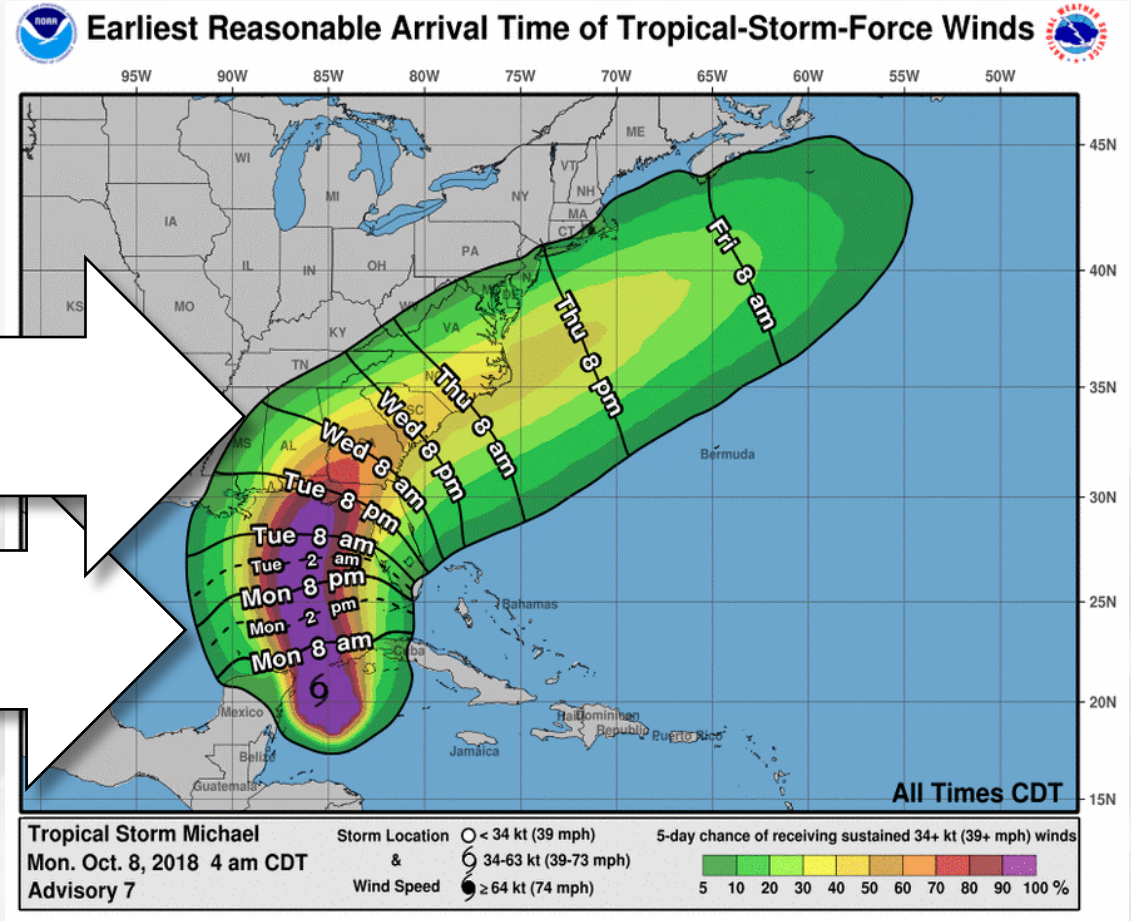
FEMA

EARLIEST REASONABLE

- **10% chance of onset**
  - Most conservative timing

- **Arrival time of TS winds**
  - Black contours

- **5-day cumulative TS probabilities**
  - Color fill



TIME OF ARRIVAL GRAPHIC
Most Likely Onset of TS Winds

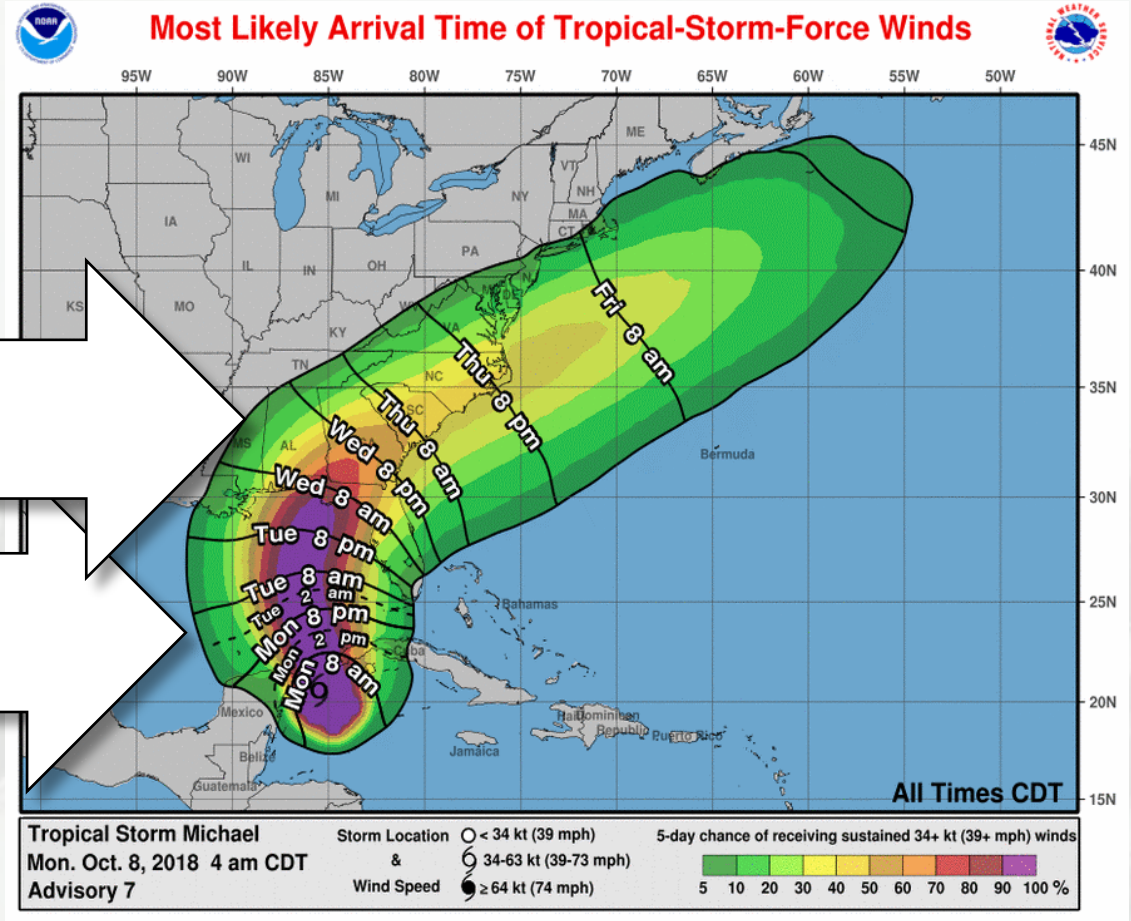
FEMA

MOST LIKELY

- **50% chance of onset**
  - Equally likely to occur before as after

- **Arrival time of TS winds**
  - Black contours

- **5-day cumulative TS probabilities**
  - Color fill



TIME OF ARRIVAL – TRAVEL DIRECTIONS

National Hurricane Center -> South Beach

FEMA

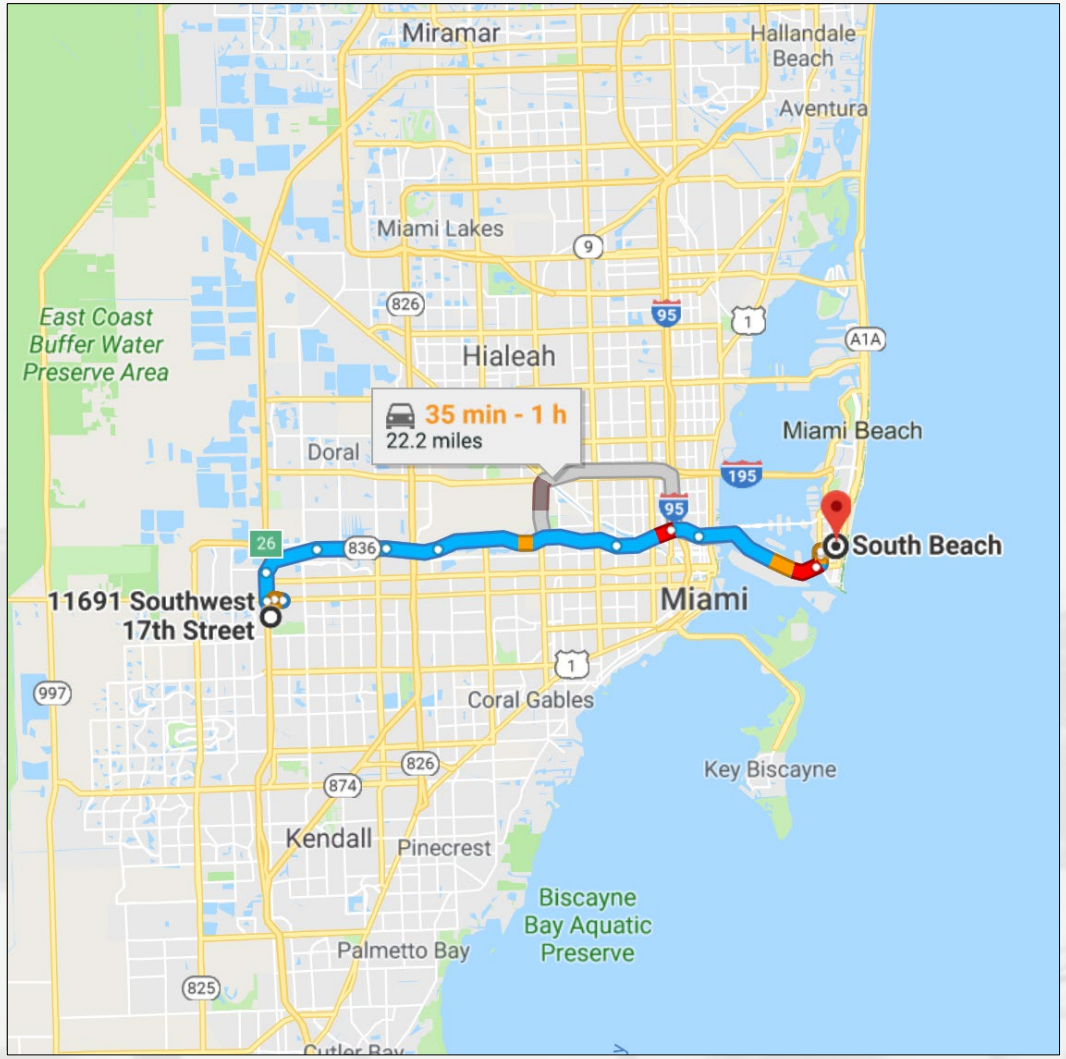
TIMING UNCERTAINTY

- **Earliest Reasonable**
  - Absolutely must be there by 5pm;
  - Leave by 4:10pm (50 min)

- **Most Likely**
  - Some wiggle room
  - Can afford to be a little late if traffic
  - Leave by 4:34pm (26 min)

Window to leave: 24 min

4:10pm – 4:34pm



TIME OF ARRIVAL GRAPHIC
Hurricane Michael #7 – Tallahassee, FL

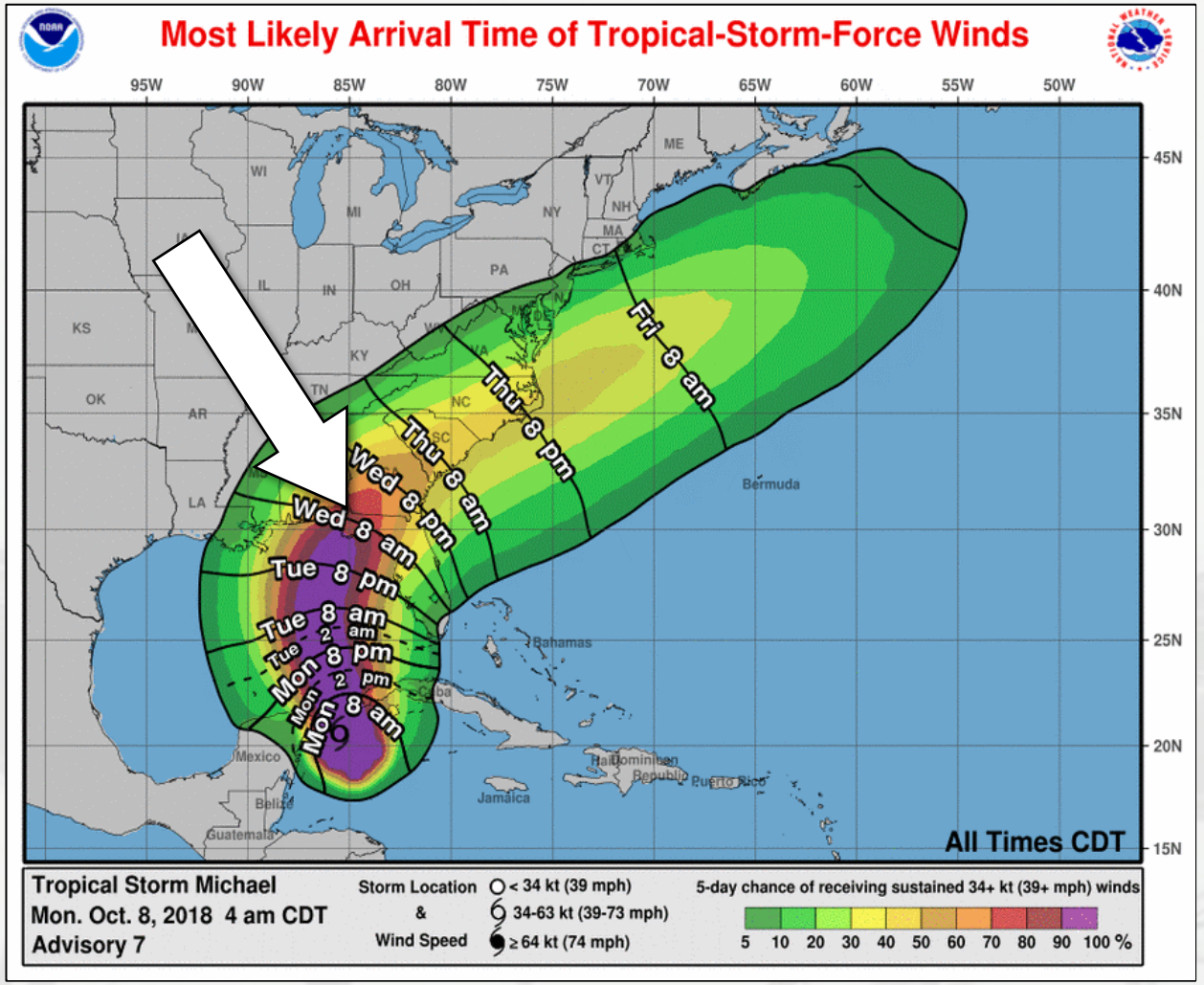
FEMA

TIMING UNCERTAINTY

- **Earliest Reasonable**
  - 10% chance of onset
  - Most conservative timing
  - Tuesday 8pm

- **Most Likely**
  - 50% chance of onset
  - Equally likely before as after
  - Wednesday 8am

Range of wind arrival: 12 h
Tue 8pm – Wed 8am



WIND TIMING UNCERTAINTY
Earliest Reasonable, Most-likely, Deterministic

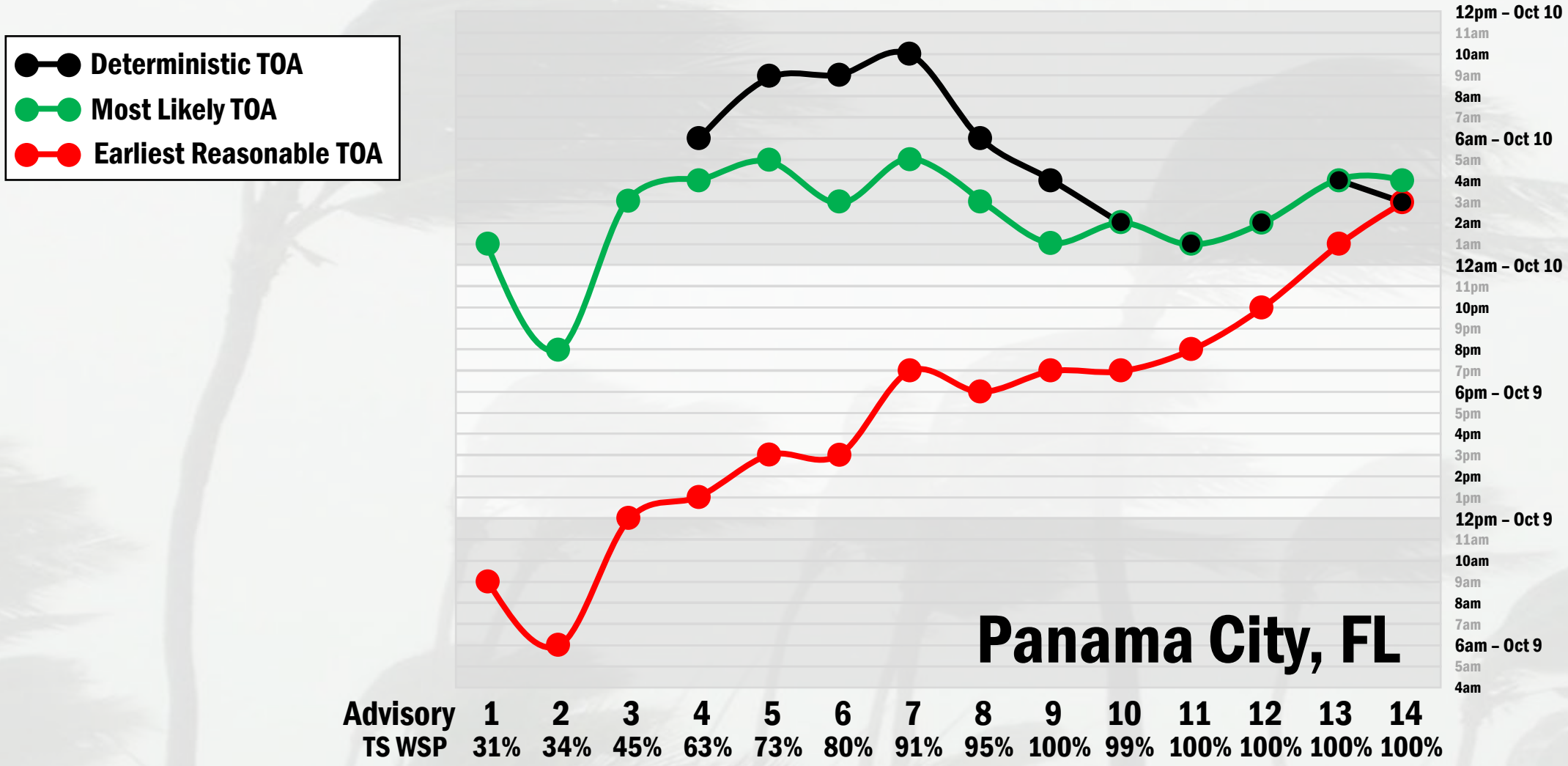
FEMA

KEY POINTS

- The earliest reasonable and most-likely times account for track, intensity, and size uncertainty; deterministic time does not
- The range between TOA products could initially be large but slowly converges within a day or so of the event
- **TOA Product Limitations**
  - Unusually large or small storms may not be handled well, especially beyond the first 24-36 hours.
  - Storms that stall or move slowly (<5mph) can have much earlier onset times than what is conveyed in the official forecast

