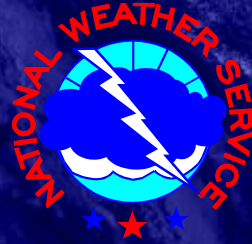


National Hurricane Center Probability Products



**Dr. Richard Knabb, Senior Hurricane Specialist
National Hurricane Center**

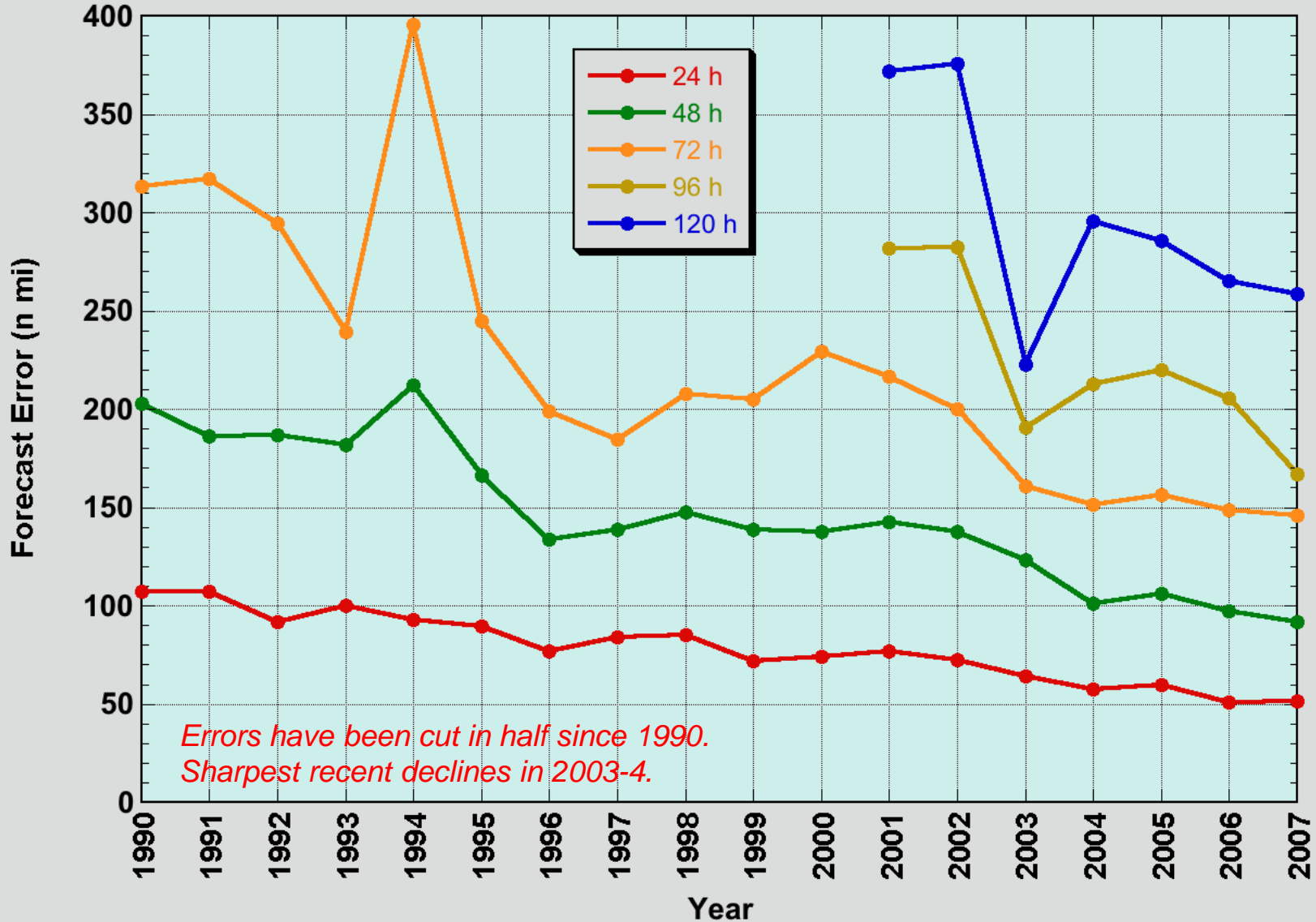
**Florida Governor's Hurricane Conference
May 2008**

NHC Tropical Cyclone Forecast Parameters

Forecast Hour (Day)	Position and Intensity	34 kt wind radii	50 kt wind radii	64 kt wind radii
3 (adv time)				
12				
24 (1)				
36				
48 (2)				
72 (3)				
96 (4)				
120 (5)				

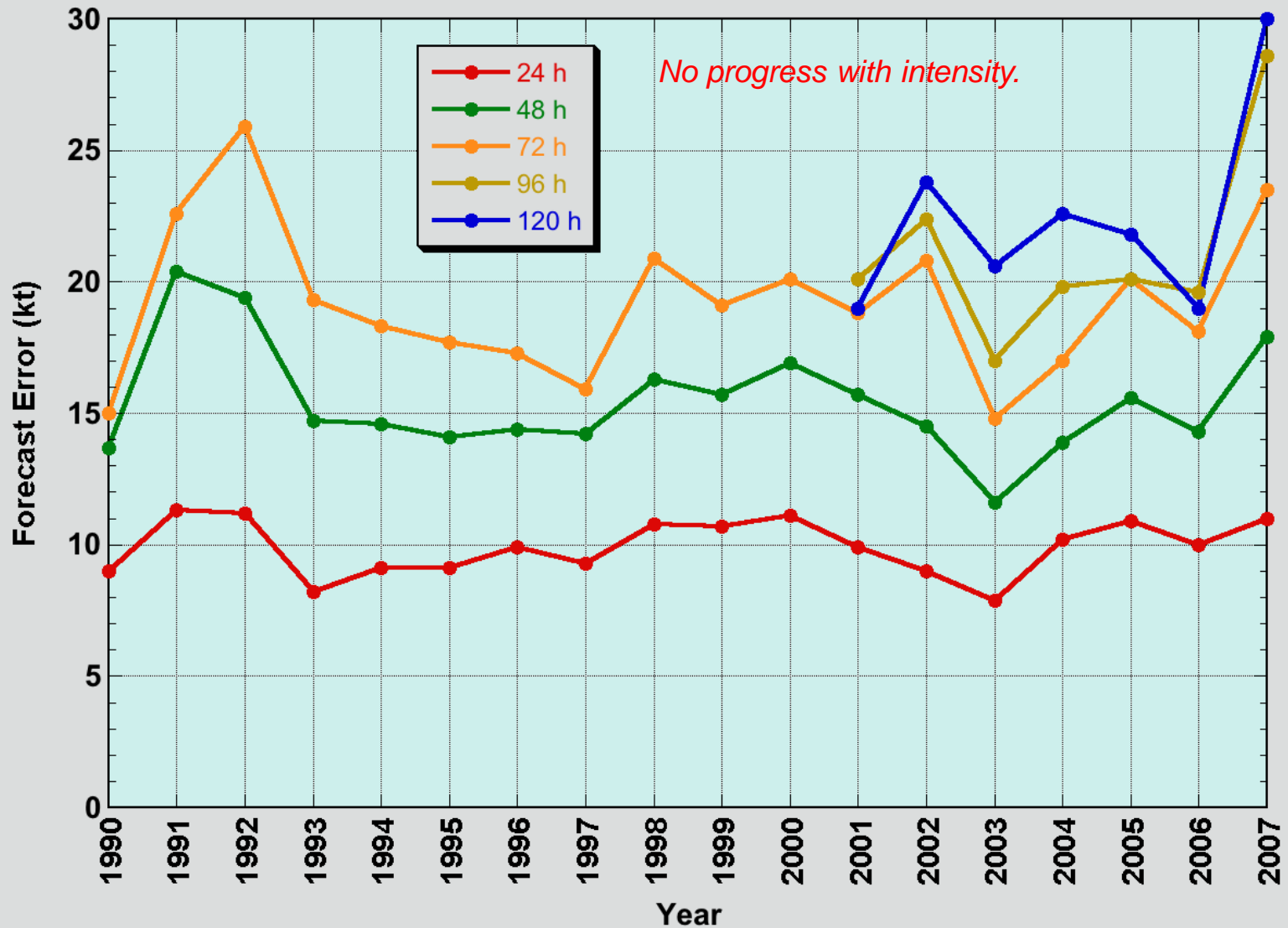
Atlantic Track Error Trends

NHC Official Track Error Trend Atlantic Basin



Atlantic Intensity Error Trends

NHC Official Intensity Error Trend Atlantic Basin



NHC Advisory Package Products

- Forecast/advisory (text)
- Public advisory (text)
- Discussion (text)
- Watch/warning track/cone graphic
- Initial size and watch/warning graphic

- Wind speed probabilities (text and graphics)
- Intensity probability table (graphic)
- Storm surge probabilities (graphic)

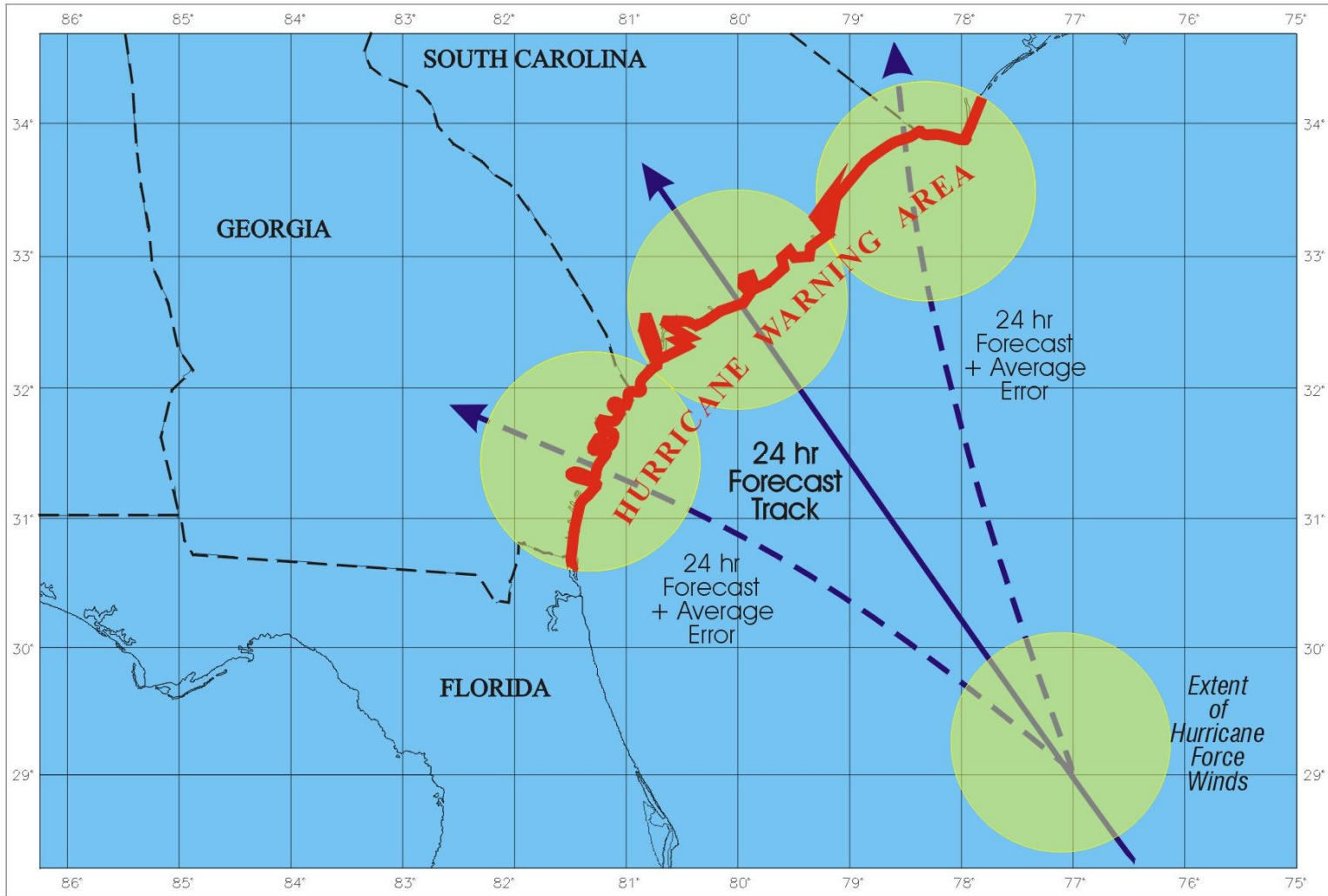
Additional Content of NHC Products

- Coastal watches and warnings
- Generalized storm surge forecast
- Generalized rainfall forecast
- Tornado potential
- General information on other hazards
- Forecaster reasoning
- Forecast uncertainties

What do coastal watches and warnings mean?