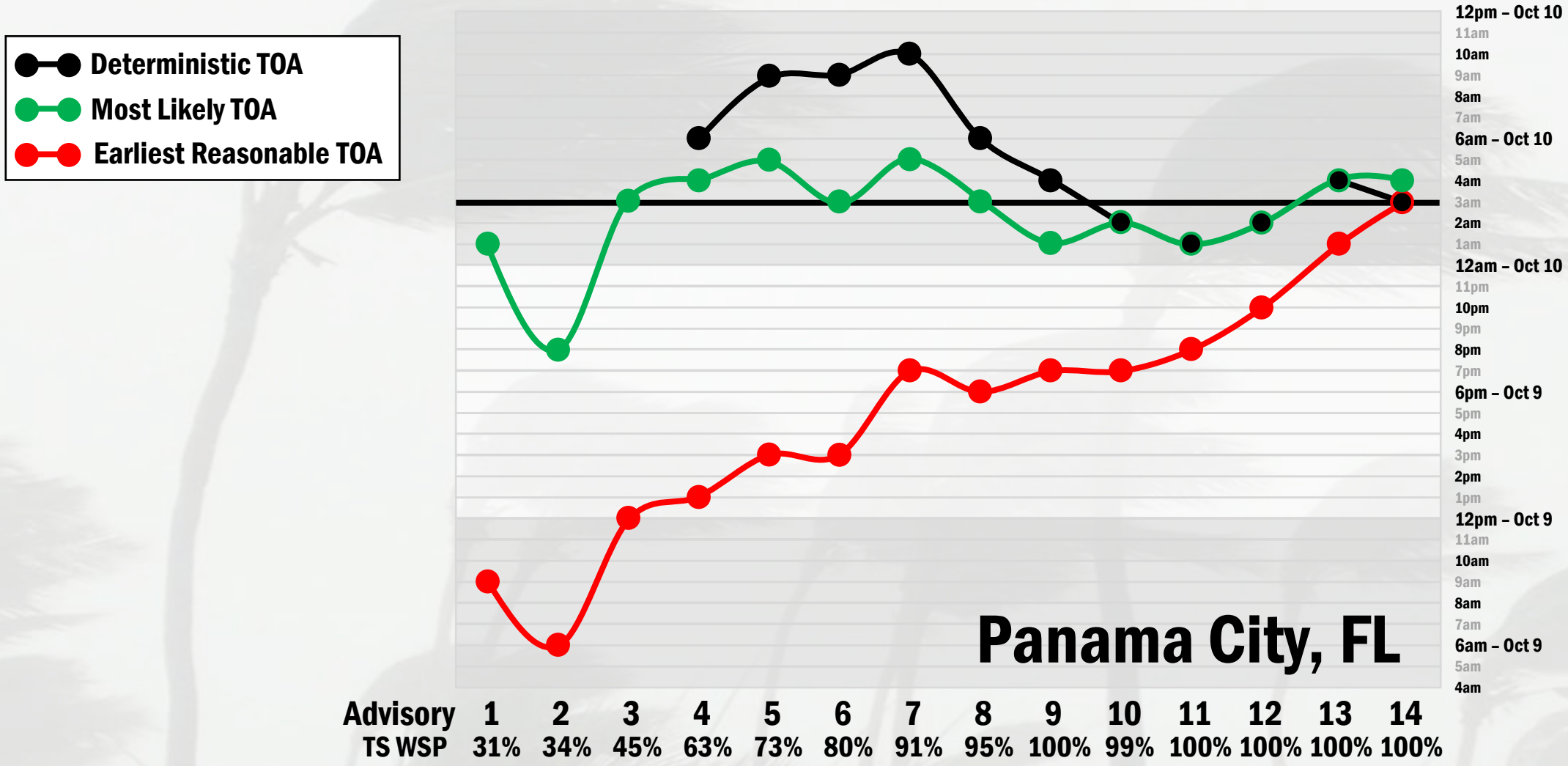
TIME OF ARRIVAL OF TS WINDS
Hurricane Michael (2018)

FEMA



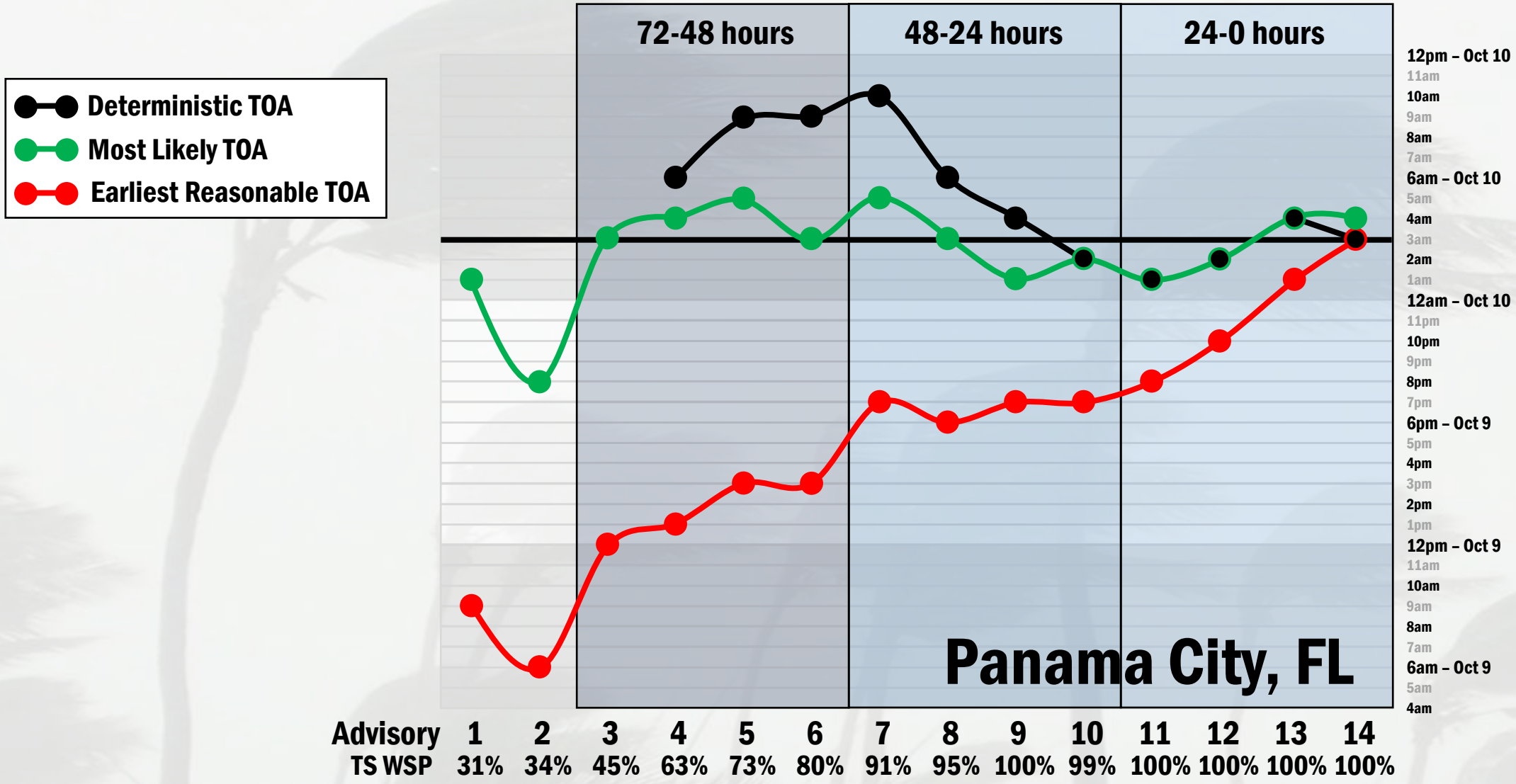
TIME OF ARRIVAL OF TS WINDS
Hurricane Michael (2018)

FEMA



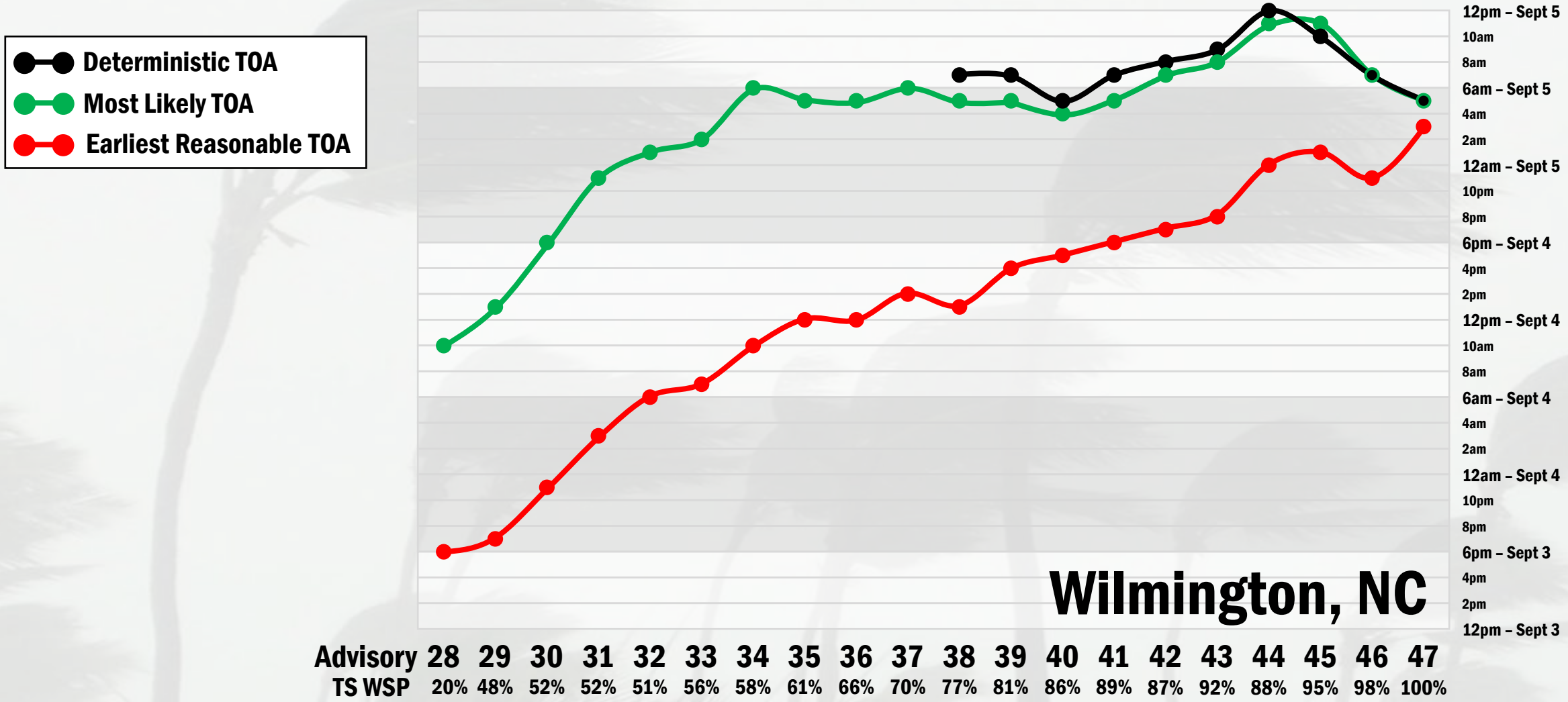
TIME OF ARRIVAL OF TS WINDS
Hurricane Michael (2018)

FEMA



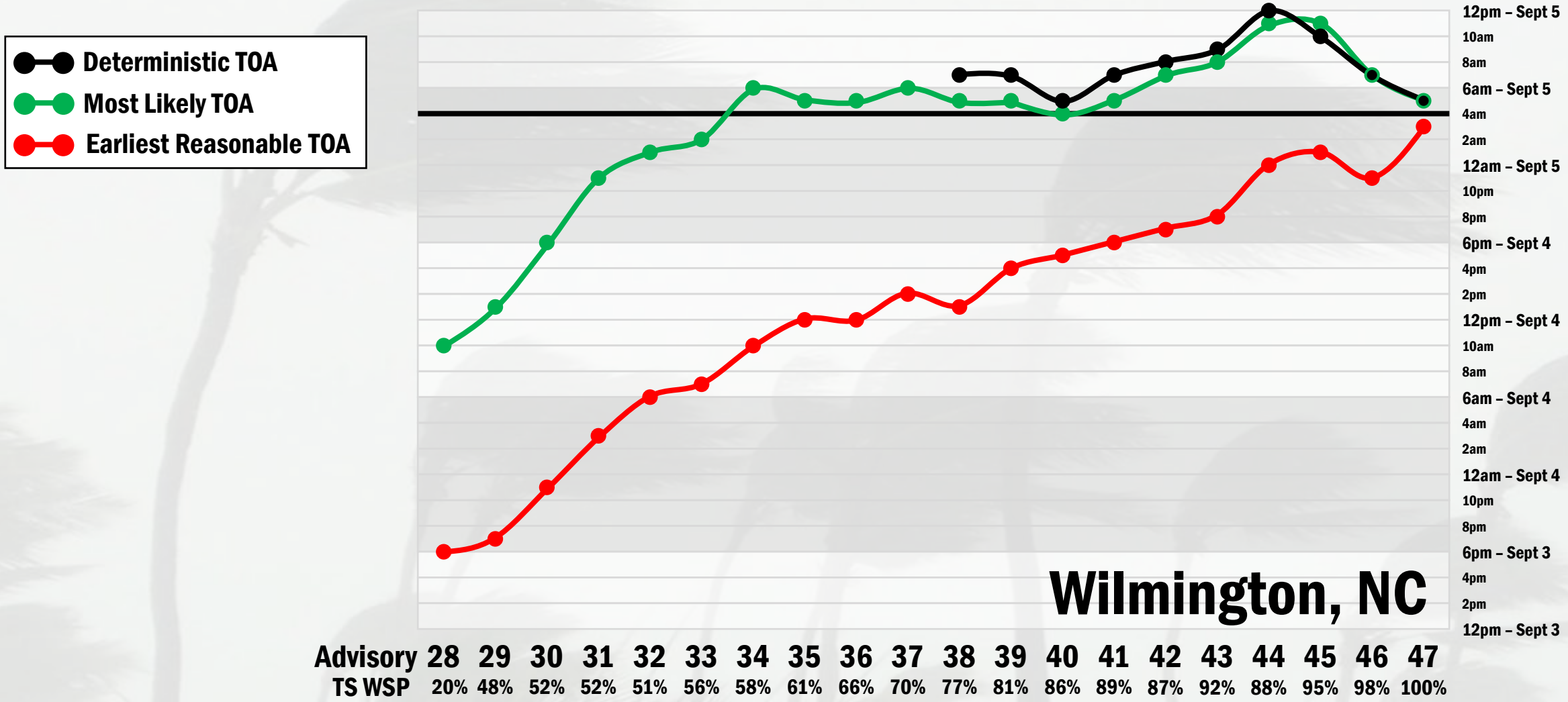
TIME OF ARRIVAL OF TS WINDS
Hurricane Dorian (2019)

FEMA



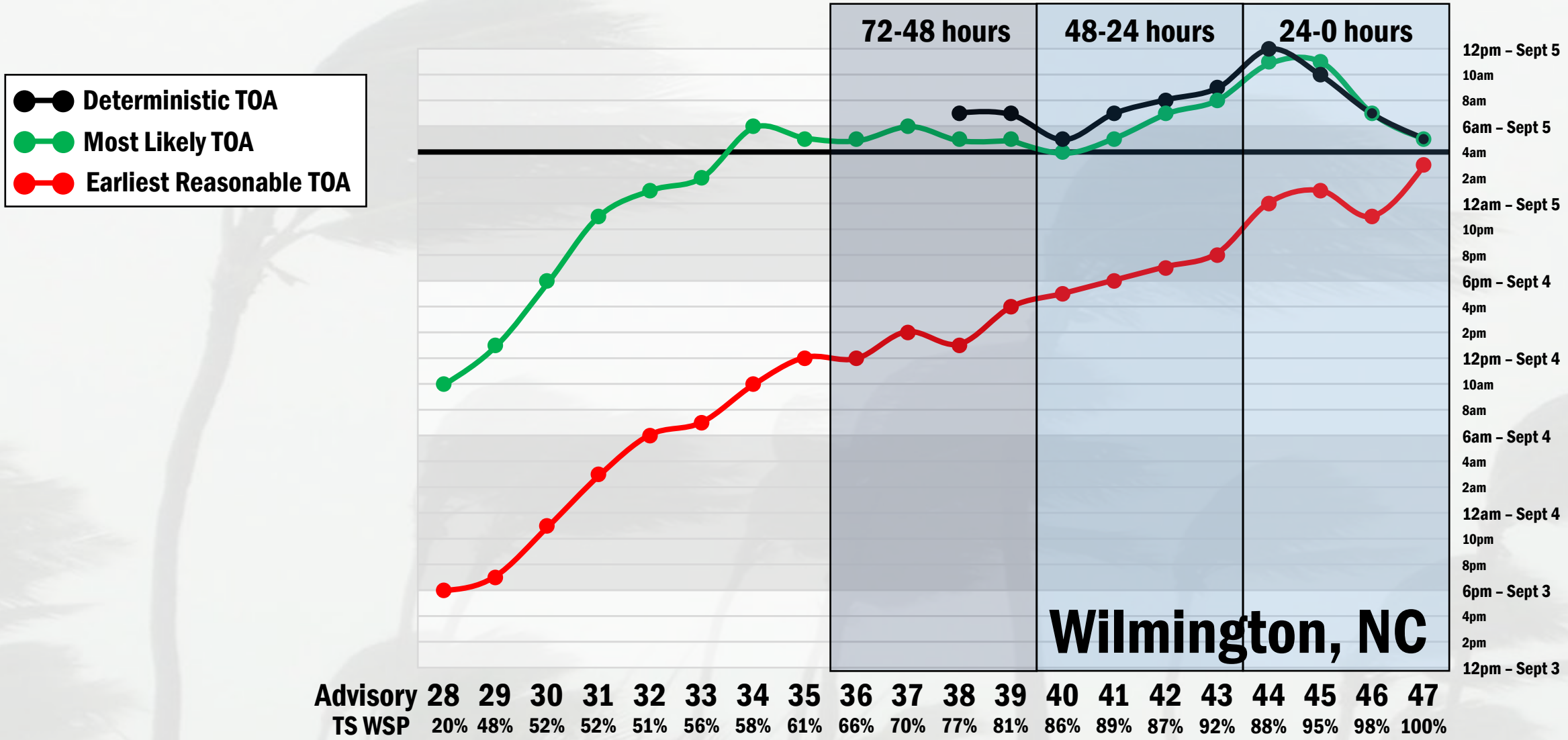
TIME OF ARRIVAL OF TS WINDS
Hurricane Dorian (2019)

FEMA



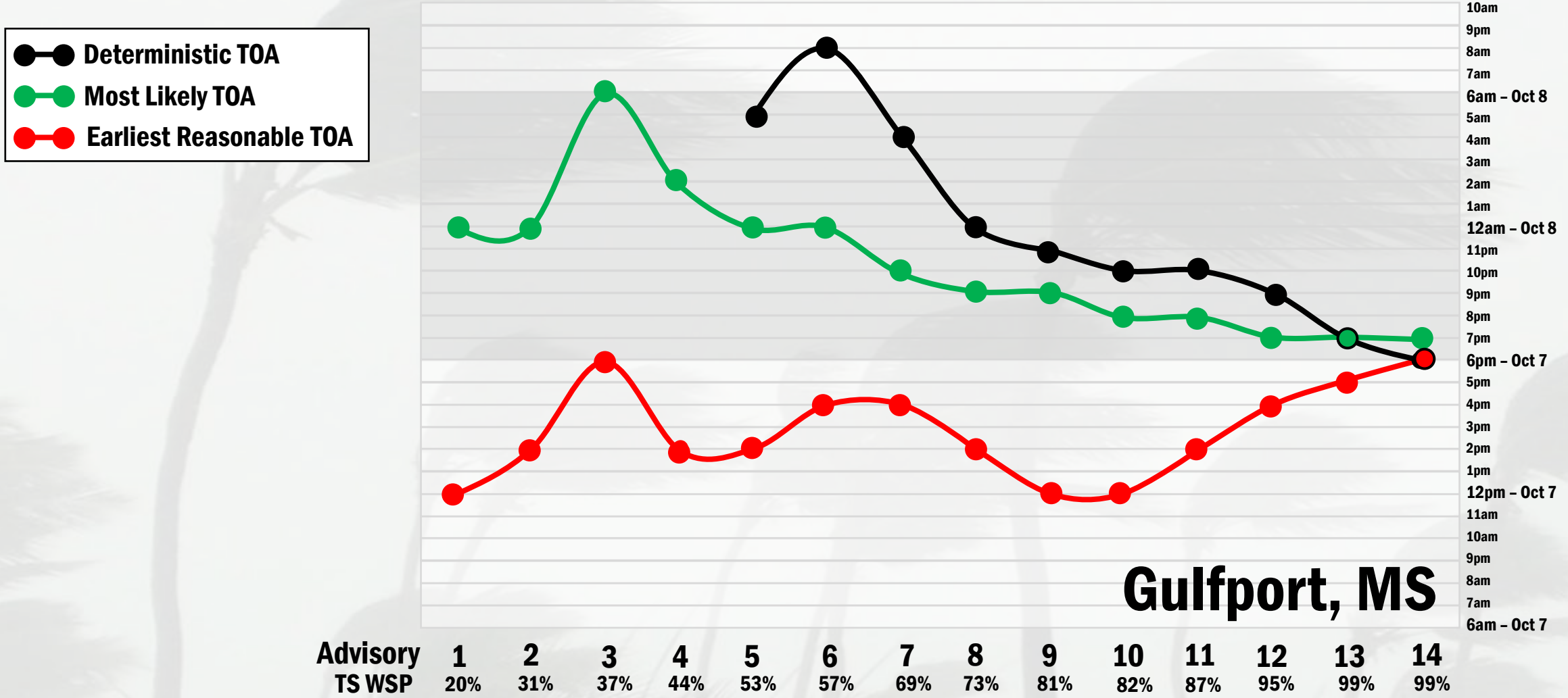
TIME OF ARRIVAL OF TS WINDS
Hurricane Dorian (2019)

FEMA



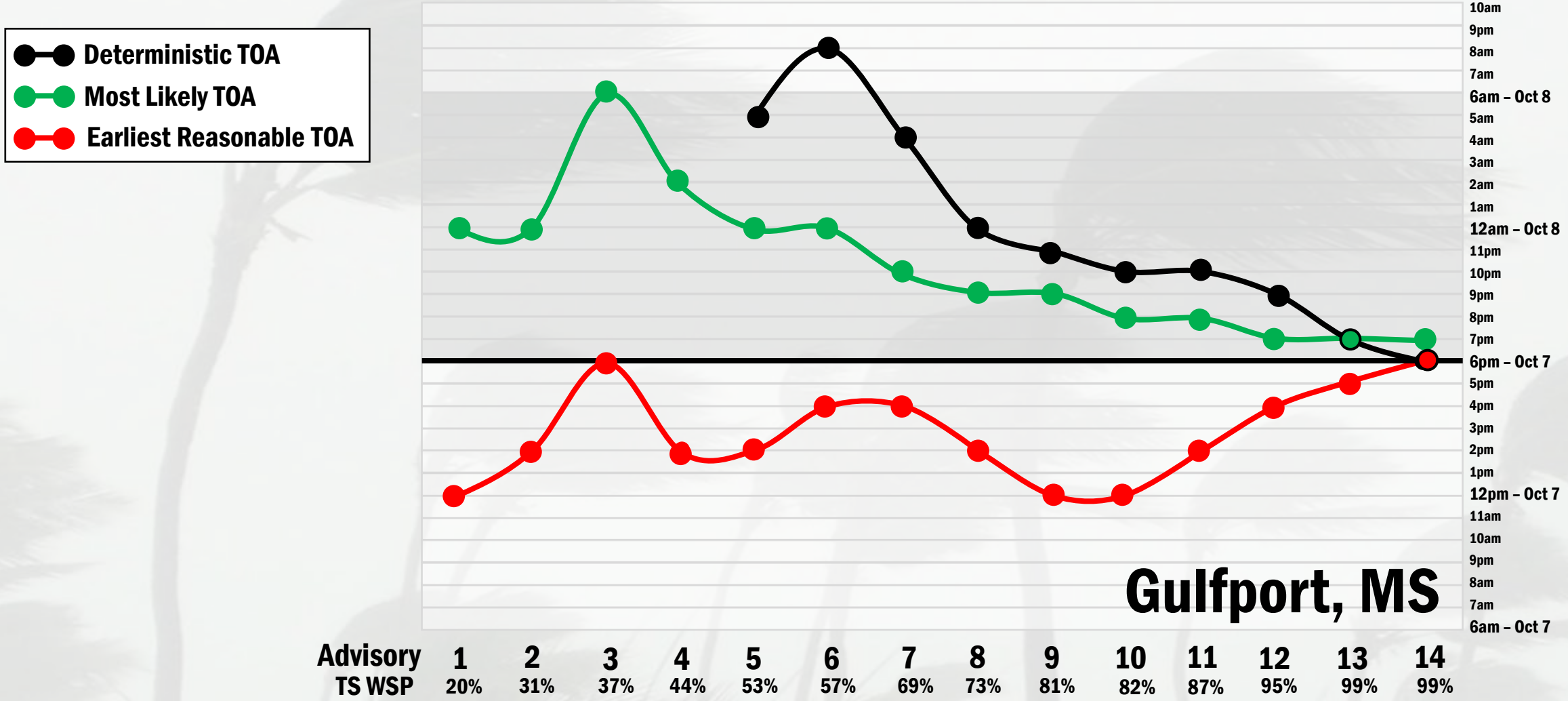
TIME OF ARRIVAL OF TS WINDS
Hurricane Nate (2017)

FEMA



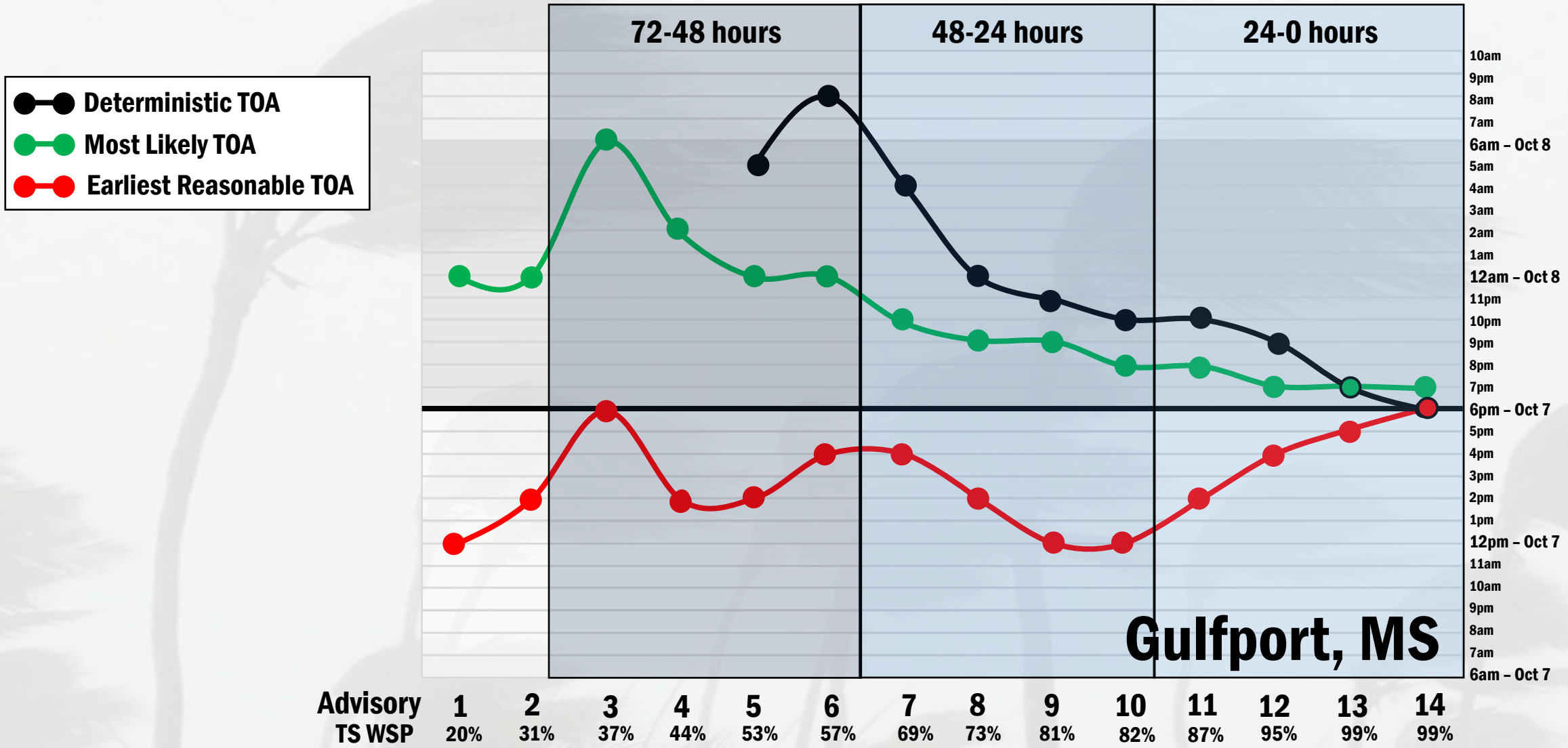
TIME OF ARRIVAL OF TS WINDS
Hurricane Nate (2017)

FEMA



TIME OF ARRIVAL OF TS WINDS
Hurricane Nate (2017)

FEMA



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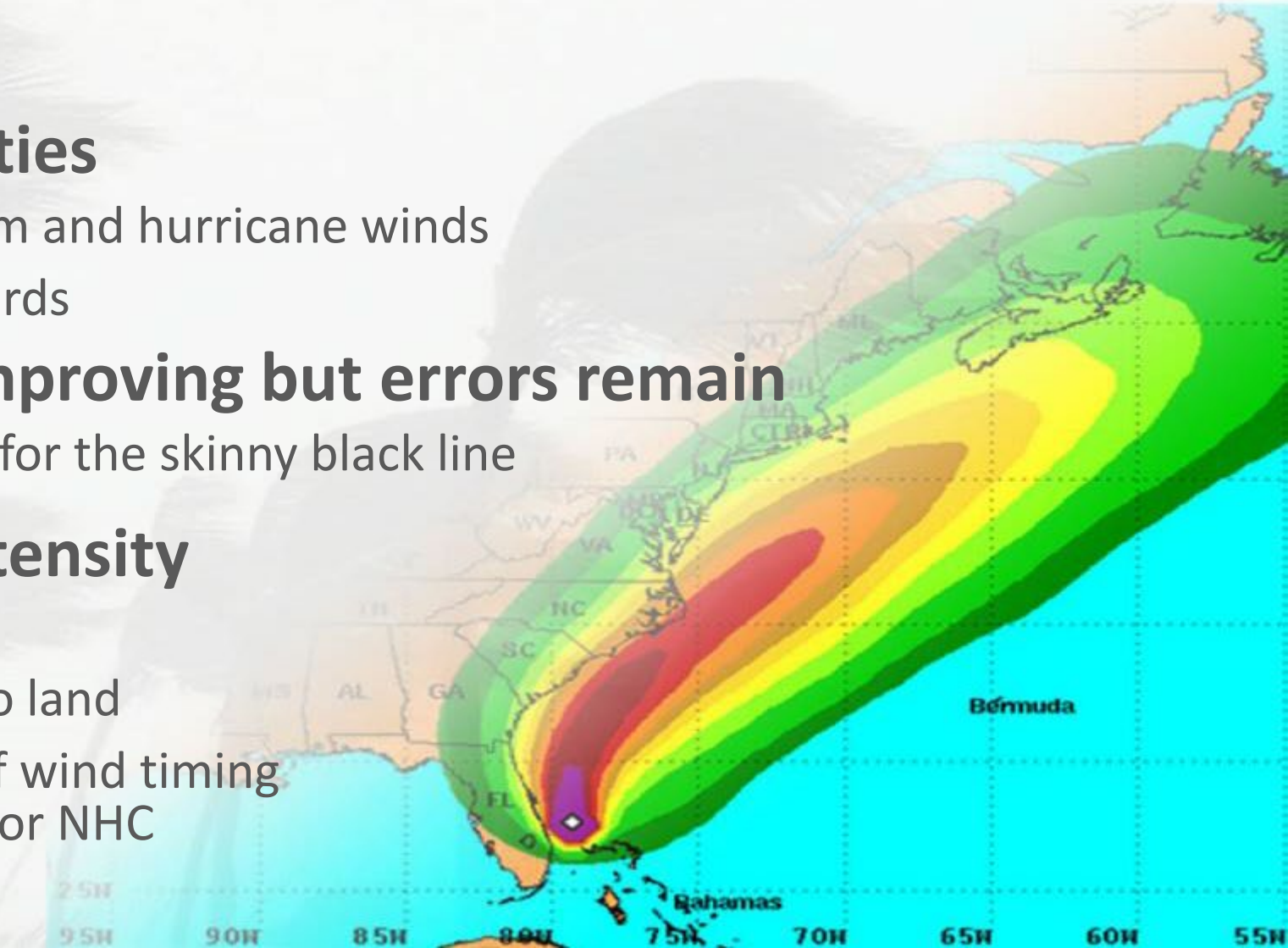
SUMMARY

- **Wind speed probabilities**
  - Likelihood of tropical storm and hurricane winds
  - Onset timing of wind hazards
- **NHC's forecasts are improving but errors remain**
  - Error cone is not the cure for the skinny black line
- **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
L0311

FEMA

Questions/Comments?