- Hurricane Warning: hurricane conditions are expected within the warning area, generally within the next 24 hours
- Hurricane Watch: hurricane conditions are possible within the watch area, generally within the next 36 hours

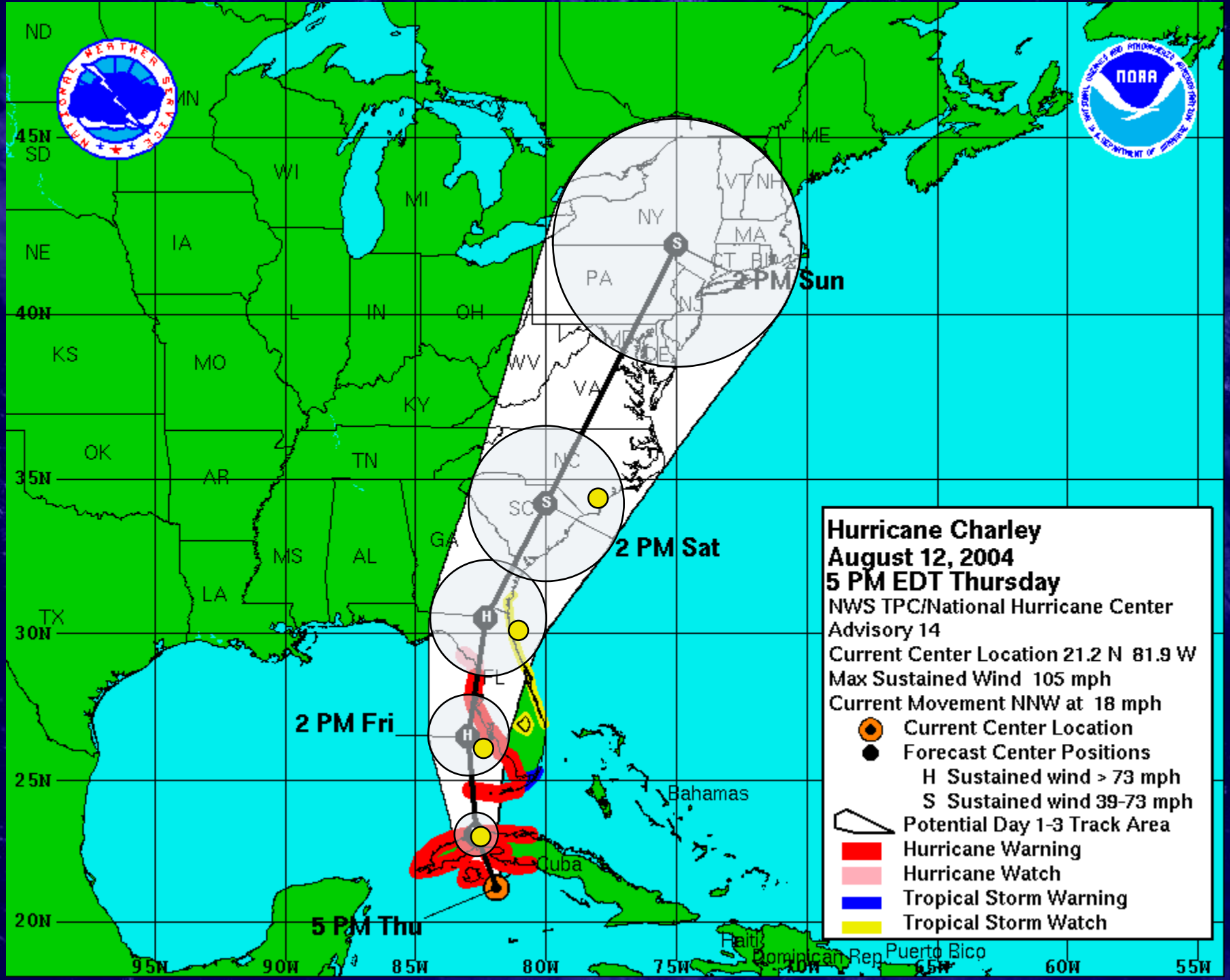
Over-warning a necessity due to forecast uncertainties



Hurricane **Watch** and **Warning** Statistics (2000-2006)

- Average storm-total watch length 489 miles
- Average storm-total length w\ hurricane winds 100 miles
- Probability of hurricane winds at point under watch **20%**

- Average storm-total warning length 417 miles
- Average storm-total length w\ hurricane winds 100 miles
- Probability of hurricane winds at warned point **25%**



Hurricane Charley
August 12, 2004
5 PM EDT Thursday
NWS TPC/National Hurricane Center
Advisory 14
Current Center Location 21.2 N 81.9 W
Max Sustained Wind 105 mph
Current Movement NNW at 18 mph

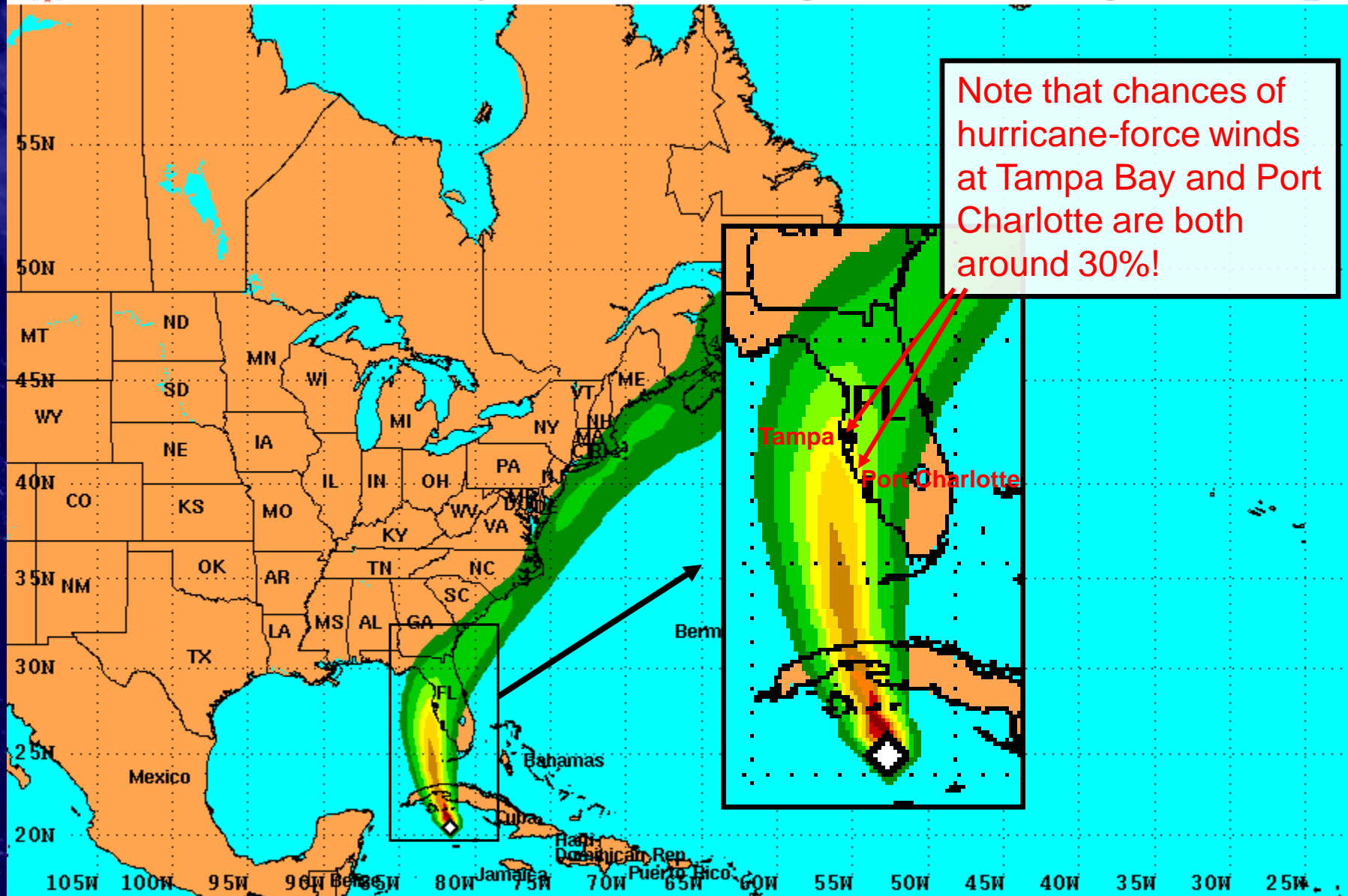
- Current Center Location
- Forecast Center Positions
 - H Sustained wind > 73 mph
 - S Sustained wind 39-73 mph
- ▭ Potential Day 1-3 Track Area
- Hurricane Warning
- Hurricane Watch
- Tropical Storm Warning
- Tropical Storm Watch

NHC wind speed probabilities

- Describe chances of a *weather event* at any specific location
- Convey chances of wind speeds of at least particular thresholds
 - 34 kt / 39 mph (tropical storm force)
 - 50 kt / 58 mph
 - 64 kt / 74 mph (hurricane force)
- Account for combined uncertainties in NHC track, intensity, and size forecasts
- Extend to 5 days
- Include inland locations



PRELIMINARY (SINGLE STORM) Hurricane Force Wind Speed Probabilities
 For the 120 hours (5 days) from 2 PM EDT Thu Aug 12 to 2 PM EDT Tue Aug 17



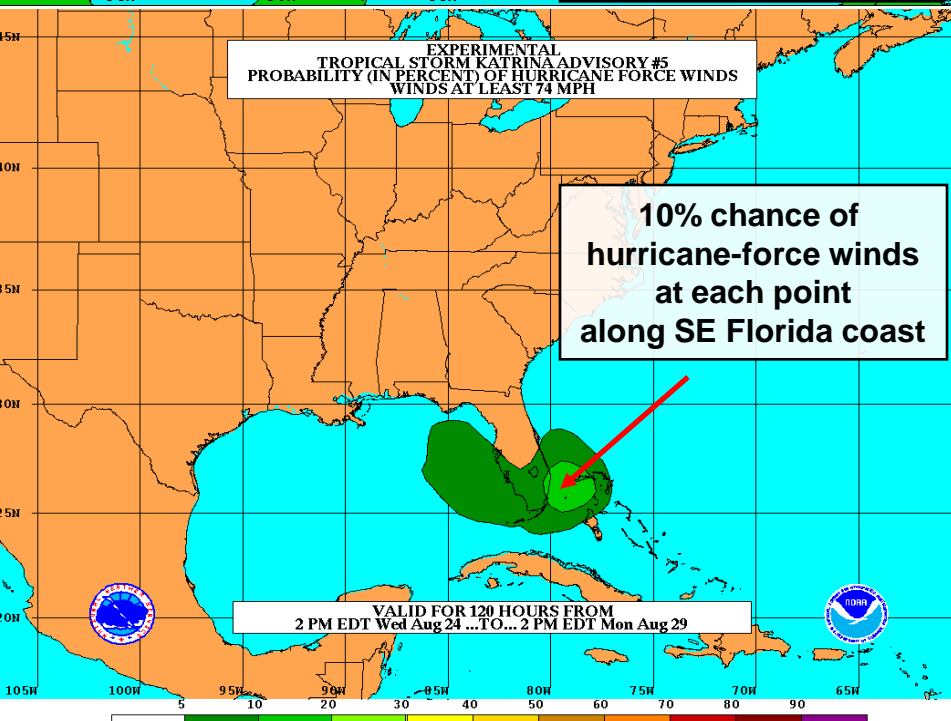
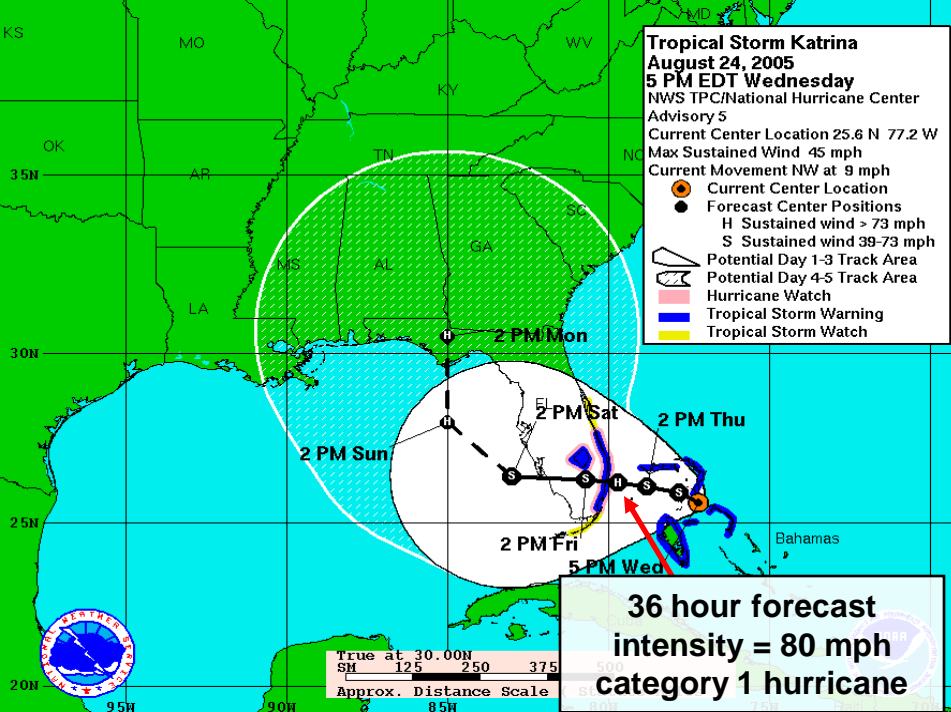
Note that chances of hurricane-force winds at Tampa Bay and Port Charlotte are both around 30%!

Probabilities of sustained hurricane force surface winds (1-minute average of 74 mph or greater) from all active tropical cyclones

◇ indicates HURRICANE CHARLEY center location at 2 PM EDT Thu Aug 12 2004 (Forecast/Advisory #14)



Katrina Advisory 5

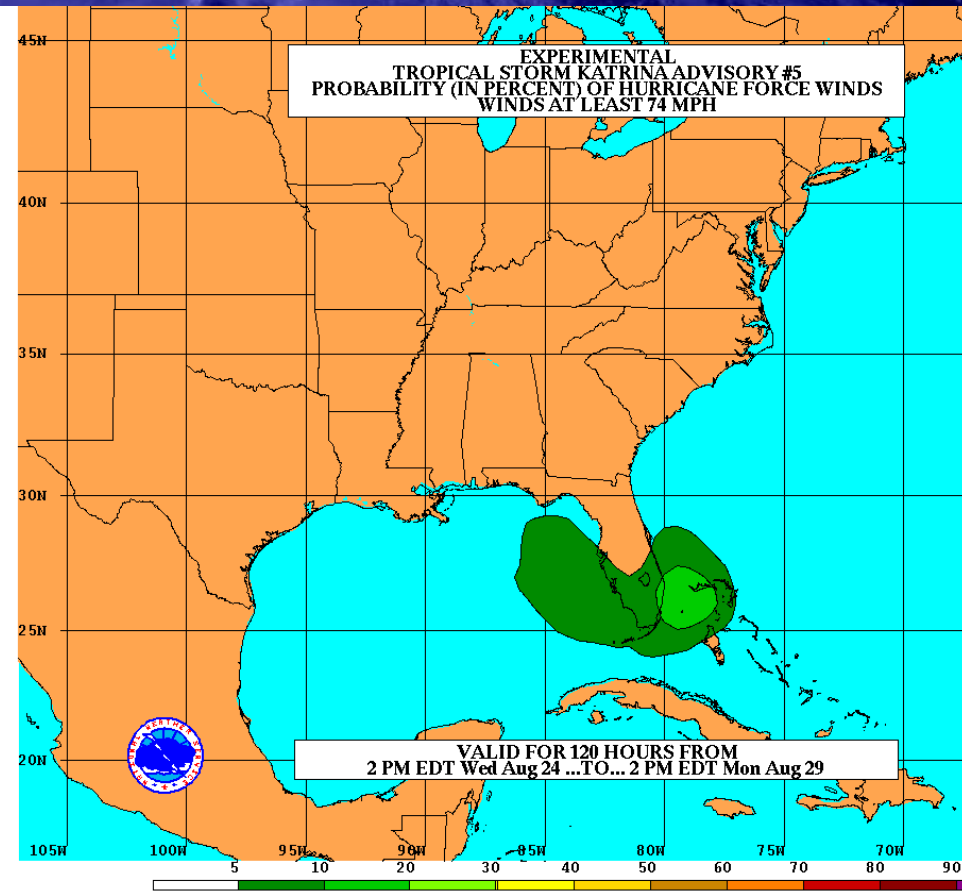
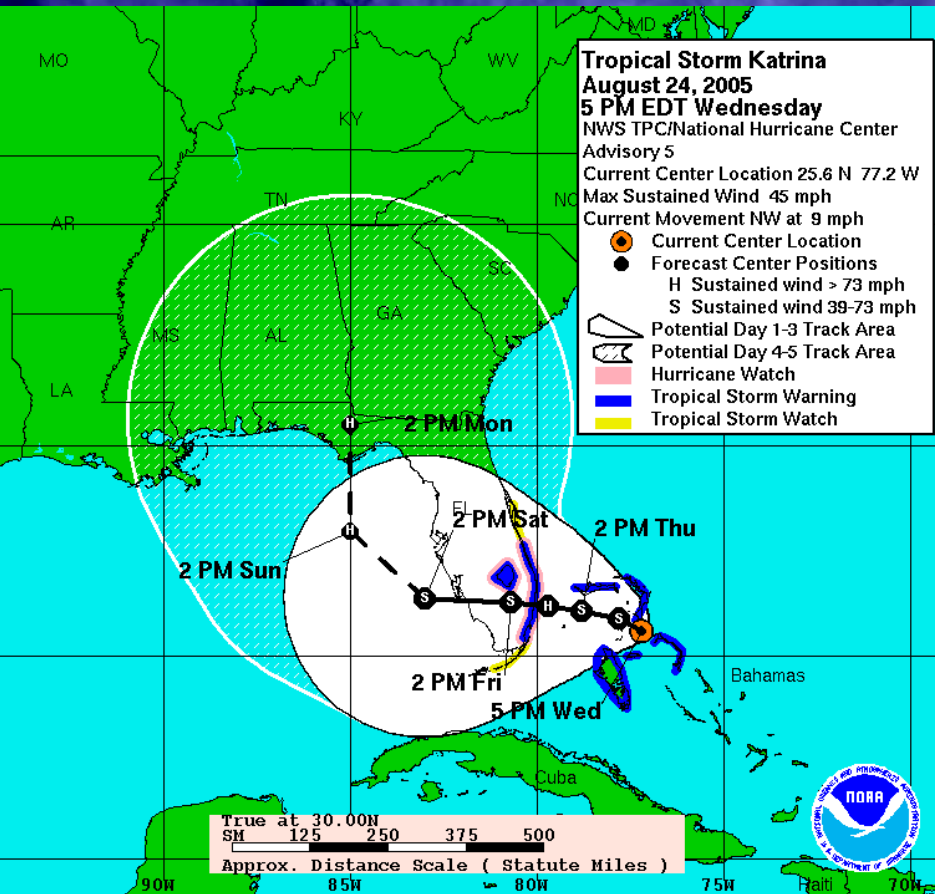


**Maximum Wind Speed (Intensity) Probability Table
From NHC Advisory 5
5 PM EDT Aug 24, 2005**

Wind Range (mph)	Forecast Time						
	12 hour for 2 PM Fri	24 hour for 2 AM Sat	36 hour for 2 PM Sat	48 hour for 2 AM Sun	72 hour for 2 AM Mon	96 hour for 2 AM Tue	120 hour for 2 AM Wed
Dissipated	<1%	<1%	1%	2%	10%	15%	13%
Tropical Depression (<39)	3%	5%	8%	7%	22%	18%	15%
Tropical Storm (39-73)	92%	66%	43%	49%	48%	34%	40%
Hurricane (74+)	6%	29%	48%	43%	20%	33%	32%
Category 1 (74-95)	5%	26%	37%	29%	15%	21%	20%
Category 2 (96-110)	<1%	2%	8%	9%	3%	8%	8%
Category 3 (111-130)	<1%	1%	2%	3%	1%	4%	3%
Category 4 (131-155)	<1%	<1%	1%	1%	<1%	1%	1%
Category 5 (>155)	<1%	<1%	<1%	<1%	<1%	<1%	<1%
NHC Forecast	60	70	80	60	65	80	75