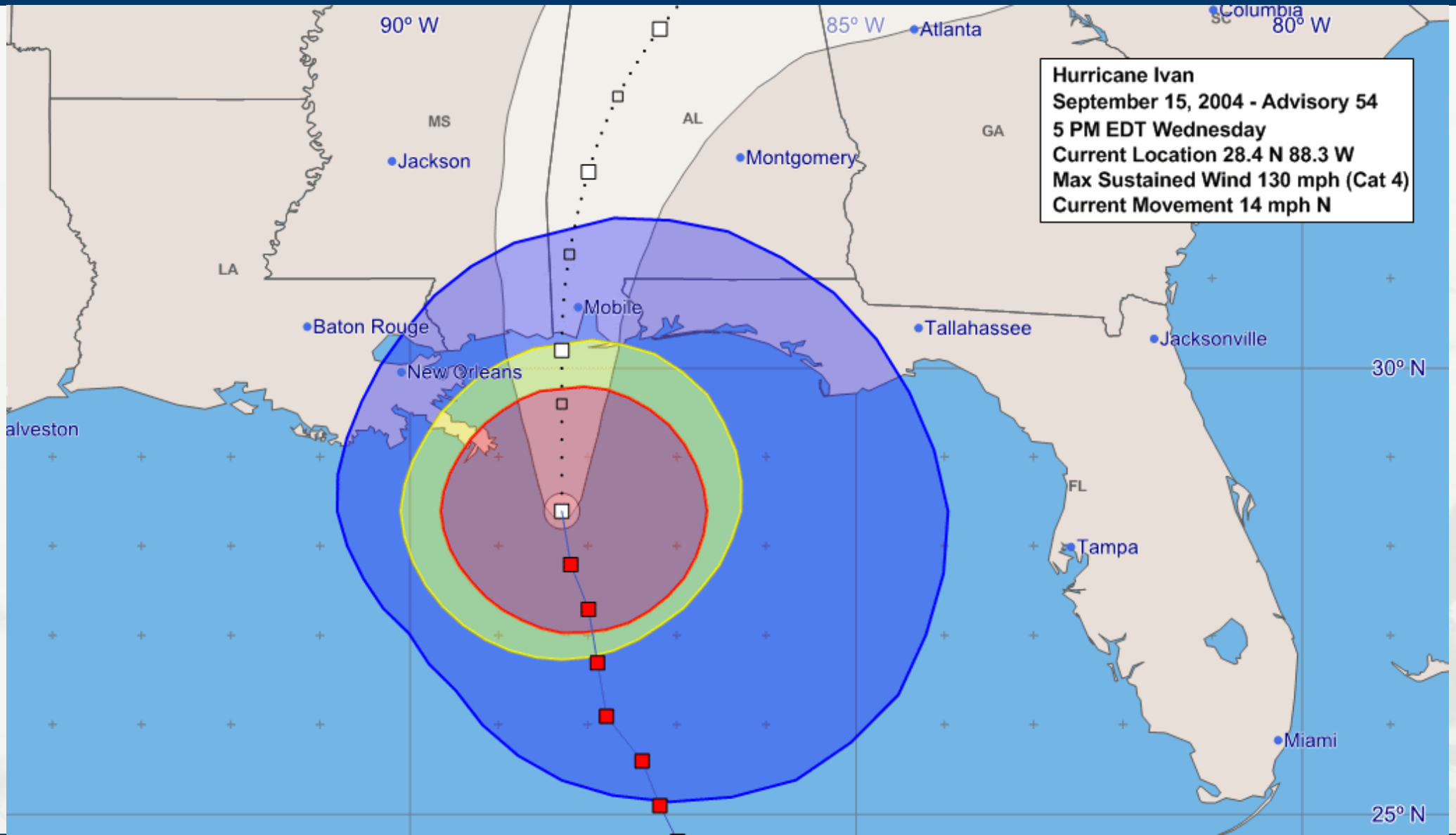
FEMA

UNIT THREE
Forecast Uncertainty

HURRICANE IVAN

What a difference a bay makes.

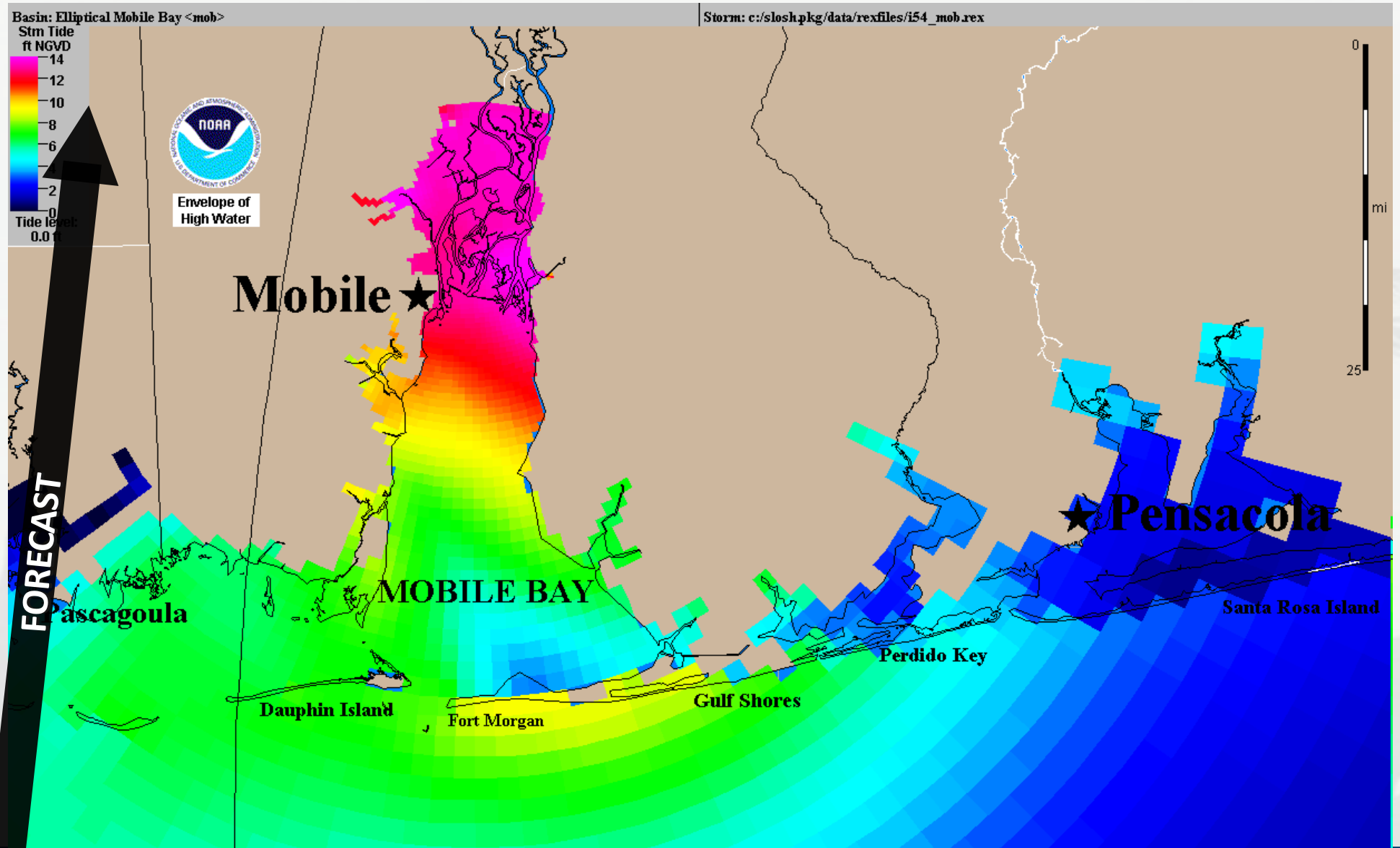
FEMA



HURRICANE IVAN

What a difference a bay makes.

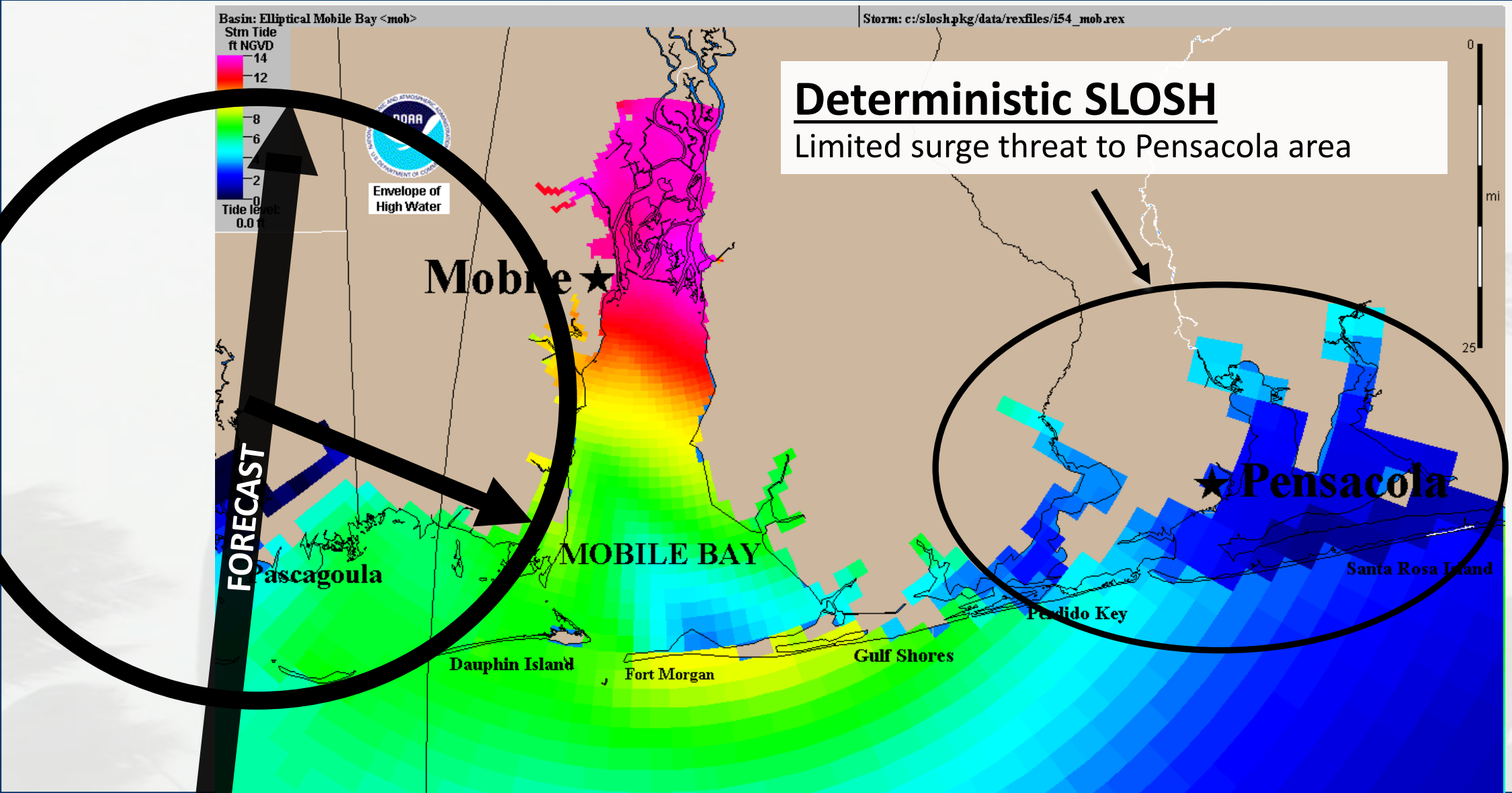
FEMA



HURRICANE IVAN

What a difference a bay makes.

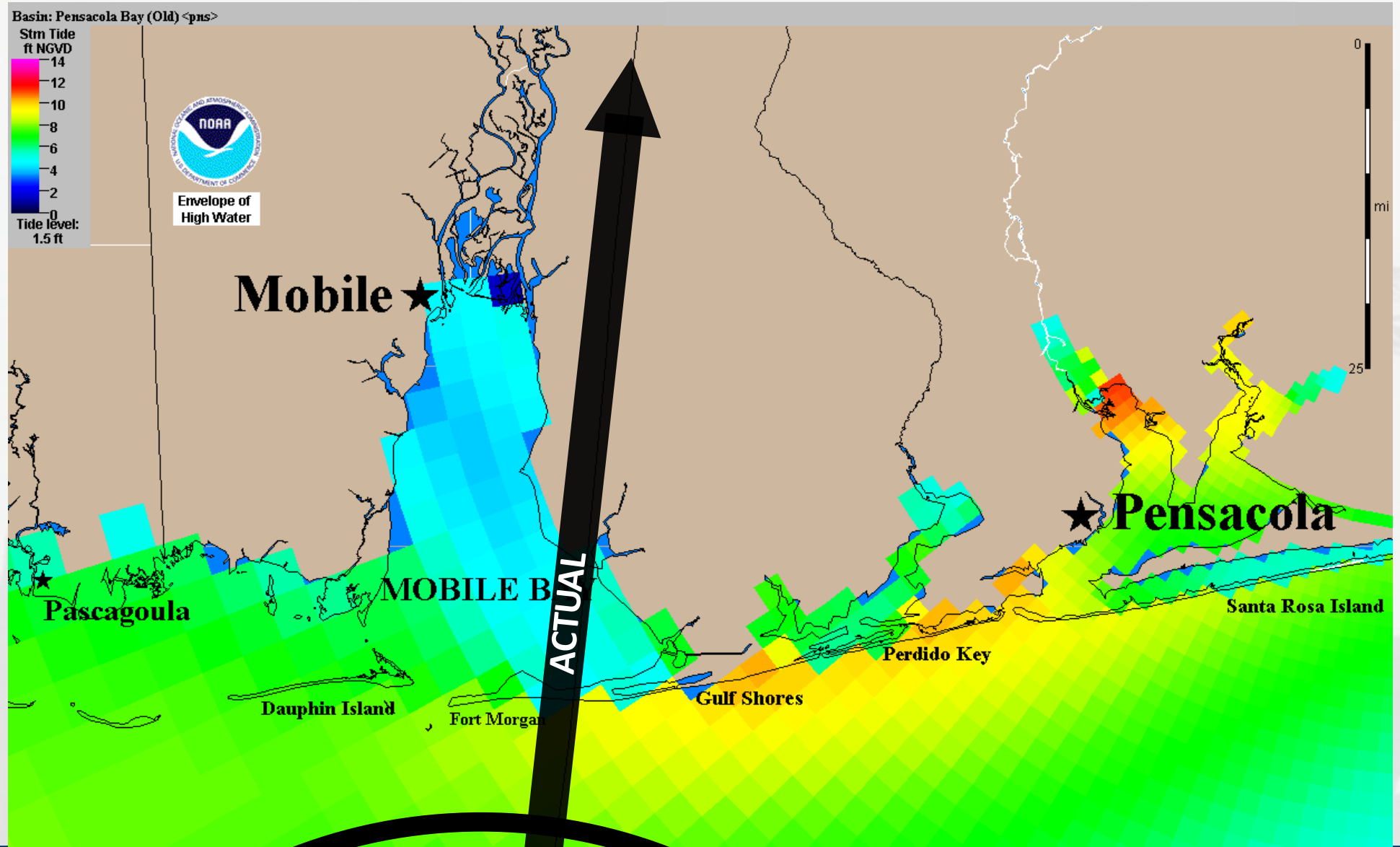
FEMA



HURRICANE IVAN

What a difference a bay makes.