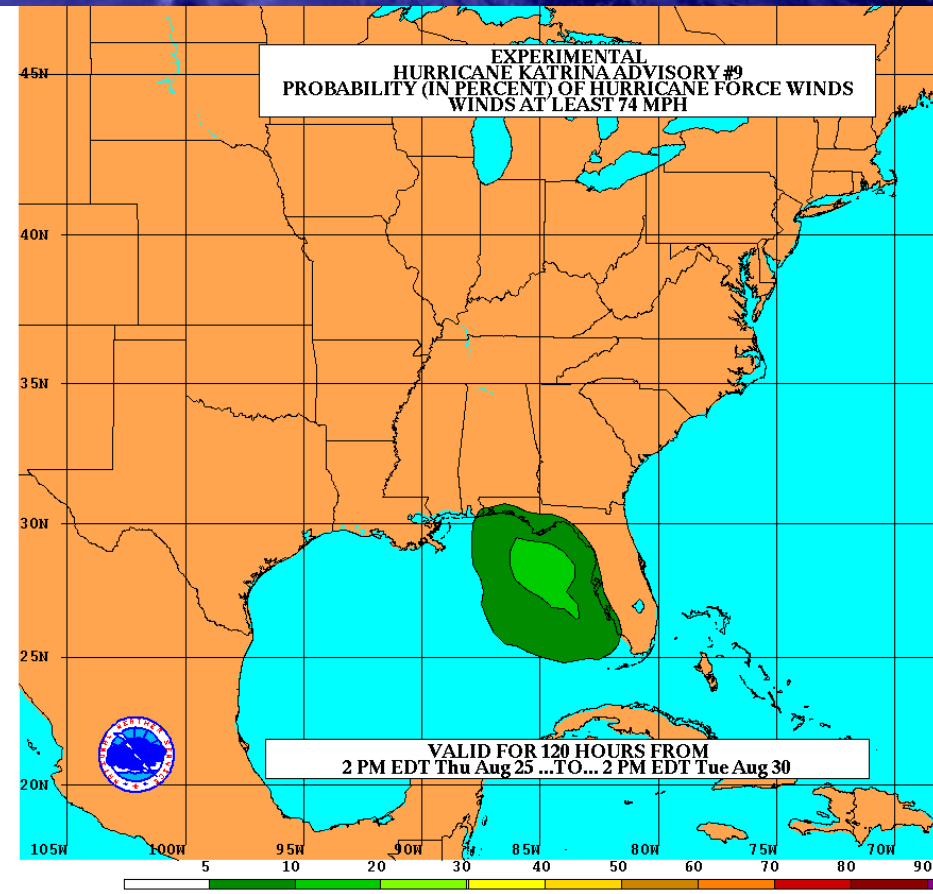
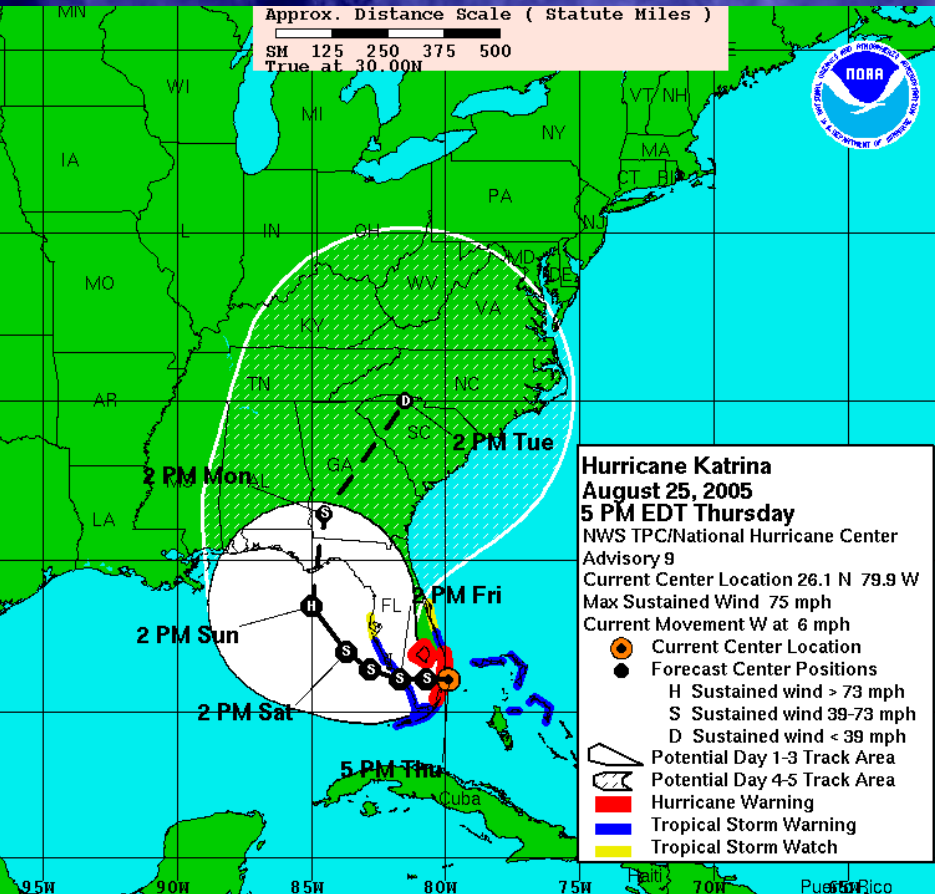
Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

Katrina Advisory #5



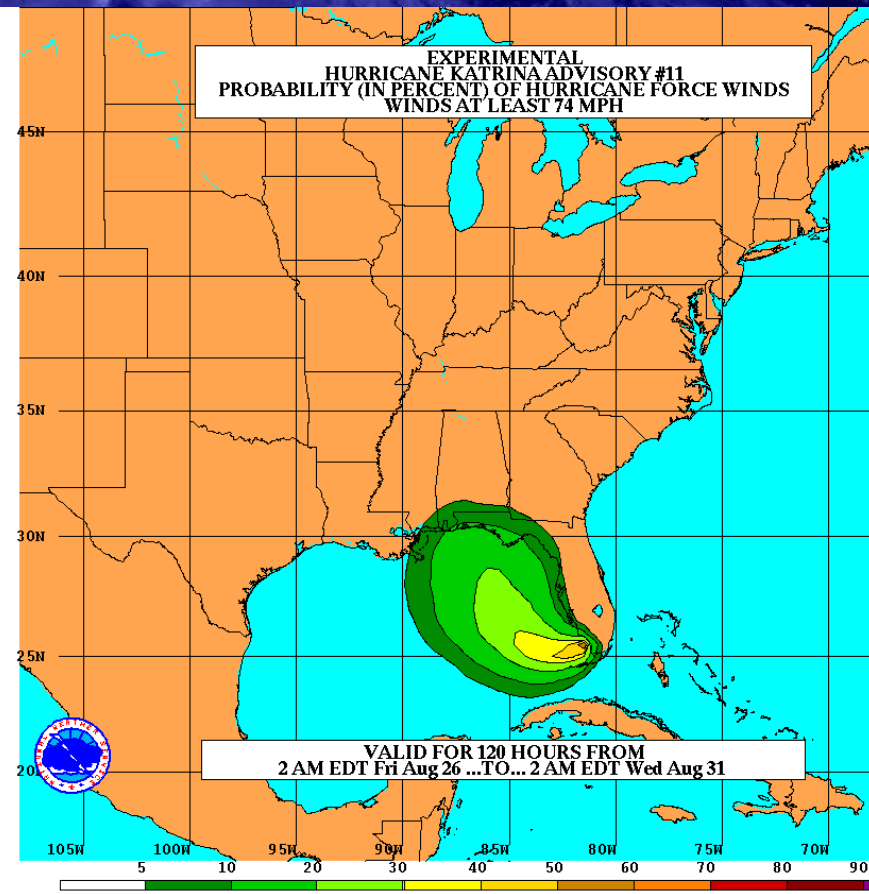
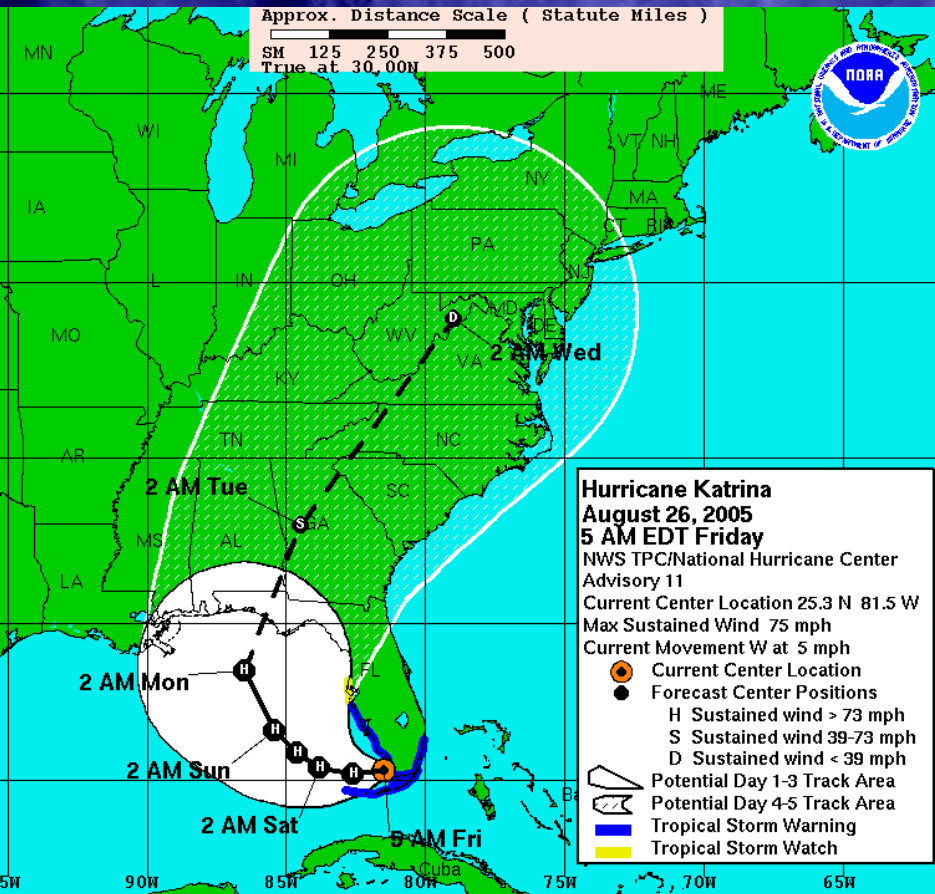
Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