FEMA



STORM SURGE
SLOSH Model

Sea,
Lake, and
Overland
Surges from
Hurricanes

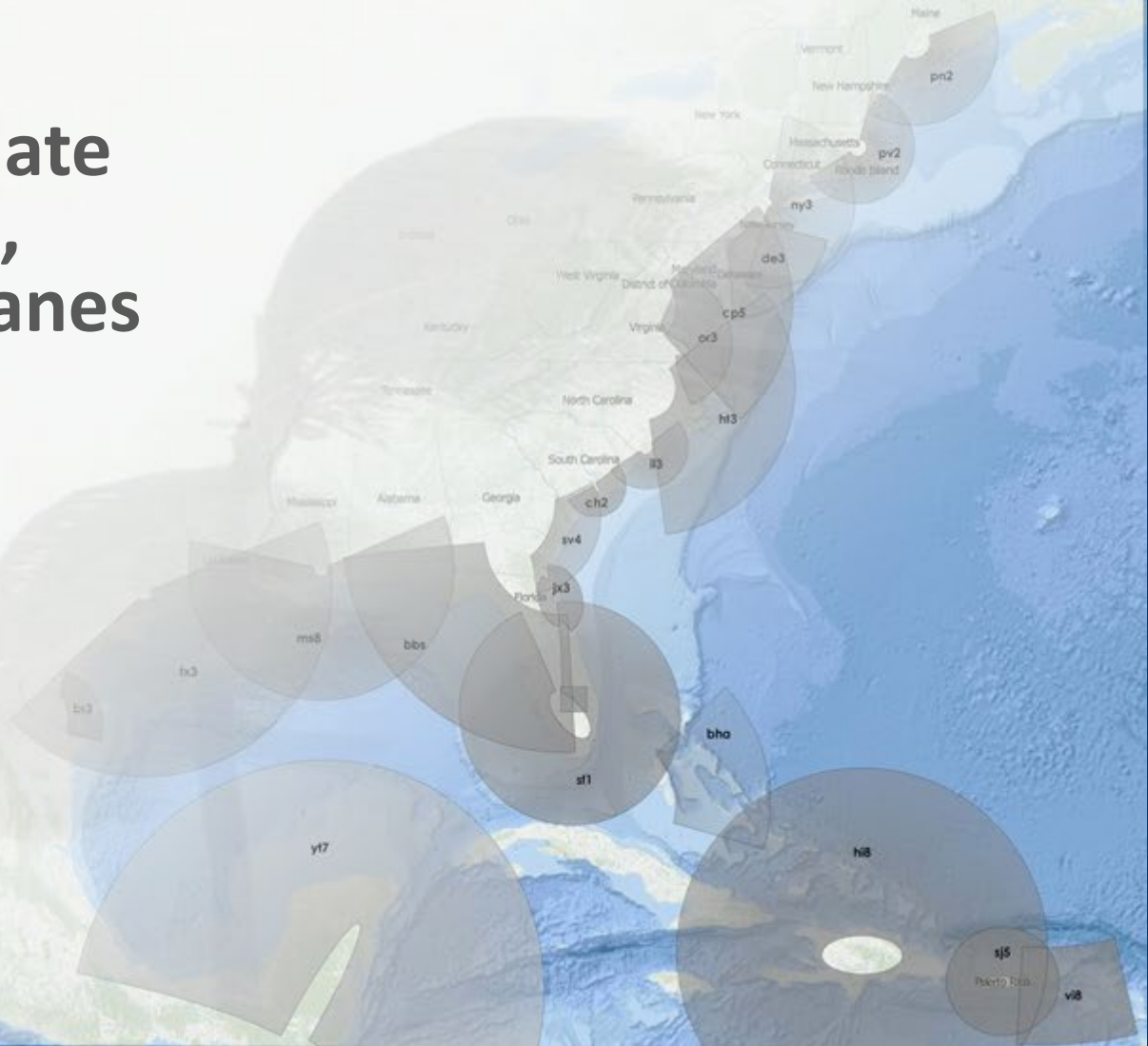
A numerical model used to estimate storm surge heights for historical, hypothetical, or predicted hurricanes

STORM SURGE
SLOSH Model

FEMA

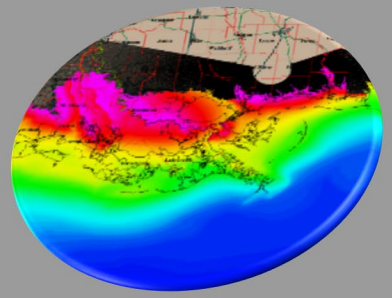
SLOSH

A numerical model used to estimate storm surge heights for historical, hypothetical, or predicted hurricanes

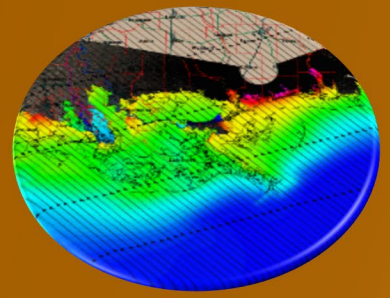


STORM SURGE
Storm Surge Risk Tools

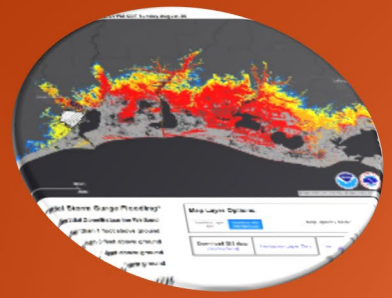
FEMA



Maximum of the MEOWs (MOMs)



Maximum Envelopes of Water (MEOWs)



Probabilistic Storm Surge (P-Surge)

Potential Storm Surge Flooding Map

Storm Surge Watch/Warning

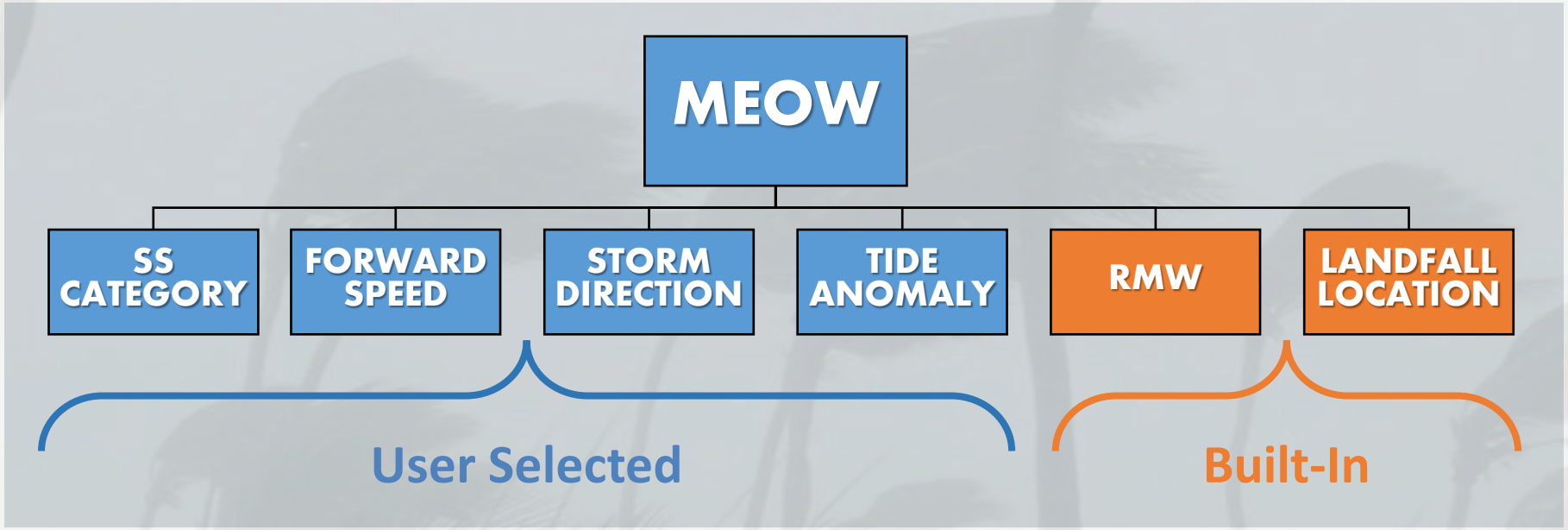
Planning / More Forecast Uncertainty → **More Forecast Certainty**

STORM SURGE
Maximum Envelope of Water (MEOW)

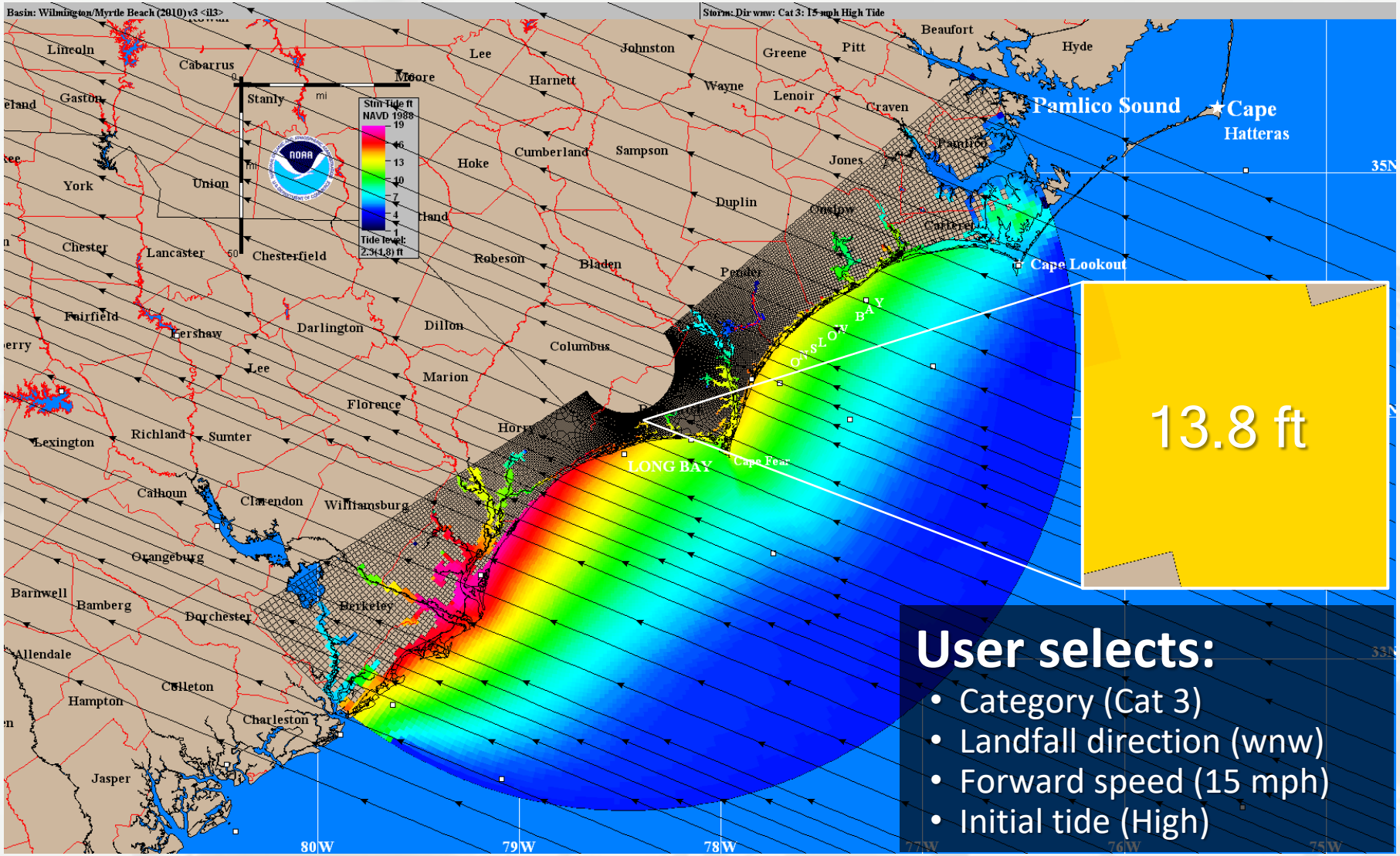
FEMA

MEOWs

- Composite of the maximum storm surge for a given set of parameters (by basin)
- Used as guidance of planning and operations



STORM SURGE
Maximum Envelope of Water (MEOW)



User selects:

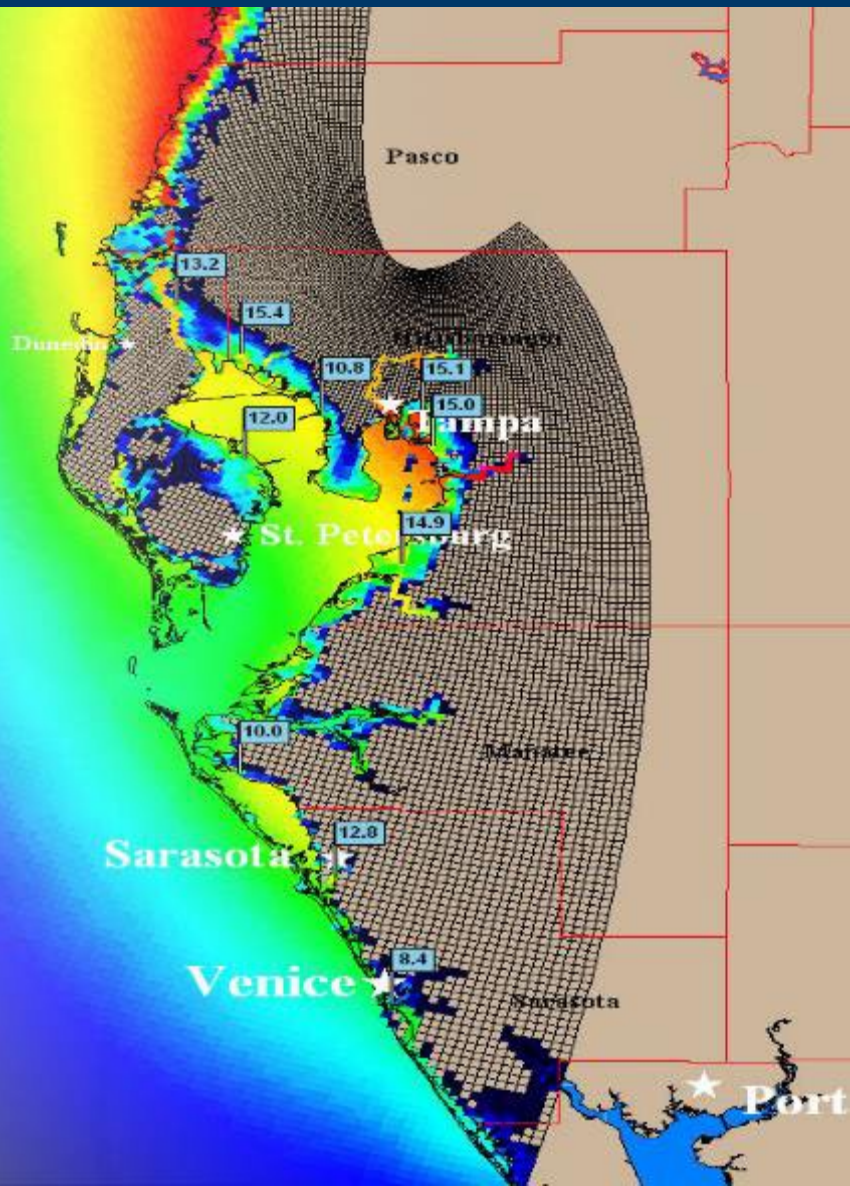
- Category (Cat 3)
- Landfall direction (wnw)
- Forward speed (15 mph)
- Initial tide (High)

STORM SURGE
Maximum of Maximums (MOM)

FEMA

MOMs

- **Worst-case for a particular category storm**
- **Combination of many scenarios**
  - Forward speed
  - Angle of approach
  - Size (Radius of maximum wind)
  - Initial tide level
- **No single hurricane will produce the regional flooding depicted in a Maximum of Maximums (MOMs)**



PROBABILISTIC STORM SURGE
Multiple Tracks and Landfall Locations

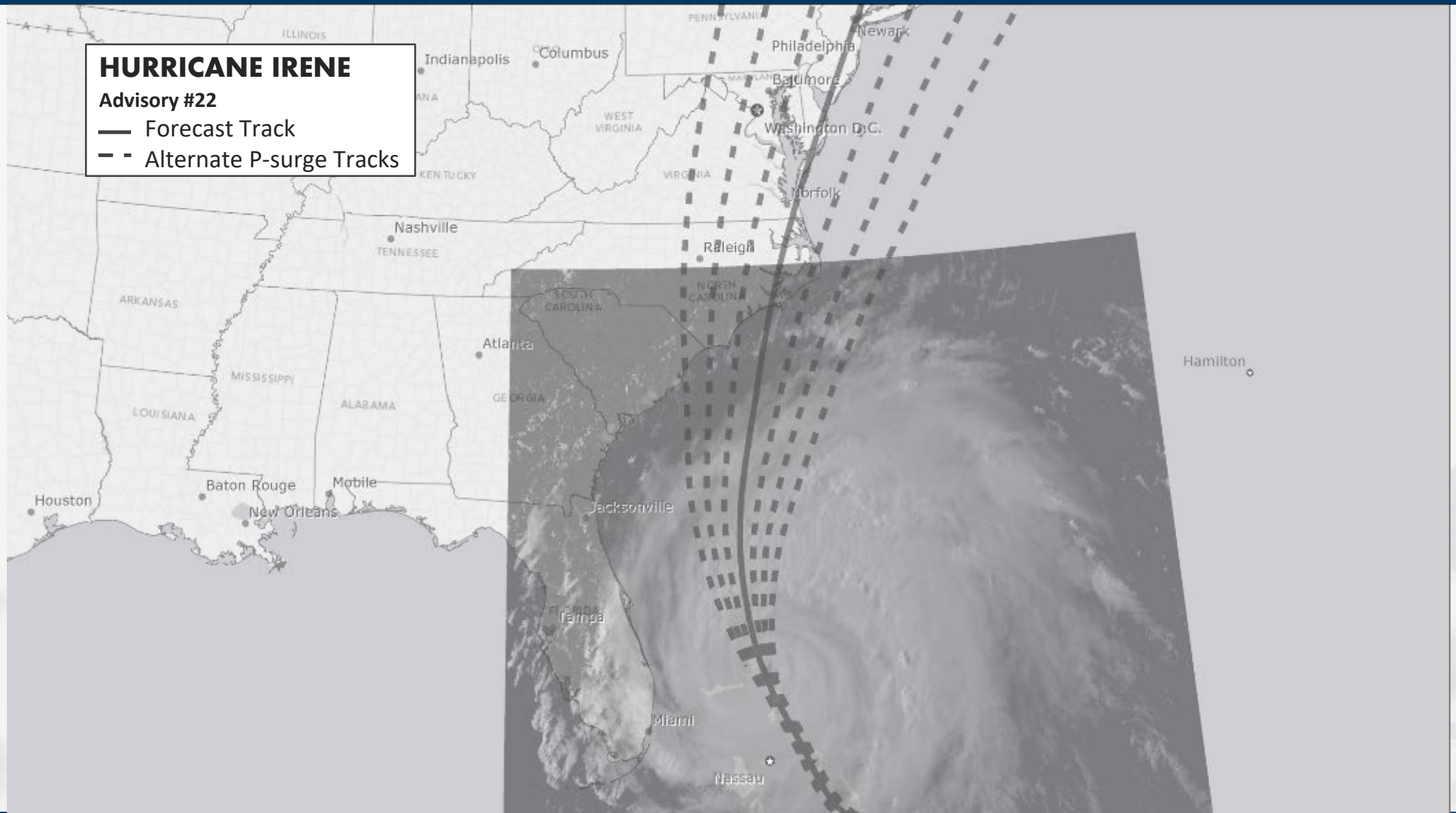
FEMA

P-SURGE

- **Based on NHC official advisory**
  - Uncertainties based on historical errors
- **Accounts for uncertainty in:**
  - Track (landfall location)
  - Size (Radius of Maximum Winds)
  - Forward speed
  - Intensity
- **Accounts for tide**
- **Heights above ground level**