Katrina Advisory #9



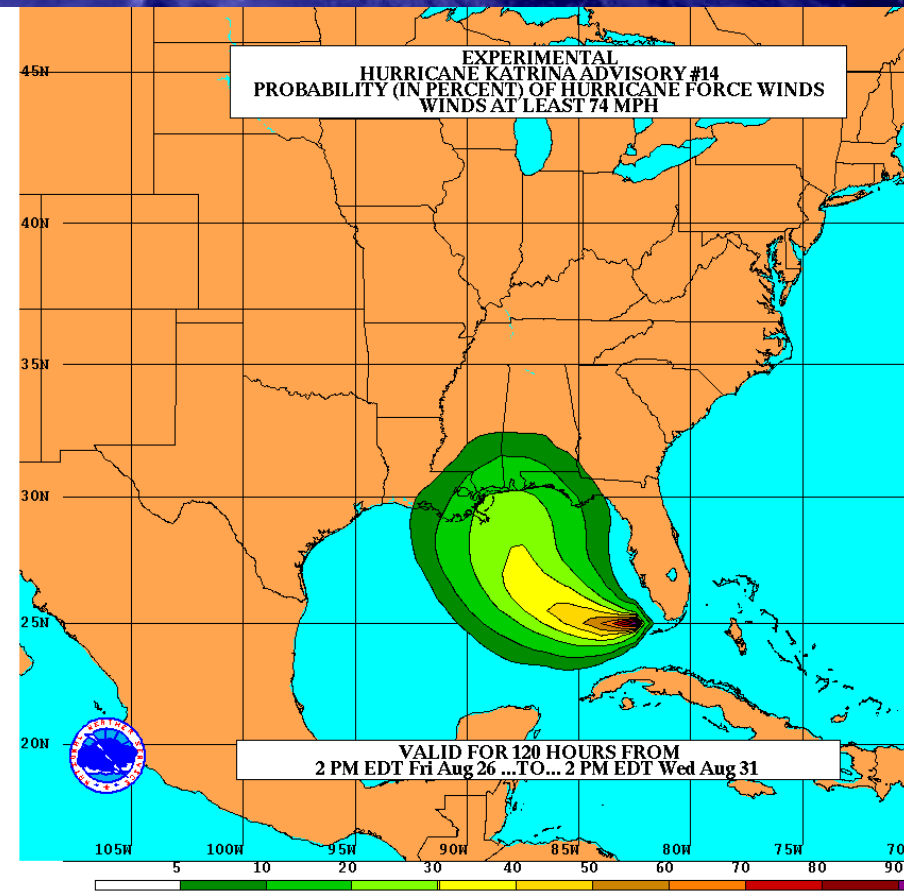
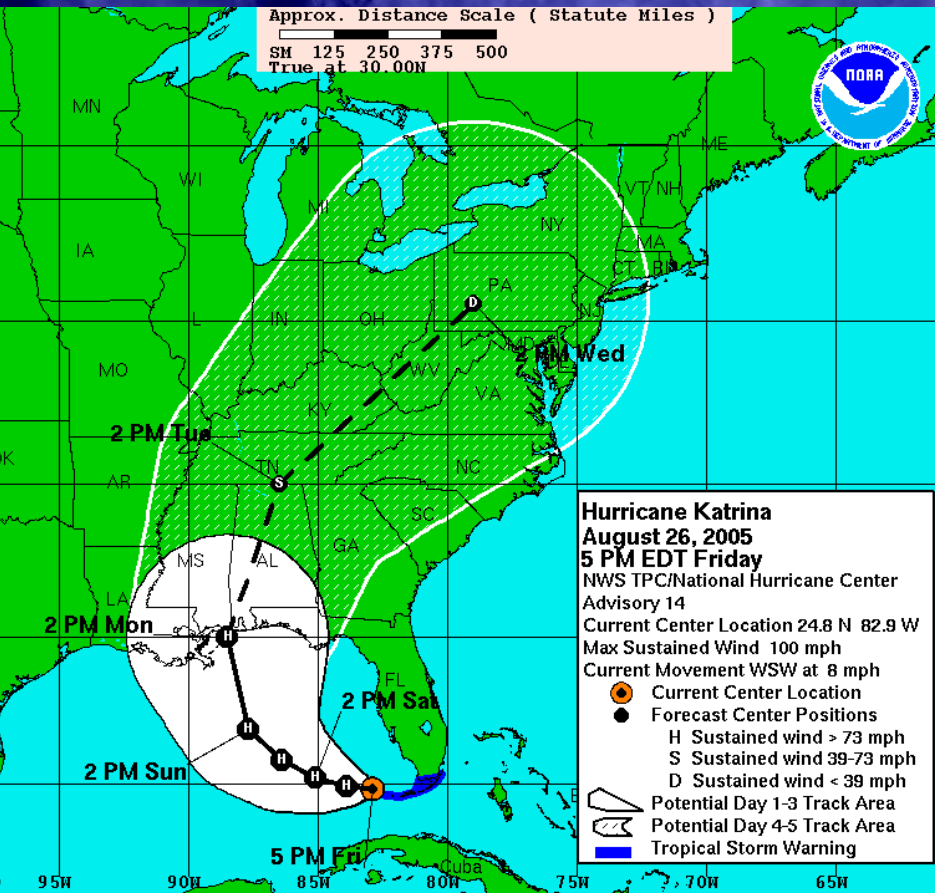
Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

Katrina Advisory #11



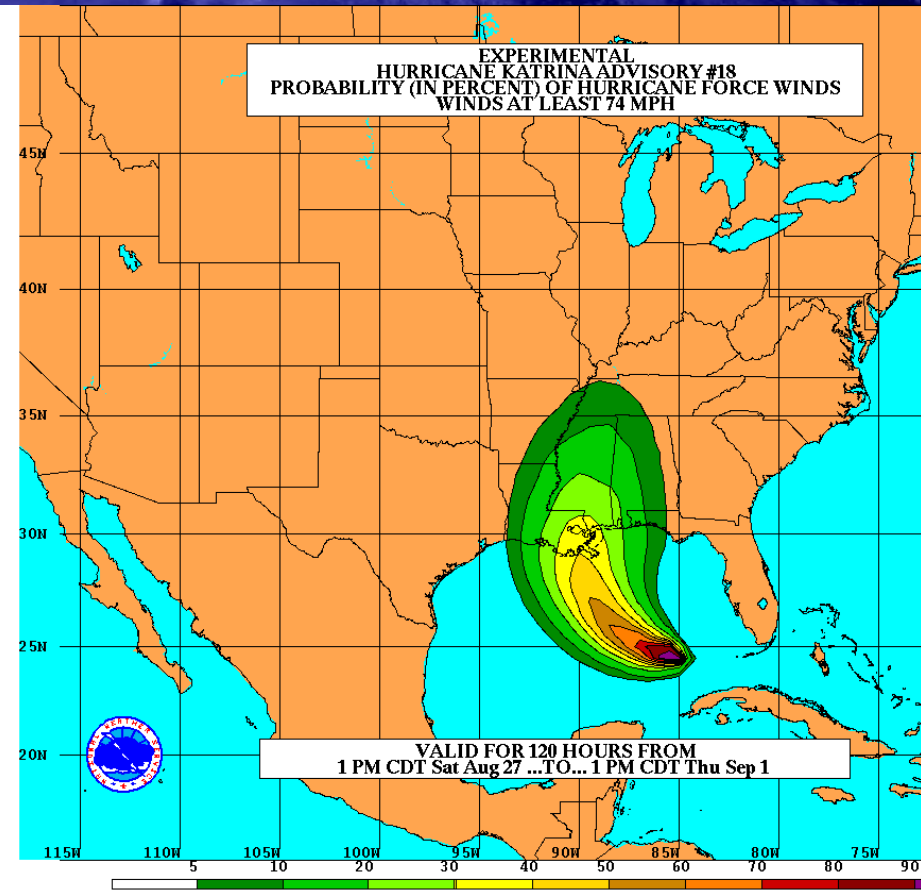
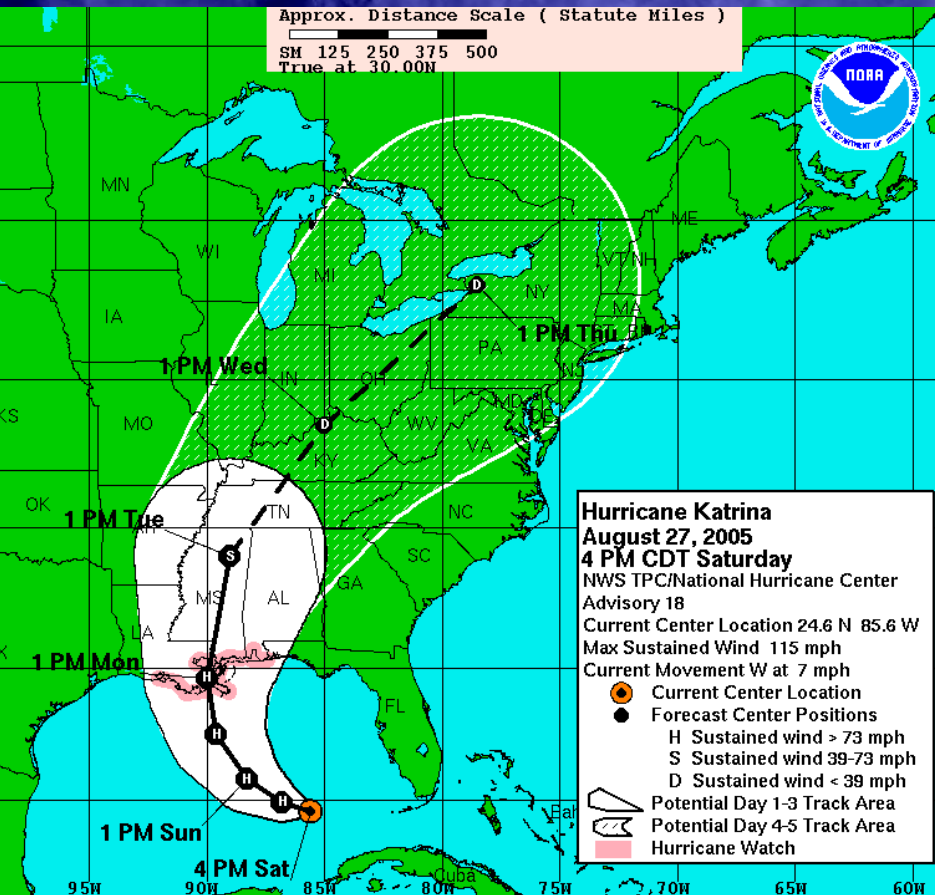
Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