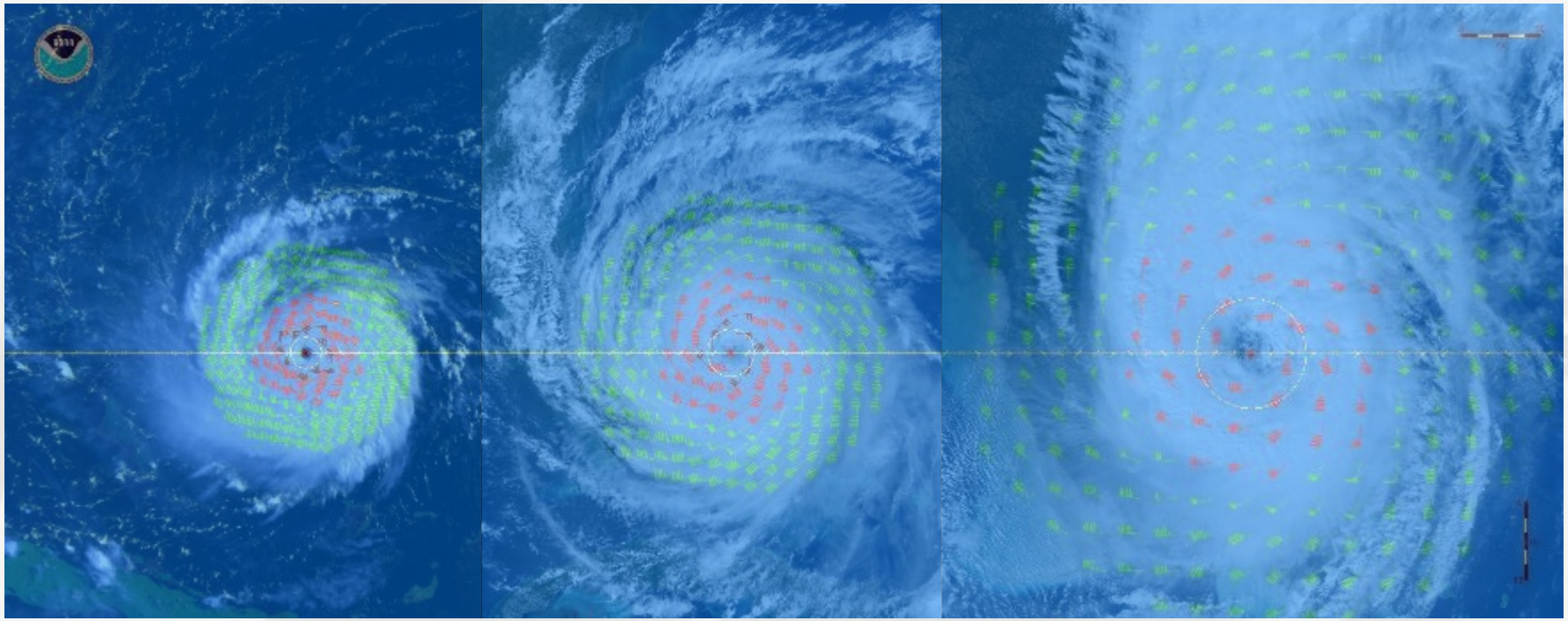
PROBABILISTIC STORM SURGE
Multiple Tracks and Landfall Locations

FEMA



PROBABILISTIC STORM SURGE

Multiple Sizes, Intensities, Forward Speeds



Size (RMW): Small, Medium, Large

Forward Speed: Fast – Slow

Intensity: Strong, Medium, Weak

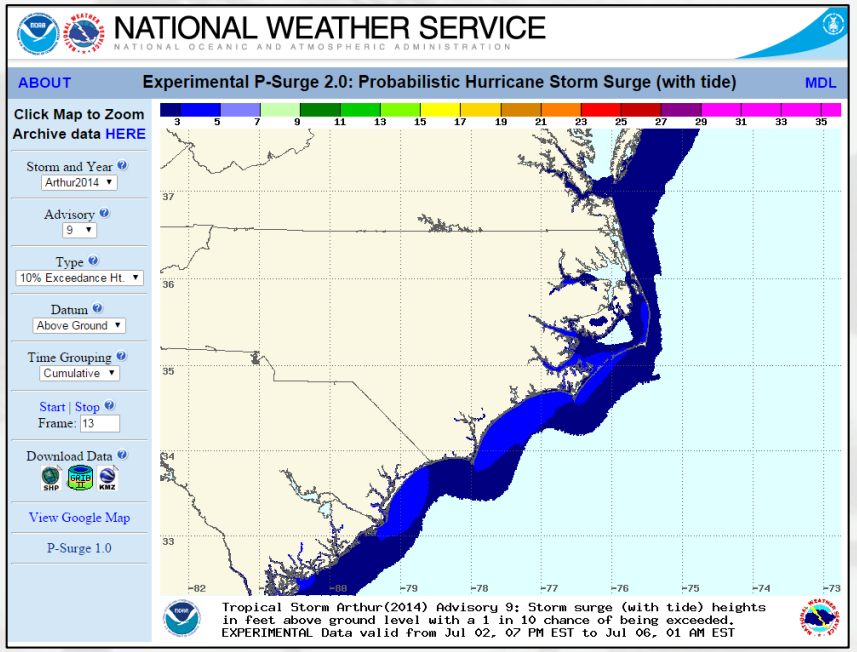
PROBABILISTIC STORM SURGE
Web-based. Timing. Availability.

FEMA

P-SURGE

- **Available with a Hurricane or Storm Surge Watch/Warning**
  - 48 hours prior to arrival of TS winds
  - Starting in 2021, *may* be available as early as 60 hours prior to arrival of TS winds *when forecaster confidence is high*
- **Approx. 1 hour after advisory**

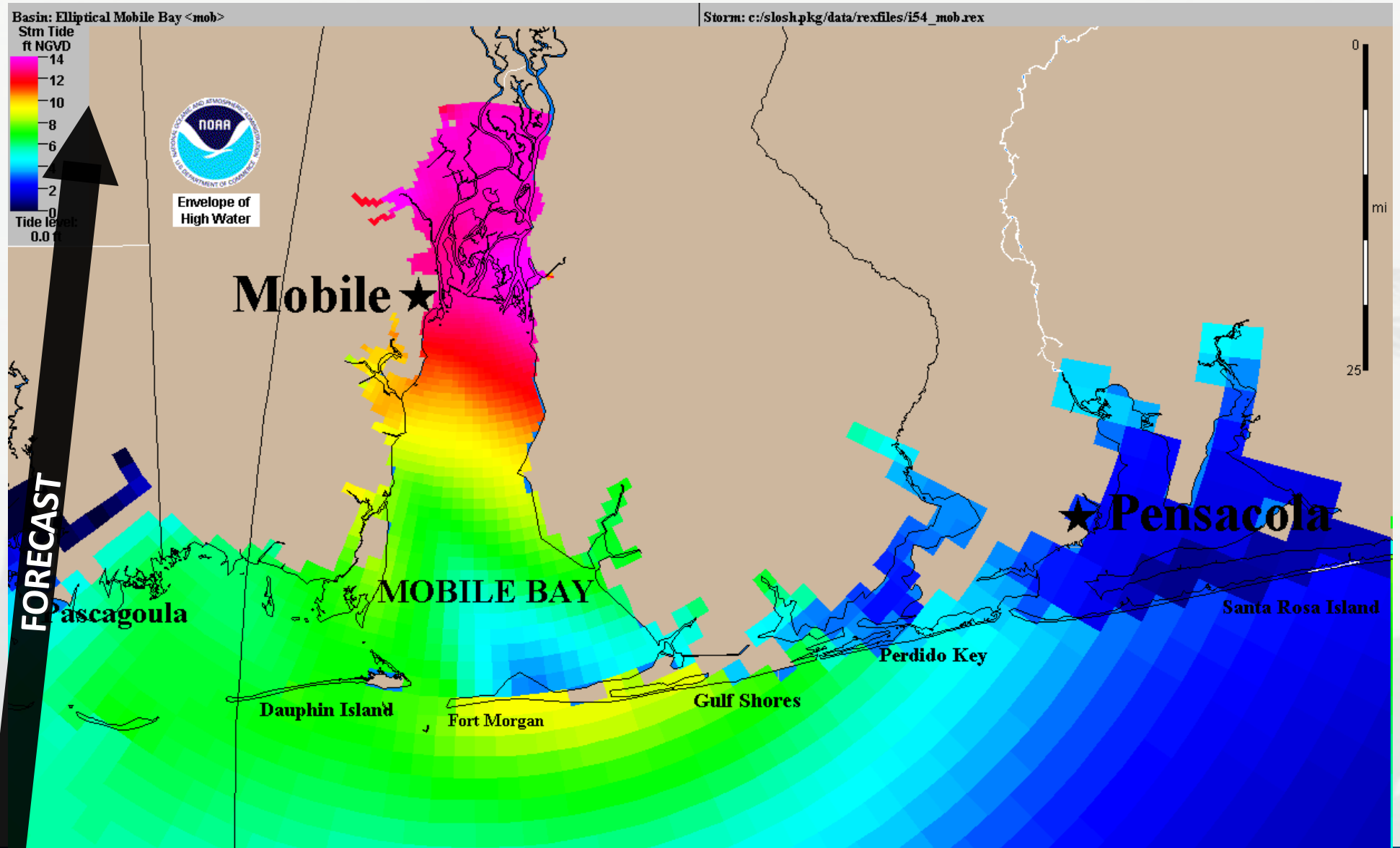
ADV TIME	P-SURGE
0500	**0600 EDT**
1100	**1200 EDT**
1700	**1800 EDT**
2300	**0000 EDT**



HURRICANE IVAN

What a difference a bay makes.

FEMA



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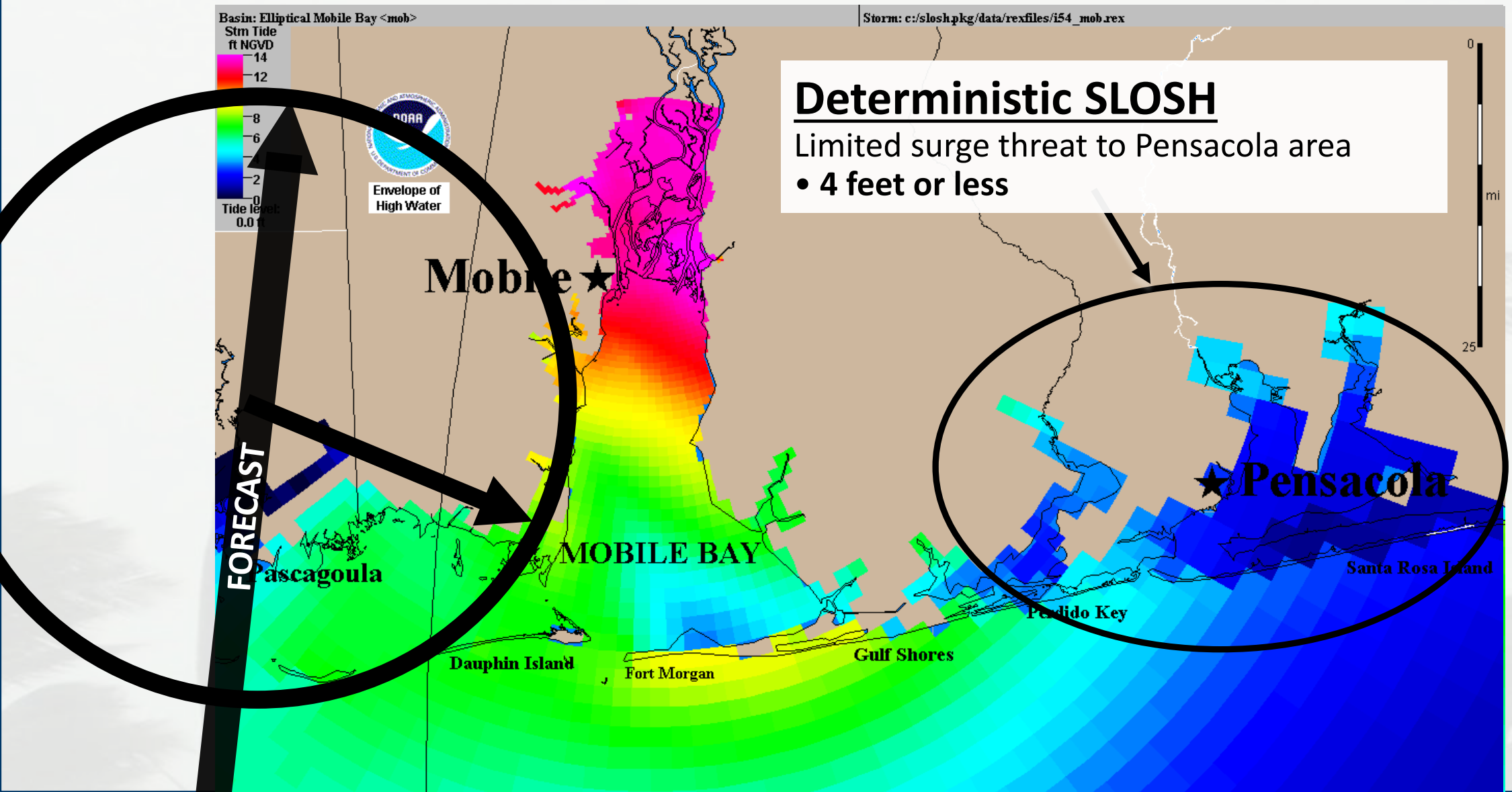

HURRICANE IVAN

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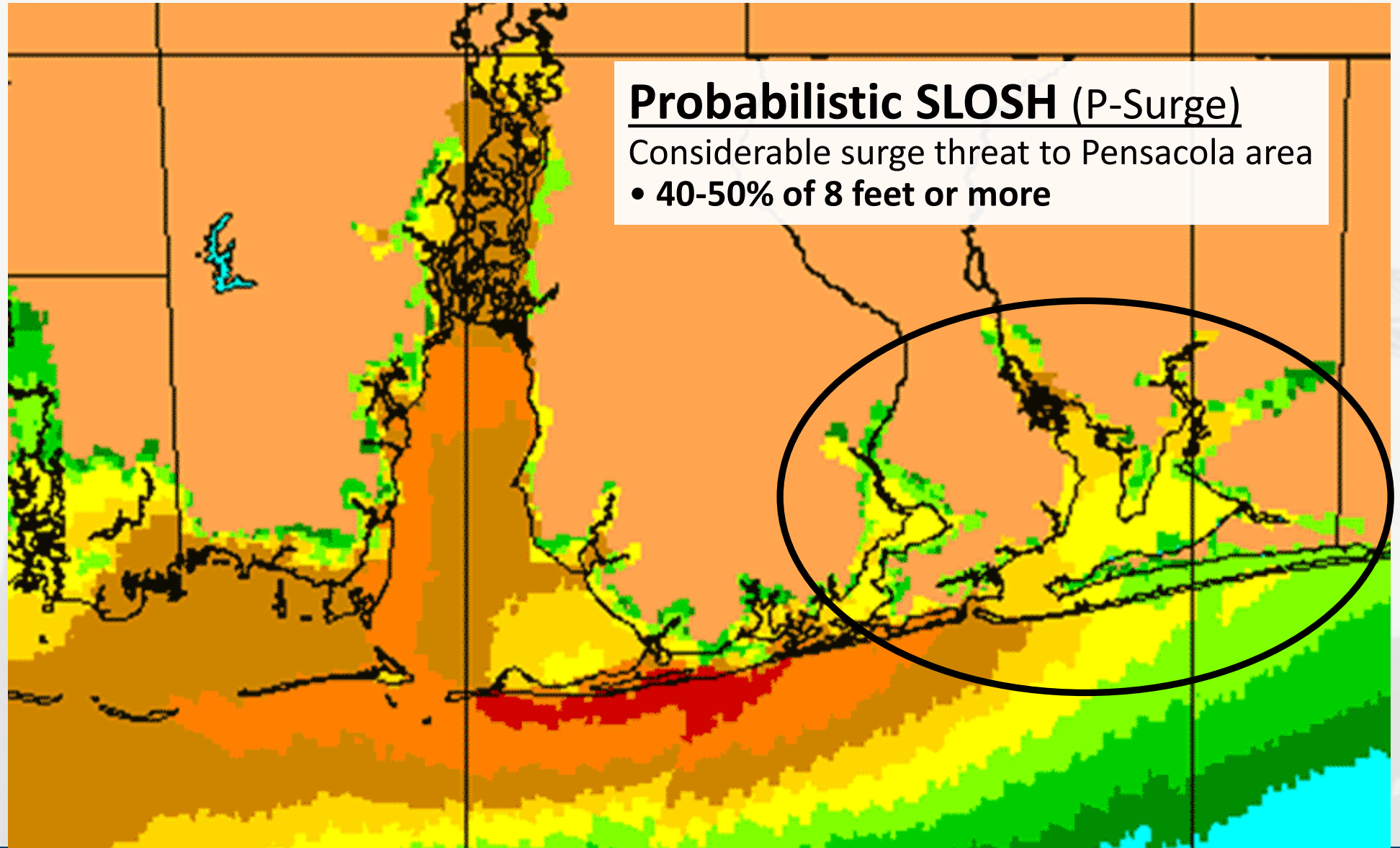

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QUESTION

In general, NHC operational storm surge products provide water levels above which reference level?

A. Mean Sea Level (MSL)
B. Ground Level (AGL)
C. NAVD88
E. Normal tidal levels

VERTICAL DATUMS

It all depends from where you measure.