Katrina Advisory #14



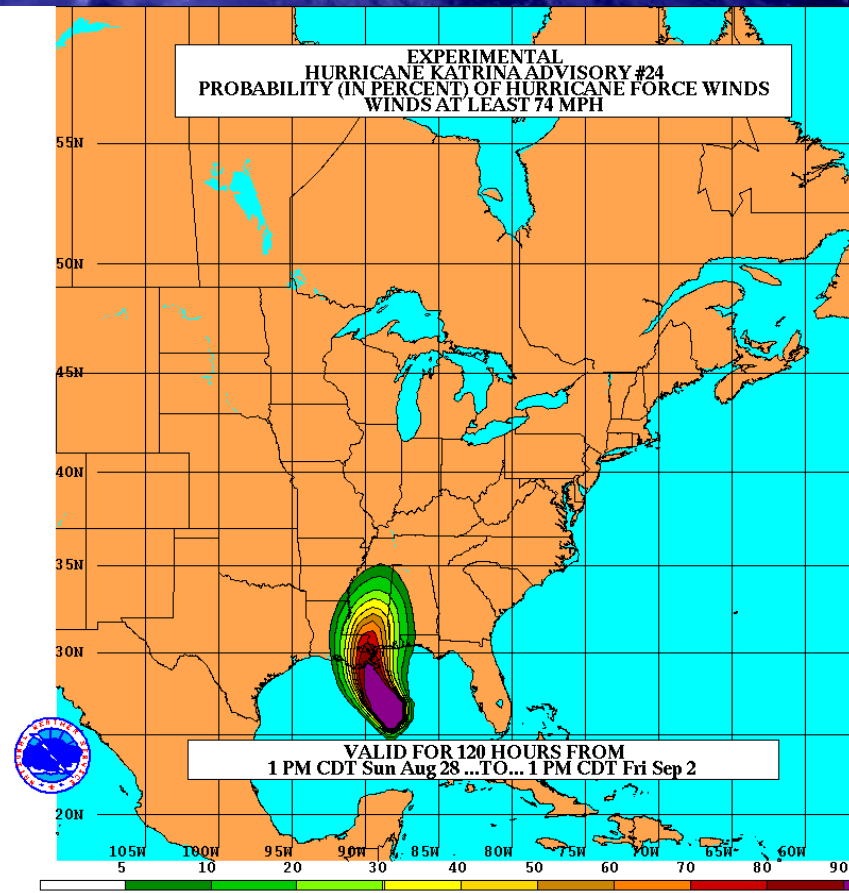
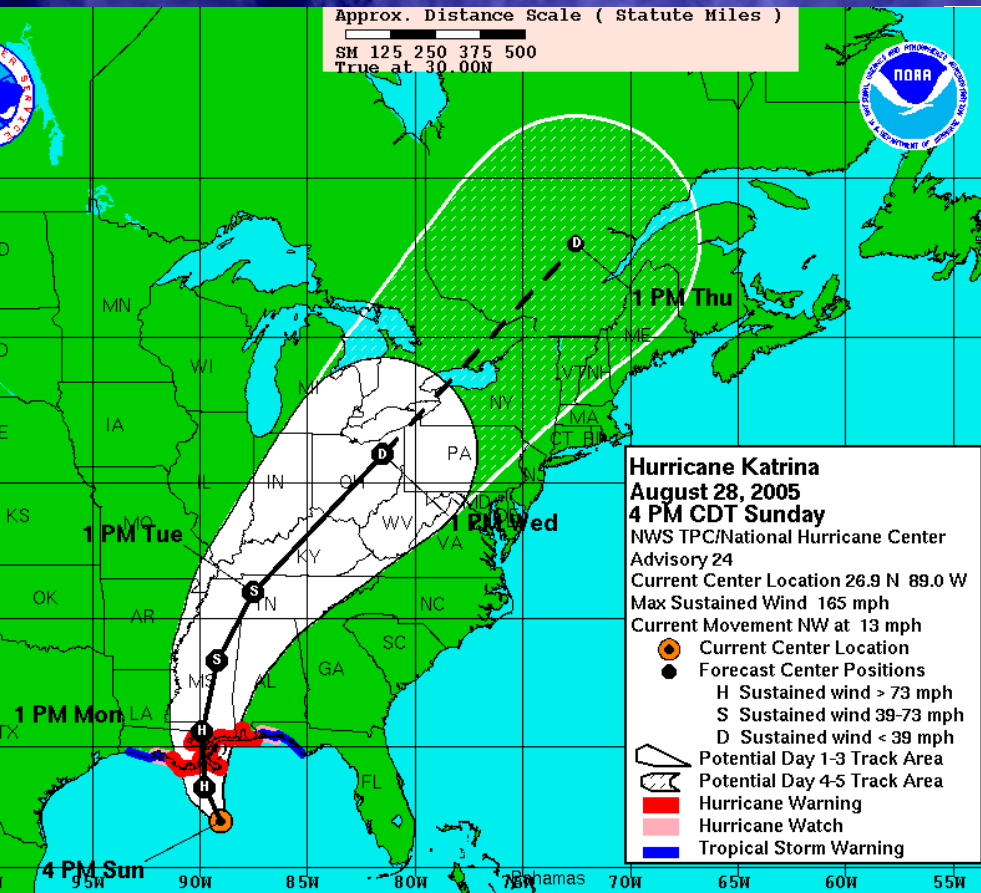
Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

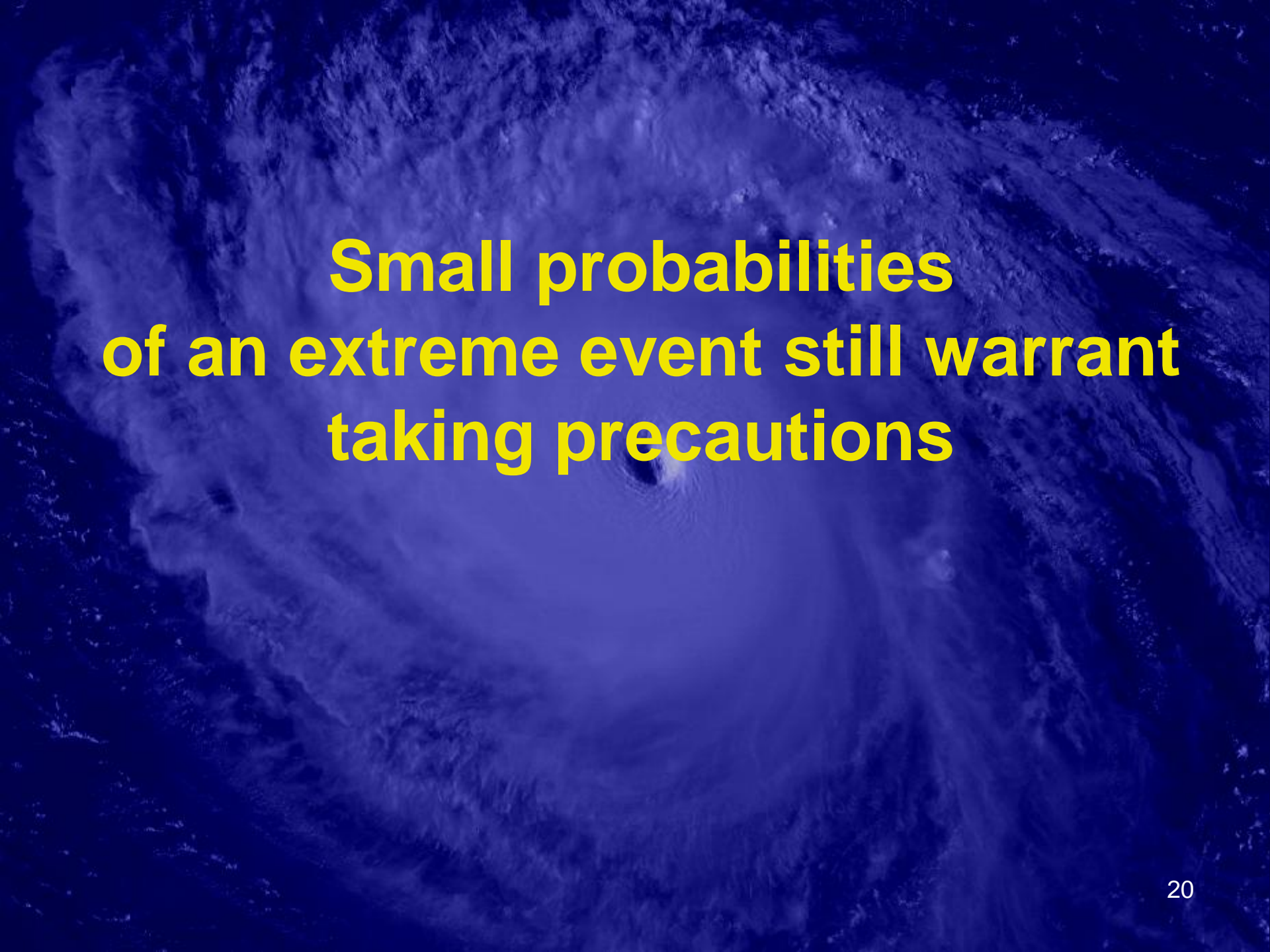
Katrina Advisory #18



Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

Katrina Advisory #24



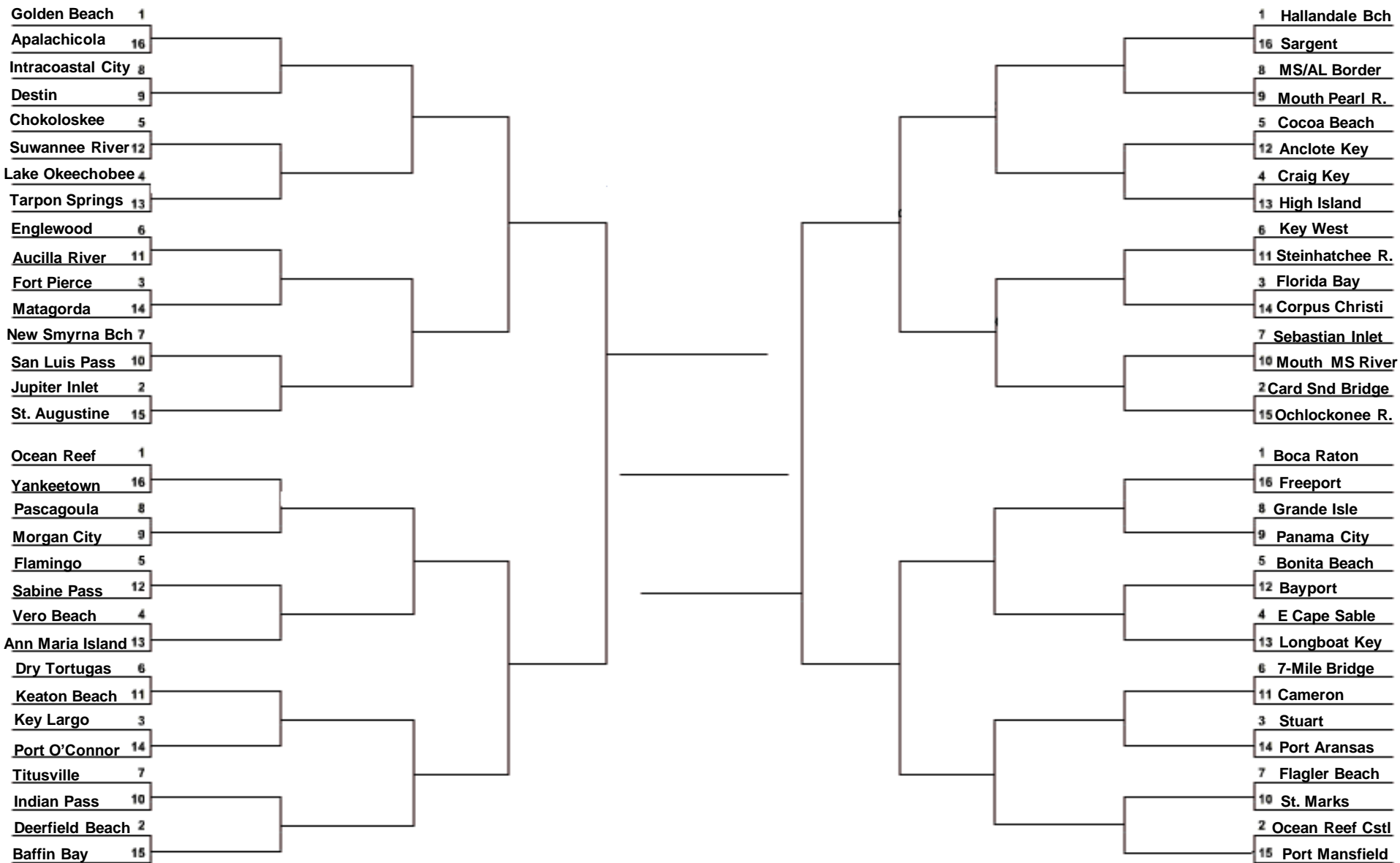
An aerial photograph of a large, circular impact crater, likely the Chicxulub crater, showing a distinct central peak and a surrounding ring of hills. The terrain is rugged and textured, with a dark blue color cast over the entire image.

**Small probabilities
of an extreme event still warrant
taking precautions**

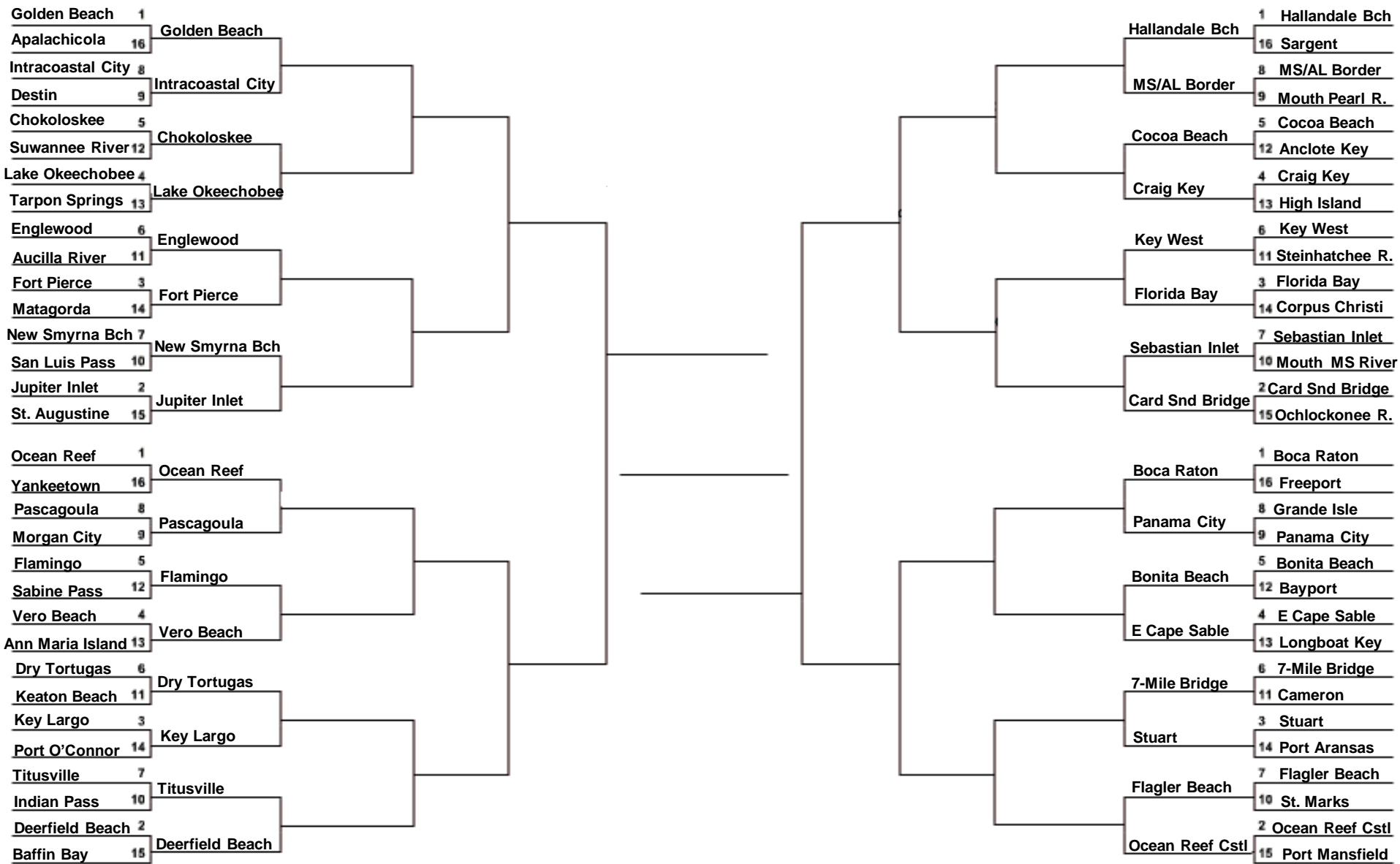
An aerial photograph of a large, circular crater, likely the Chicxulub crater, showing concentric rings and a central peak. The image is overlaid with a dark blue gradient.

Probabilities apply to specific locations, not large regions

Who is going to get hurricane force winds?



Who is going to get hurricane force winds?



Who is going to get hurricane force winds?



Who is going to get hurricane force winds?



Who is going to get hurricane force winds?



Who is going to get hurricane force winds?



Interpretation of the Wind Speed Probability Text Product

What is the chance that winds of tropical storm force (34 kt or greater) will occur at Charlotte NC during the next five days?

TIME PERIODS	FROM 18Z FRI TO 06Z SAT	FROM 06Z SAT TO 18Z SAT	FROM 18Z SAT TO 06Z SUN	FROM 06Z SUN TO 18Z SUN	FROM 18Z SUN TO 18Z MON	FROM 18Z MON TO 18Z TUE	FROM 18Z TUE TO 18Z WED
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
RALEIGH NC	34 X	X(X)	X(X)	2(2)	10(12)	8(20)	10(30)
RALEIGH NC	50 X	X(X)	X(X)	X(X)	2(2)	3(5)	5(10)
RALEIGH NC	64 X	X(X)	X(X)	X(X)	X(X)	2(2)	2(4)
CAPE HATTERAS	34 X	X(X)	X(X)	1(1)	4(5)	3(8)	7(15)
CAPE HATTERAS	50 X	X(X)	X(X)	X(X)	X(X)	1(1)	2(3)
CHARLOTTE NC	34 X	X(X)	X(X)	3(3)	18(21)	12(33)	9(42)
CHARLOTTE NC	50 X	X(X)	X(X)	X(X)	4(4)	6(10)	4(14)
CHARLOTTE NC	64 X	X(X)	X(X)	X(X)	2(2)	2(4)	2(6)

34 kt
probabilities
at Charlotte
NC



Interpretation of the Wind Speed Probability Text Product

What is the chance that winds of tropical storm force (34 kt or greater) will occur at Charlotte NC during the next five days?

42%

TIME PERIODS	FROM 18Z FRI TO 06Z SAT	FROM 06Z SAT TO 18Z SAT	FROM 18Z SAT TO 06Z SUN	FROM 06Z SUN TO 18Z SUN	FROM 18Z SUN TO 18Z MON	FROM 18Z MON TO 18Z TUE	FROM 18Z TUE TO 18Z WED
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
RALEIGH NC	34 X	X(X)	X(X)	2(2)	10(12)	8(20)	10(30)
RALEIGH NC	50 X	X(X)	X(X)	X(X)	2(2)	3(5)	5(10)
RALEIGH NC	64 X	X(X)	X(X)	X(X)	X(X)	2(2)	2(4)
CAPE HATTERAS	34 X	X(X)	X(X)	1(1)	4(5)	3(8)	7(15)
CAPE HATTERAS	50 X	X(X)	X(X)	X(X)	X(X)	1(1)	2(3)
CHARLOTTE NC	34 X	X(X)	X(X)	3(3)	18(21)	12(33)	9(42)
CHARLOTTE NC	50 X	X(X)	X(X)	X(X)	4(4)	6(10)	4(14)
CHARLOTTE NC	64 X	X(X)	X(X)	X(X)	2(2)	2(4)	2(6)

34 kt probabilities at Charlotte NC

Interpretation of the Wind Speed Probability Text Product

What is the chance that winds of tropical storm force (34 kt or greater) will occur at Charlotte NC during the next five days?

42%

When are these winds most likely to start?

34 kt
probabilities
at Charlotte
NC



TIME PERIODS	FROM 18Z FRI TO 06Z SAT	FROM 06Z SAT TO 18Z SAT	FROM 18Z SAT TO 06Z SUN	FROM 06Z SUN TO 18Z SUN	FROM 18Z SUN TO 18Z MON	FROM 18Z MON TO 18Z TUE	FROM 18Z TUE TO 18Z WED
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
RALEIGH NC	34 X	X(X)	X(X)	2(2)	10(12)	8(20)	10(30)
RALEIGH NC	50 X	X(X)	X(X)	X(X)	2(2)	3(5)	5(10)
RALEIGH NC	64 X	X(X)	X(X)	X(X)	X(X)	2(2)	2(4)
CAPE HATTERAS	34 X	X(X)	X(X)	1(1)	4(5)	3(8)	7(15)
CAPE HATTERAS	50 X	X(X)	X(X)	X(X)	X(X)	1(1)	2(3)
CHARLOTTE NC	34 X	X(X)	X(X)	3(3)	18(21)	12(33)	9(42)
CHARLOTTE NC	50 X	X(X)	X(X)	X(X)	4(4)	6(10)	4(14)
CHARLOTTE NC	64 X	X(X)	X(X)	X(X)	2(2)	2(4)	2(6)

Interpretation of the Wind Speed Probability Text Product

What is the chance that winds of tropical storm force (34 kt or greater) will occur at Charlotte NC during the next five days?

42%

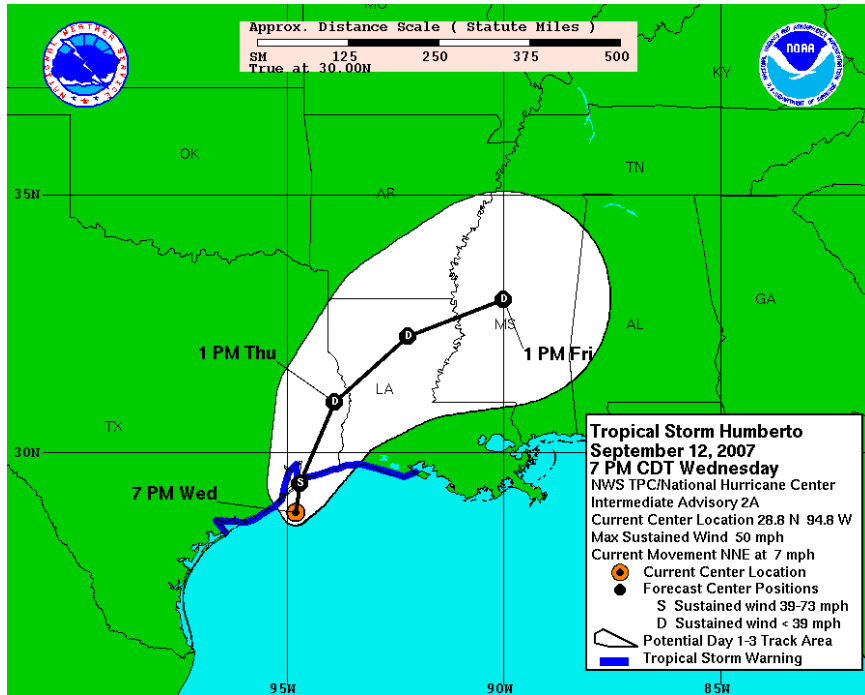
When are these winds most likely to start?