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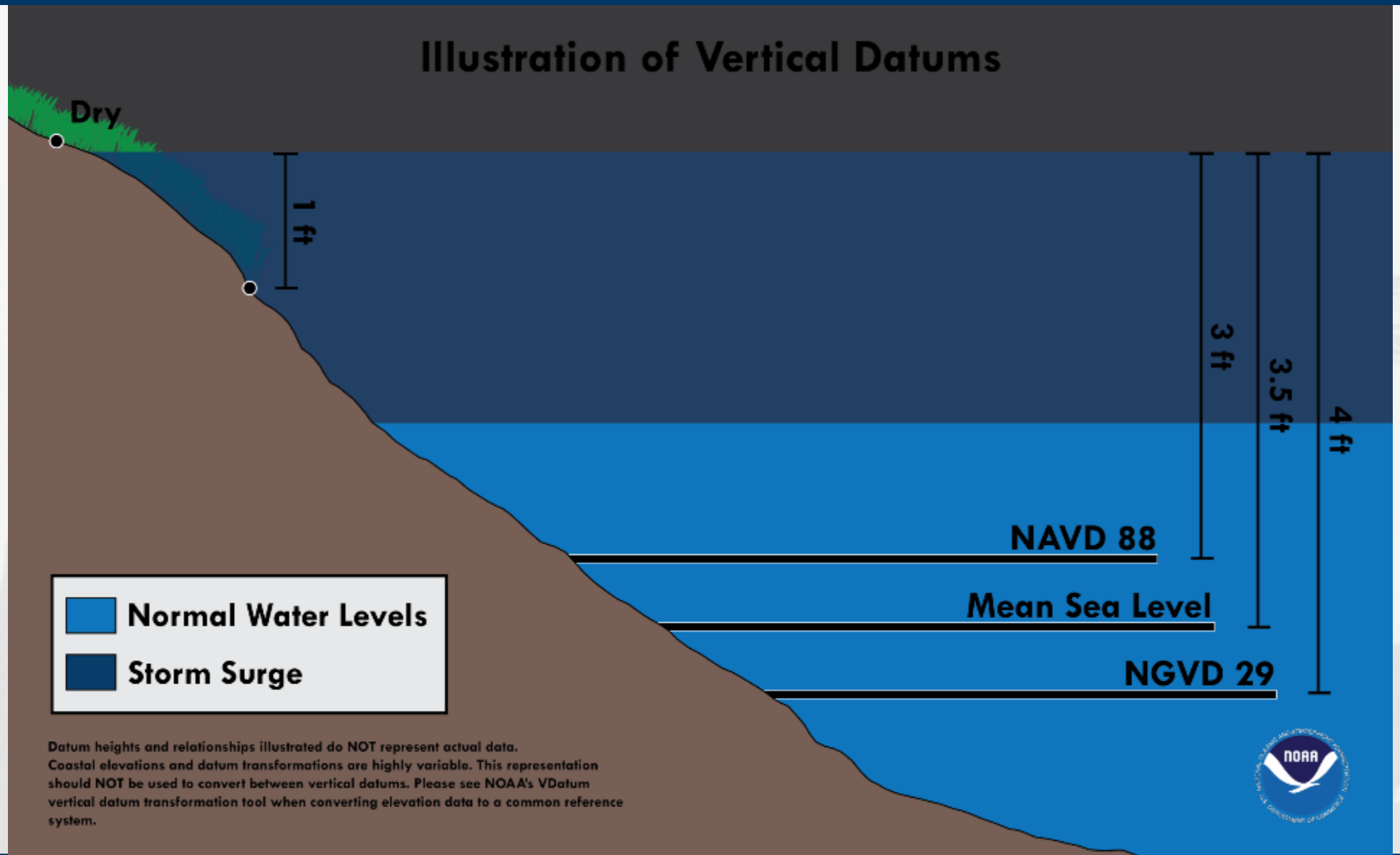
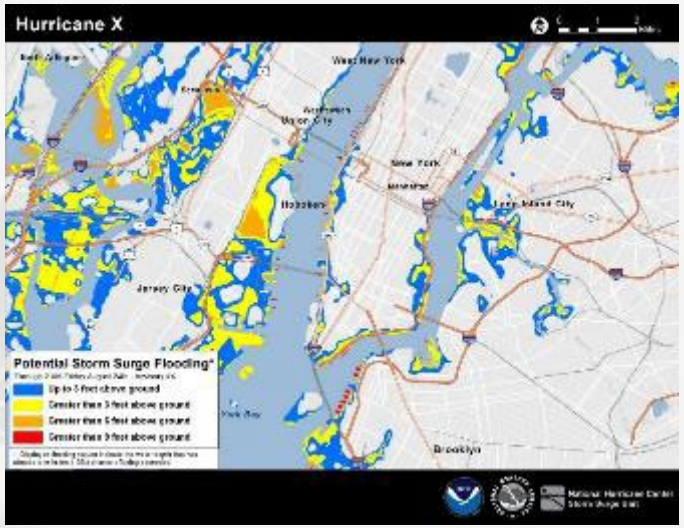


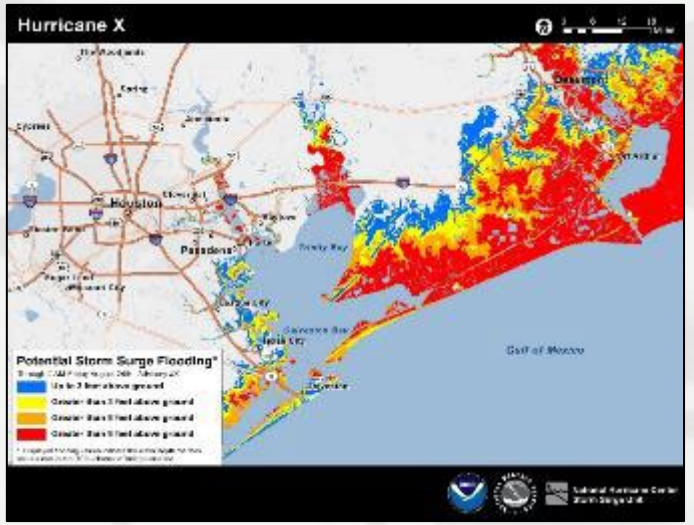
STORM SURGE
Potential Storm Surge Flooding Map

FEMA

MAP OF POTENTIAL INUNDATION

- **Height above ground that the water could reach**
  - Reasonable worst-case scenario for any individual location
  - Values have a 10% chance of being exceeded
- **Issuance with same criteria as P-Surge**
- **Available 60+ minutes after the advisory release**

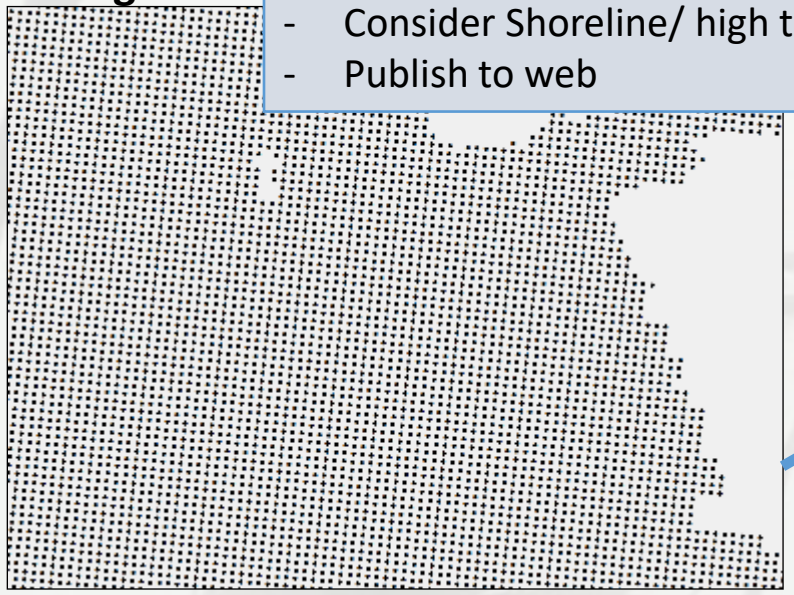




STORM SURGE
Potential Storm Surge Flooding Map

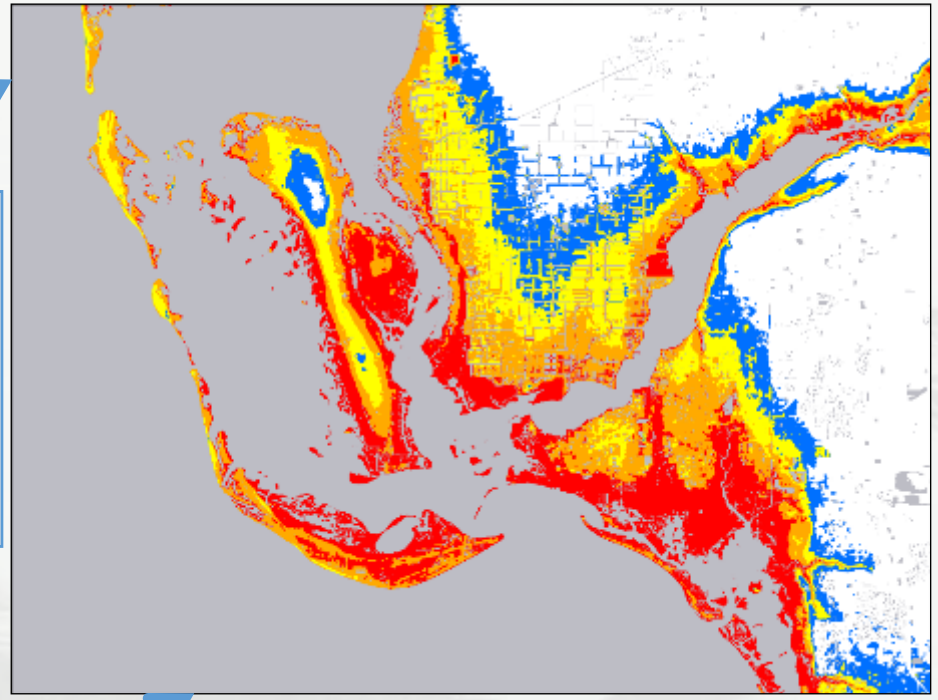
FEMA

Psurge2.9



Geoprocessing

- Interpolation
- Processing with elevation data
- Smoothing
- Consider Shoreline/ high tide
- Publish to web



POTENTIAL STORM SURGE FLOODING MAP
Intertidal/Wetlands Mask

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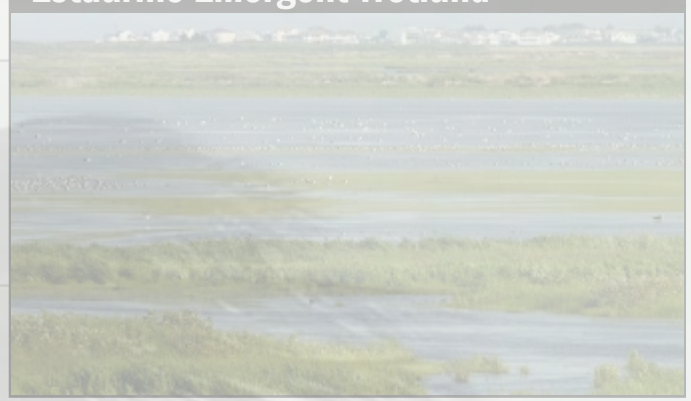
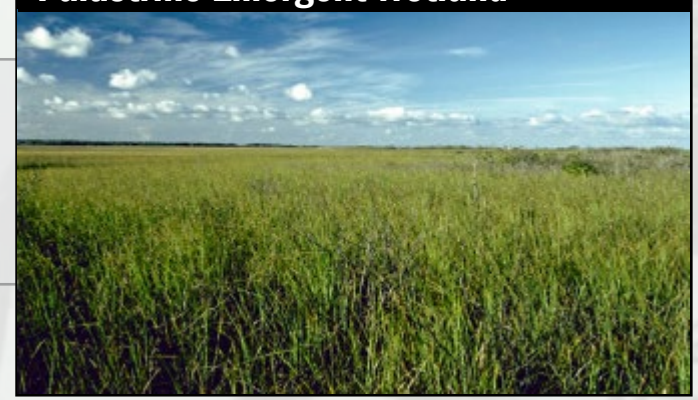
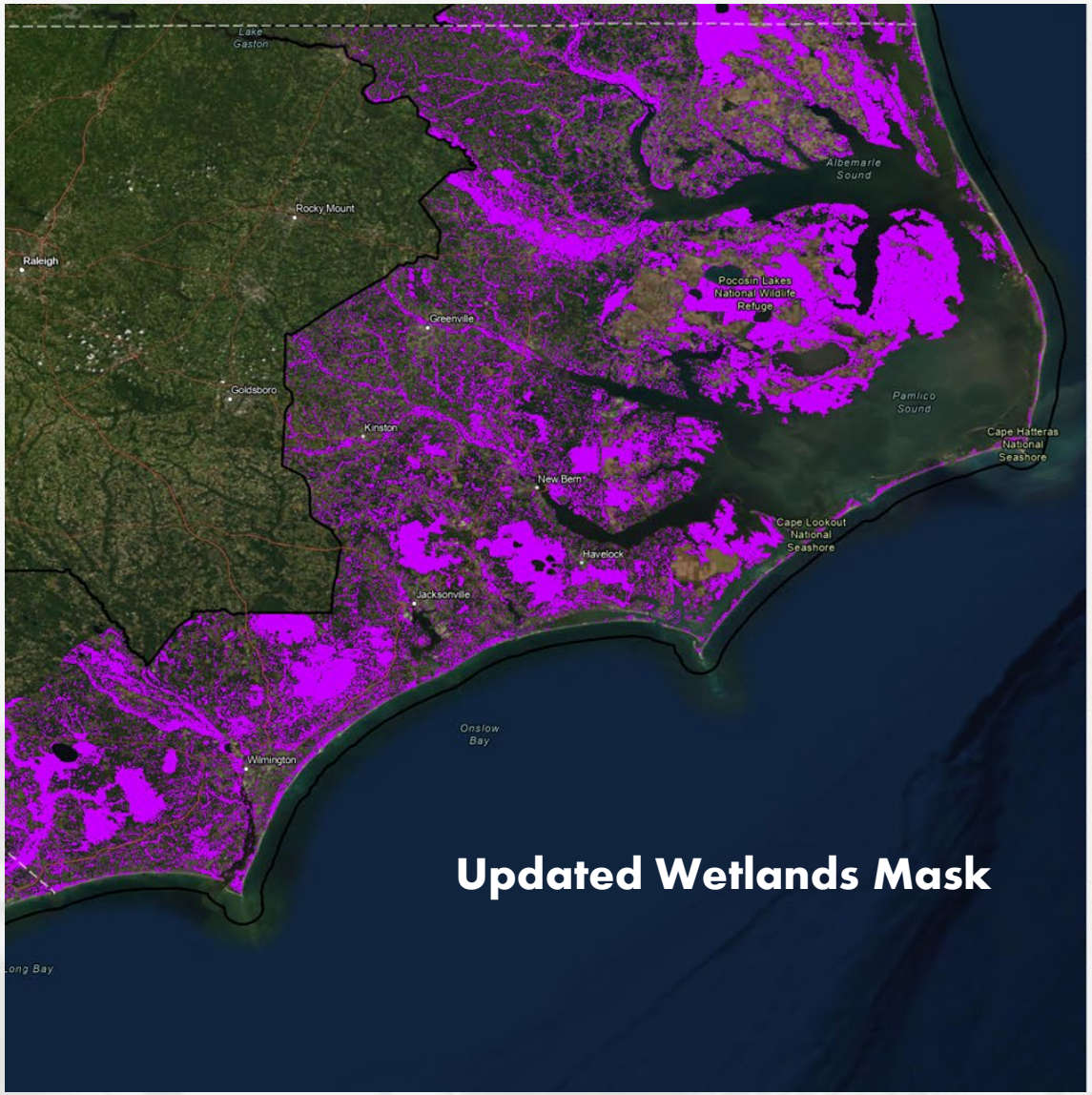
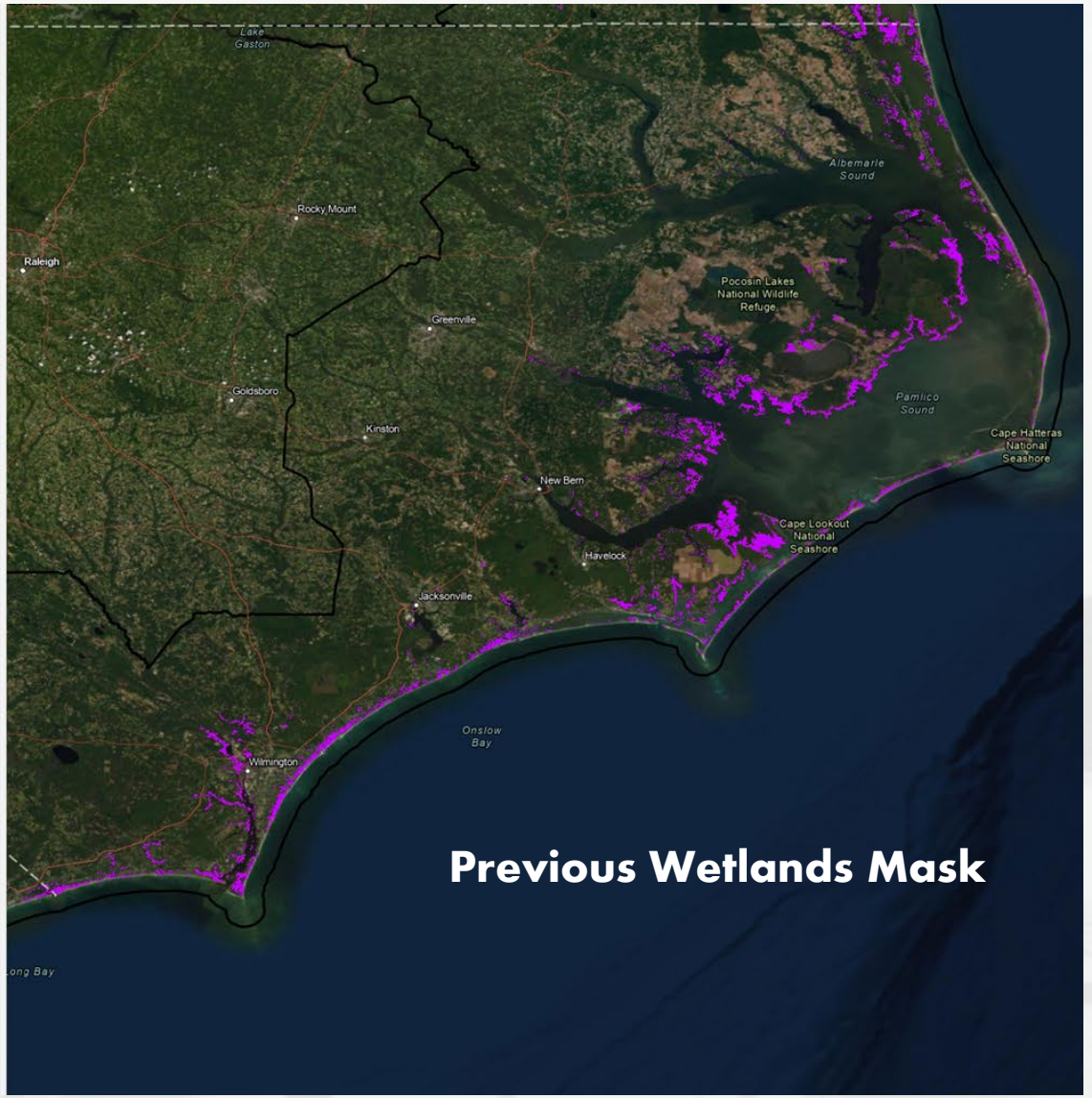
Tidal (Estuarine) Wetlands	**Estuarine Forested Wetland**	**Estuarine Scrub/Shrub Wetland**	**Estuarine Emergent Wetland**
			
	Mangroves Everglades National Park, Florida	Tidal Shrub Swamp Virginia	Salt Marsh Brigantine, New Jersey
Non-Tidal (Palustrine) Wetlands	**Palustrine Forested Wetland**	**Palustrine Scrub/Shrub Wetland**	**Palustrine Emergent Wetland**
			
	Cypress Swamp Bayou Corne, Louisiana	Short Pocosin Pocosin Lakes National Wildlife Refuge, North Carolina	Sawgrass Prairie Everglades National Park, Florida

POTENTIAL STORM SURGE FLOODING MAP

Intertidal/Wetlands Mask

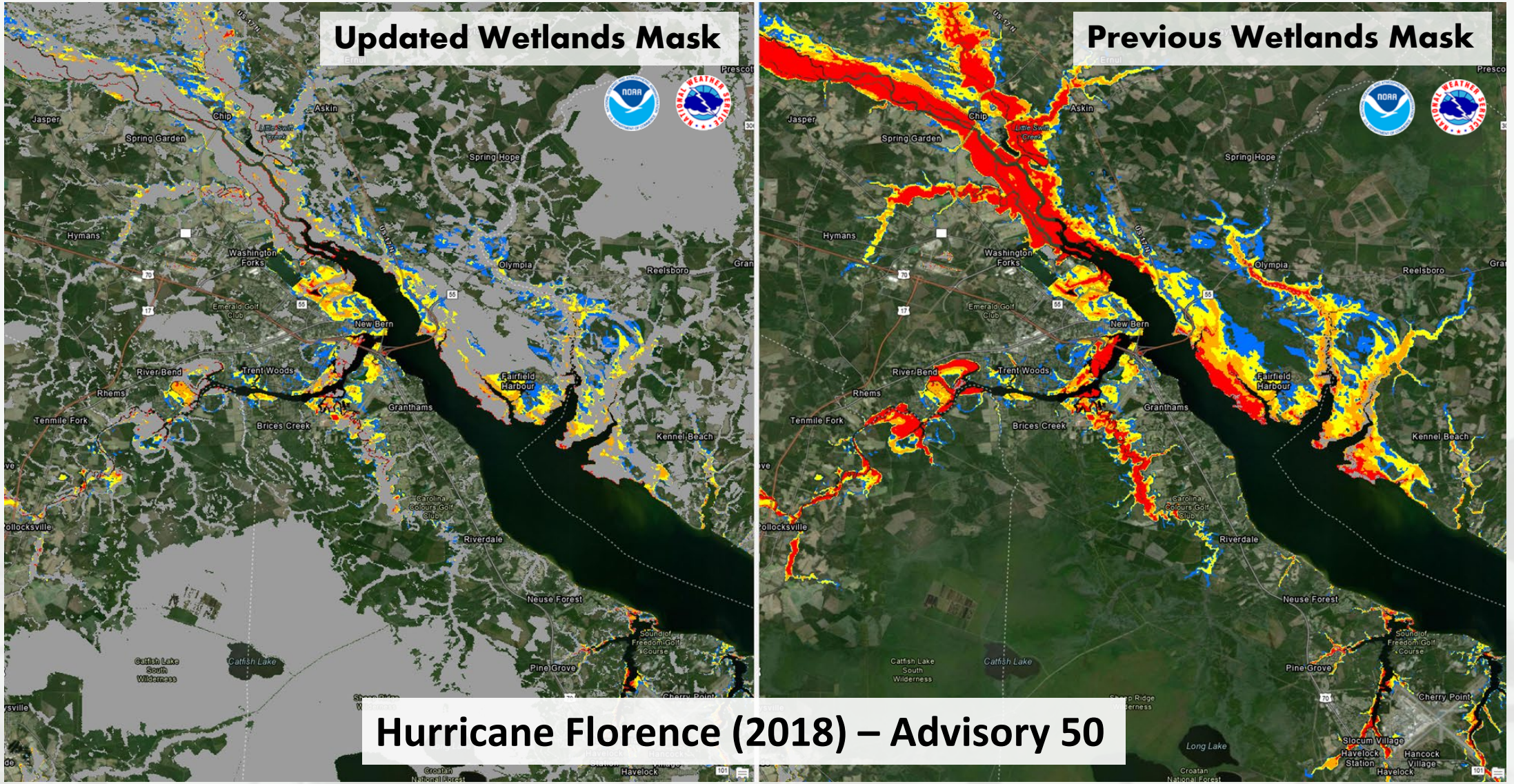
FEMA





POTENTIAL STORM SURGE FLOODING MAP
Intertidal/Wetlands Mask

FEMA



Hurricane Florence (2018) – Advisory 50

STORM SURGE
Potential Storm Surge Flooding Map

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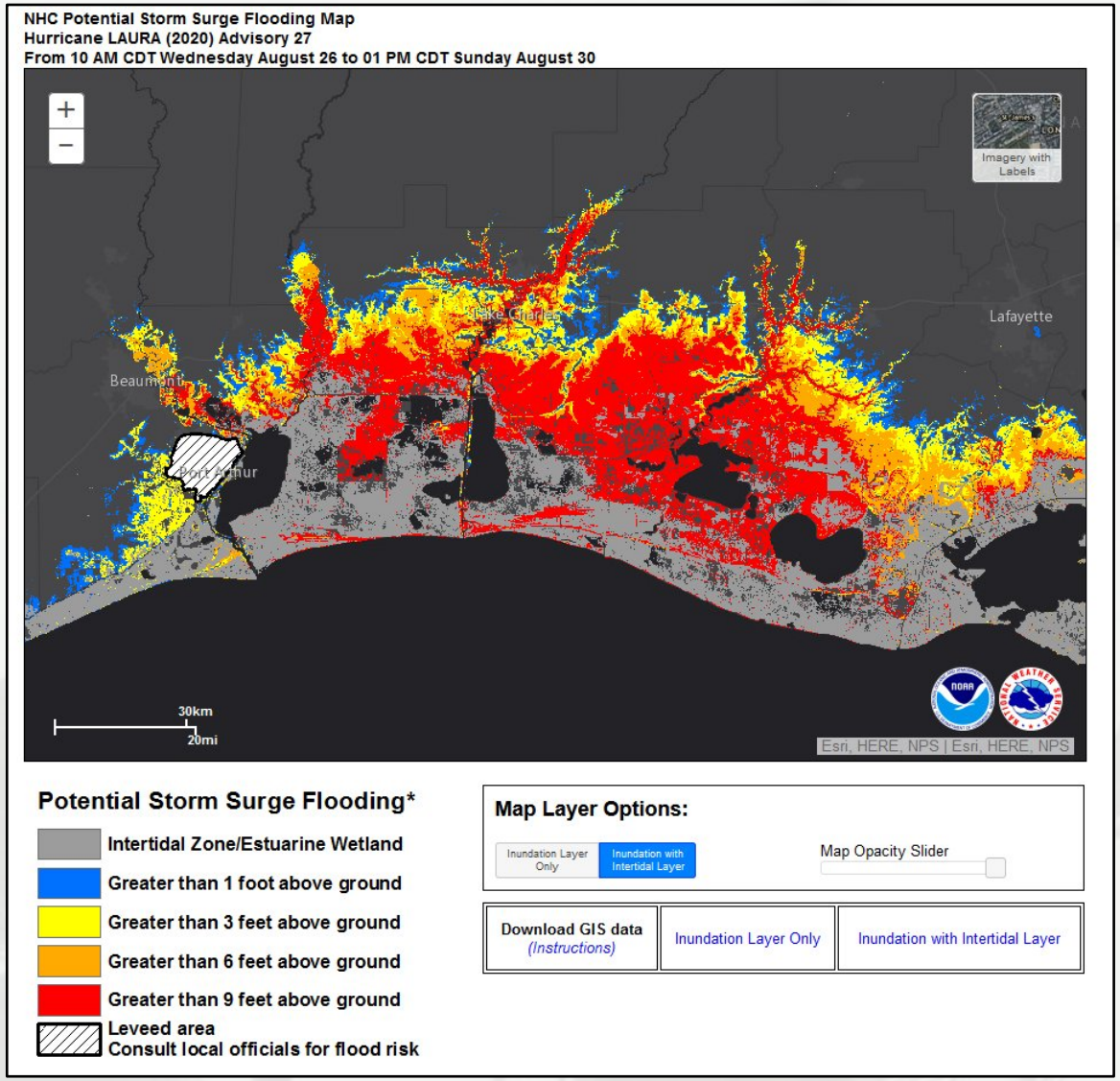
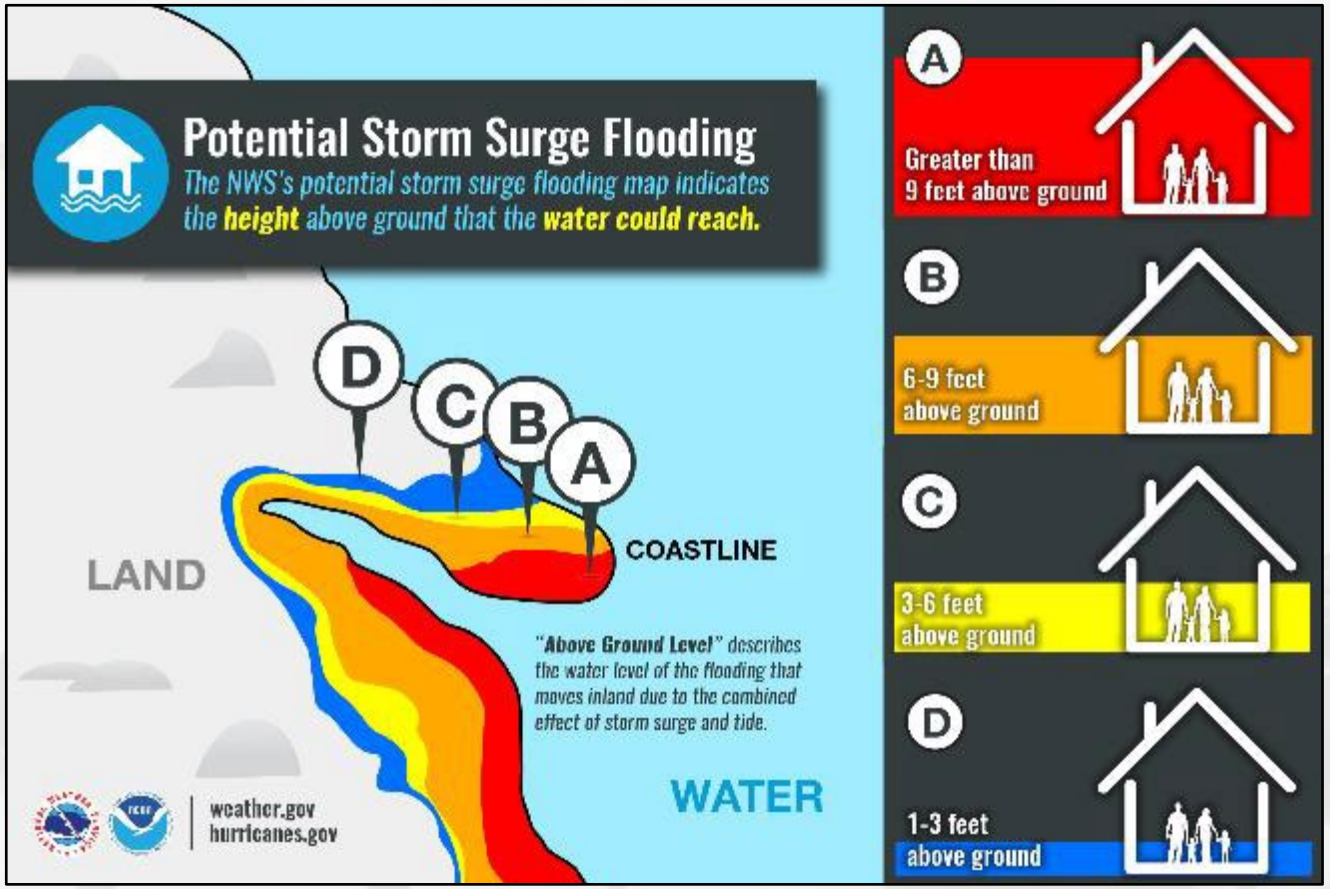
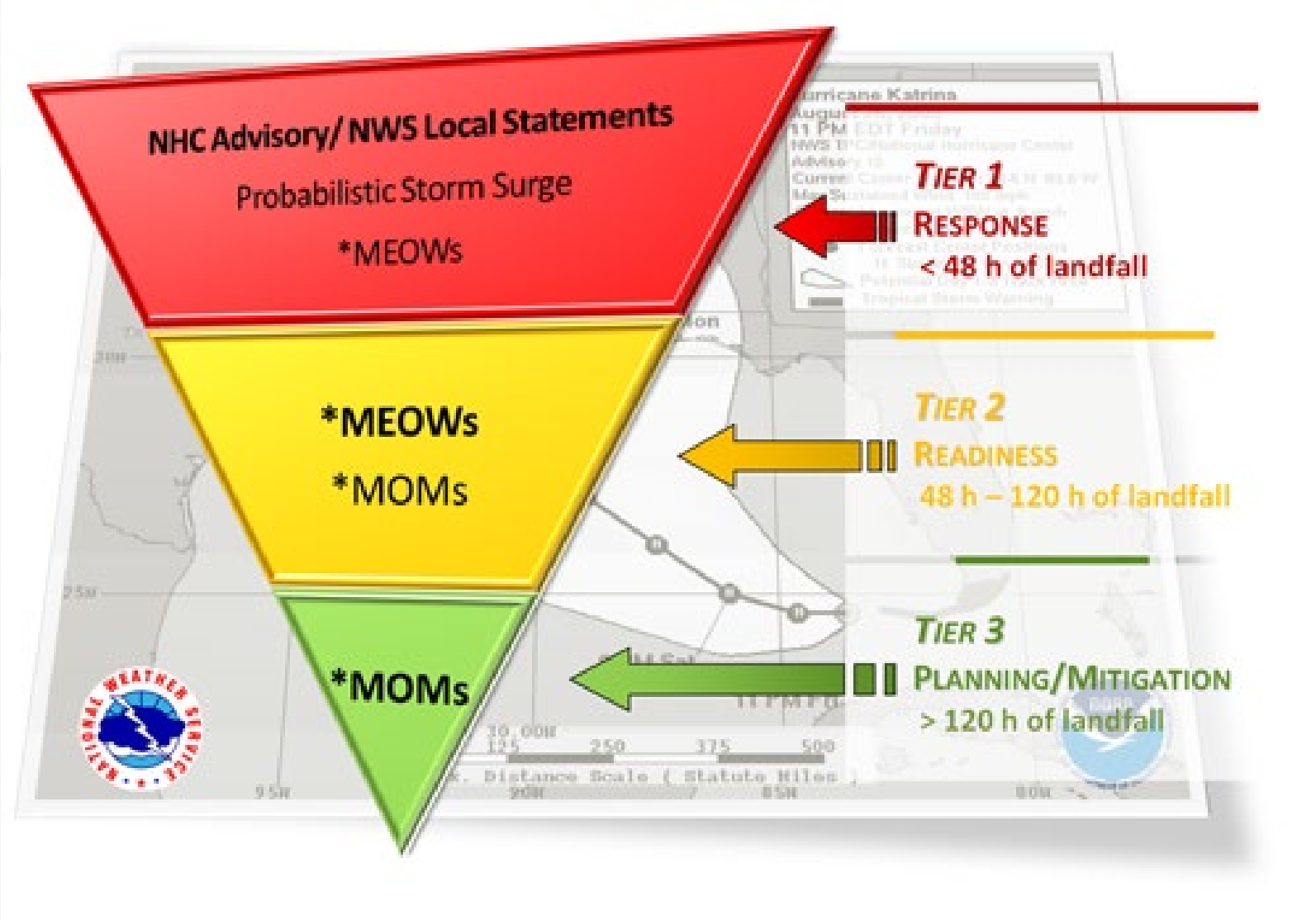




STORM SURGE
Decision Support Timeframes



HURRICANE READINESS
L0311

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Questions/Comments?