From 18Z Sun to 18Z Mon (18% chance)

TIME PERIODS	FROM 18Z FRI TO 06Z SAT	FROM 06Z SAT TO 18Z SAT	FROM 18Z SAT TO 06Z SUN	FROM 06Z SUN TO 18Z SUN	FROM 18Z SUN TO 18Z MON	FROM 18Z MON TO 18Z TUE	FROM 18Z TUE TO 18Z WED
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
RALEIGH NC	34 X	X(X)	X(X)	2(2)	10(12)	8(20)	10(30)
RALEIGH NC	50 X	X(X)	X(X)	X(X)	2(2)	3(5)	5(10)
RALEIGH NC	64 X	X(X)	X(X)	X(X)	X(X)	2(2)	2(4)
CAPE HATTERAS	34 X	X(X)	X(X)	1(1)	4(5)	3(8)	7(15)
CAPE HATTERAS	50 X	X(X)	X(X)	X(X)	X(X)	1(1)	2(3)
CHARLOTTE NC	34 X	X(X)	X(X)	3(3)	18(21)	12(33)	9(42)
CHARLOTTE NC	50 X	X(X)	X(X)	X(X)	4(4)	6(10)	4(14)
CHARLOTTE NC	64 X	X(X)	X(X)	X(X)	2(2)	2(4)	2(6)

34 kt probabilities at Charlotte NC

Intensity Probability Table



Small probabilities are important

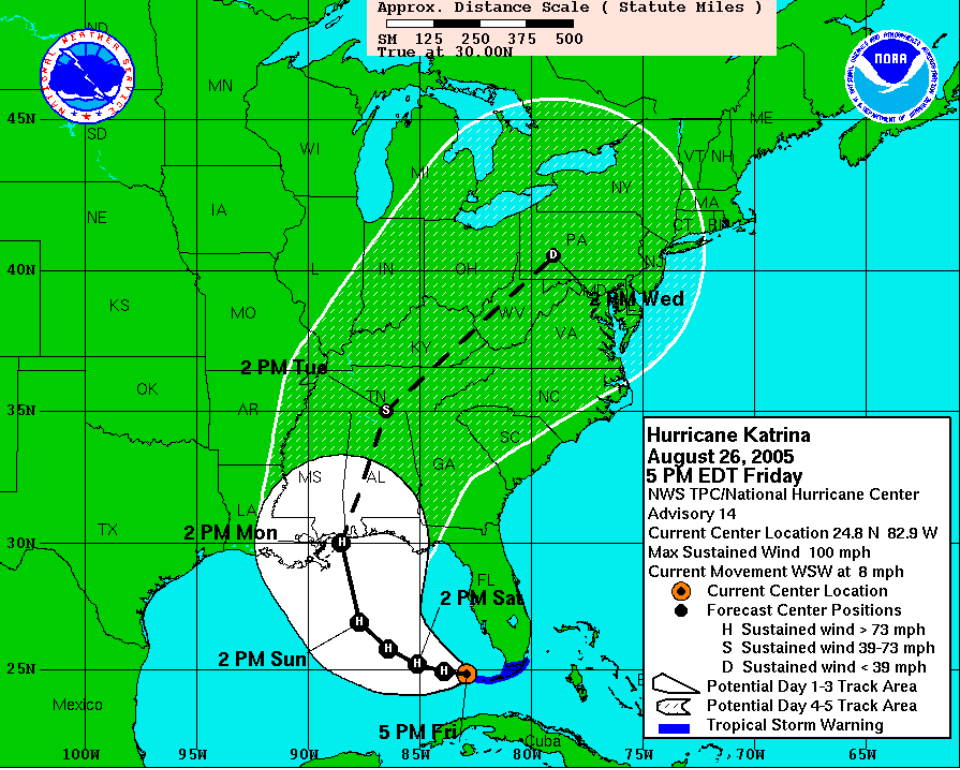
Probability of Humberto reaching Hurricane strength in 12 h is 6%



Maximum Wind Speed (Intensity) Probability Table
 From NHC Advisory 2
 5 PM EDT Sep 12, 2007



Wind Range (mph)	Forecast Time (hours)						
	12	24	36	48	72	96	120
Dissipated	1%	14%	29%	45%			
Tropical Depression (<39)	26%	55%	50%	36%			
Tropical Storm (39-73)	67%	30%	20%	18%			
Hurricane (74+)	6%	2%	2%	1%			
Category 1 (74-95)	6%	1%	1%	1%			
Category 2 (96-110)	<1%	<1%	<1%	<1%			
Category 3 (111-130)	<1%	<1%	<1%	<1%			
Category 4 (131-155)	<1%	<1%	<1%	<1%			
Category 5 (>155)	<1%	<1%	<1%	<1%			
NHC Fcst (mph)	65	35	25	20	0	0	0



Katrina

Advisory 14

Verifying Intensity

Official NHC Intensity Forecast

- 12 hour forecast- 105 mph (cat. 2) **cat. 2**
- 24 hour forecast- 110 mph (cat. 2) **cat. 3**
- 36 hour forecast- 115 mph (cat. 3) **cat. 4**
- 48 hour forecast- 120 mph (cat. 3) **cat. 5**
- Landfall - 130 mph (cat. 3) **cat. 3**
- 72 hour forecast - 135 mph (cat. 4) **cat. 1**



Maximum Wind Speed (Intensity) Probability Table
 From NHC Advisory 14
 5 PM EDT Aug 26, 2005



Wind Range (mph)	Forecast Time						
	12 hour for 2 PM Fri	24 hour for 2 AM Sat	36 hour for 2 PM Sat	48 hour for 2 AM Sun	72 hour for 2 AM Mon	96 hour for 2 AM Tue	120 hour for 2 AM Wed
Dissipated	<1%	<1%	<1%	<1%	8%	46%	58%
Tropical Depression (<39)	<1%	<1%	<1%	<1%	13%	26%	20%
Tropical Storm (39-73)	1%	3%	4%	5%	20%	13%	6%
Hurricane (74+)	99%	97%	96%	94%	58%	15%	17%
Category 1 (74-95)	26%	21%	19%	18%	14%	3%	2%
Category 2 (96-110)	60%	47%	34%	26%	12%	2%	4%
Category 3 (111-130)	13%	25%	34%	34%	19%	5%	5%
Category 4 (131-155)	1%	3%	7%	14%	12%	4%	4%
Category 5 (>155)	<1%	<1%	1%	2%	3%	1%	1%

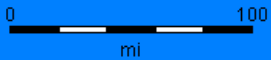
NHC Forecast	105	110	115	120	135	40	30
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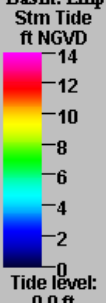
NHC TRACK ERROR 12 hr. OUT

IVAN Adv #54
Sep 15 2004 21z
132 mph 933 mb

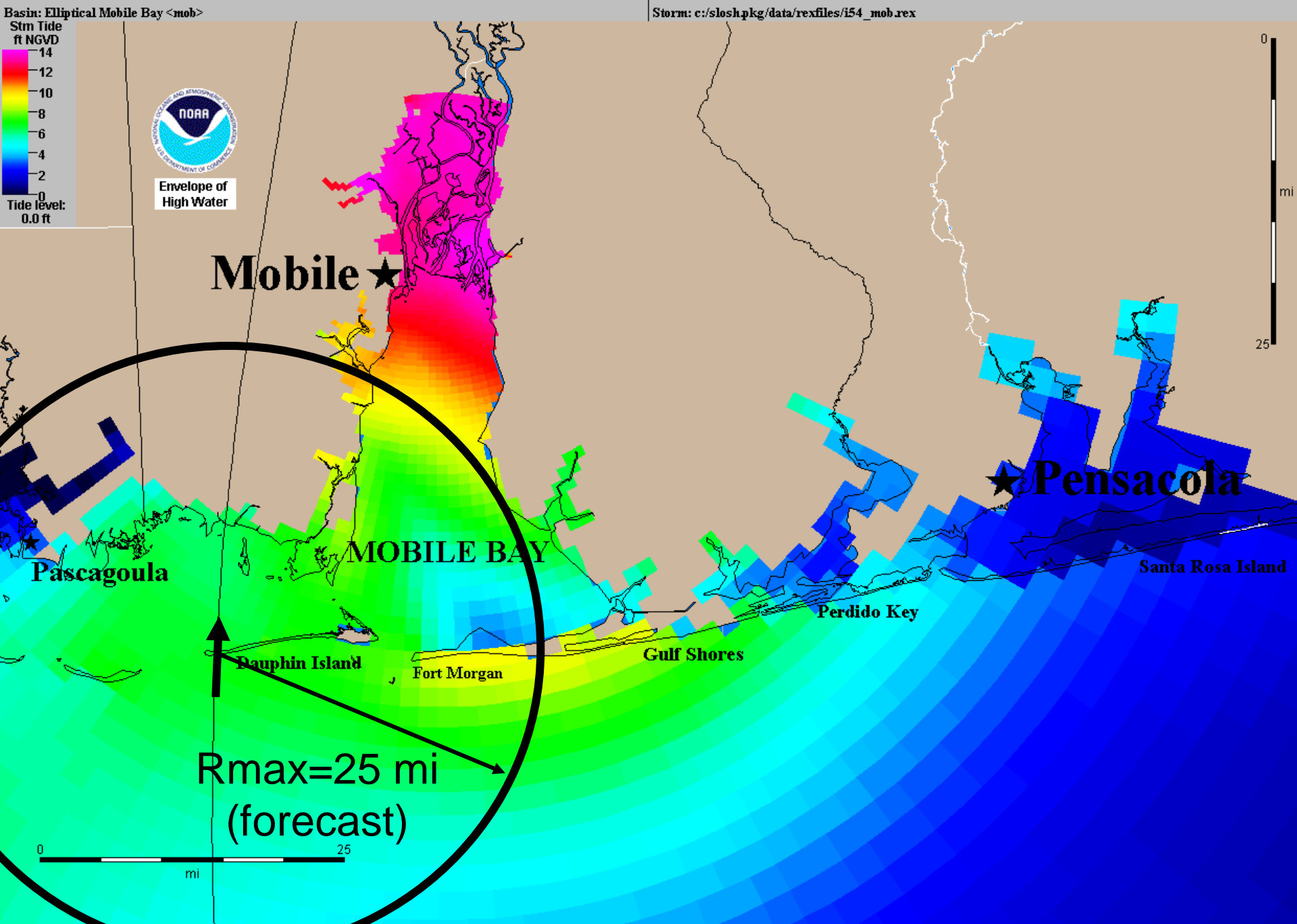
- Hurricane
- ▲ Tropical Storm
- Tropical Depression



Hurricane Ivan forecast approximately 12 h before landfall



Envelope of
High Water



Rmax=25 mi
(forecast)



Surge based on NHC forecast about 12 h before landfall

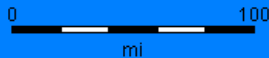


TRACK FORECAST

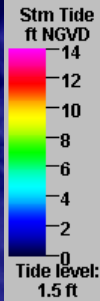
ACTUAL TRACK

IVAN Adv #54
Sep 15 2004 21z
132 mph 933 mb

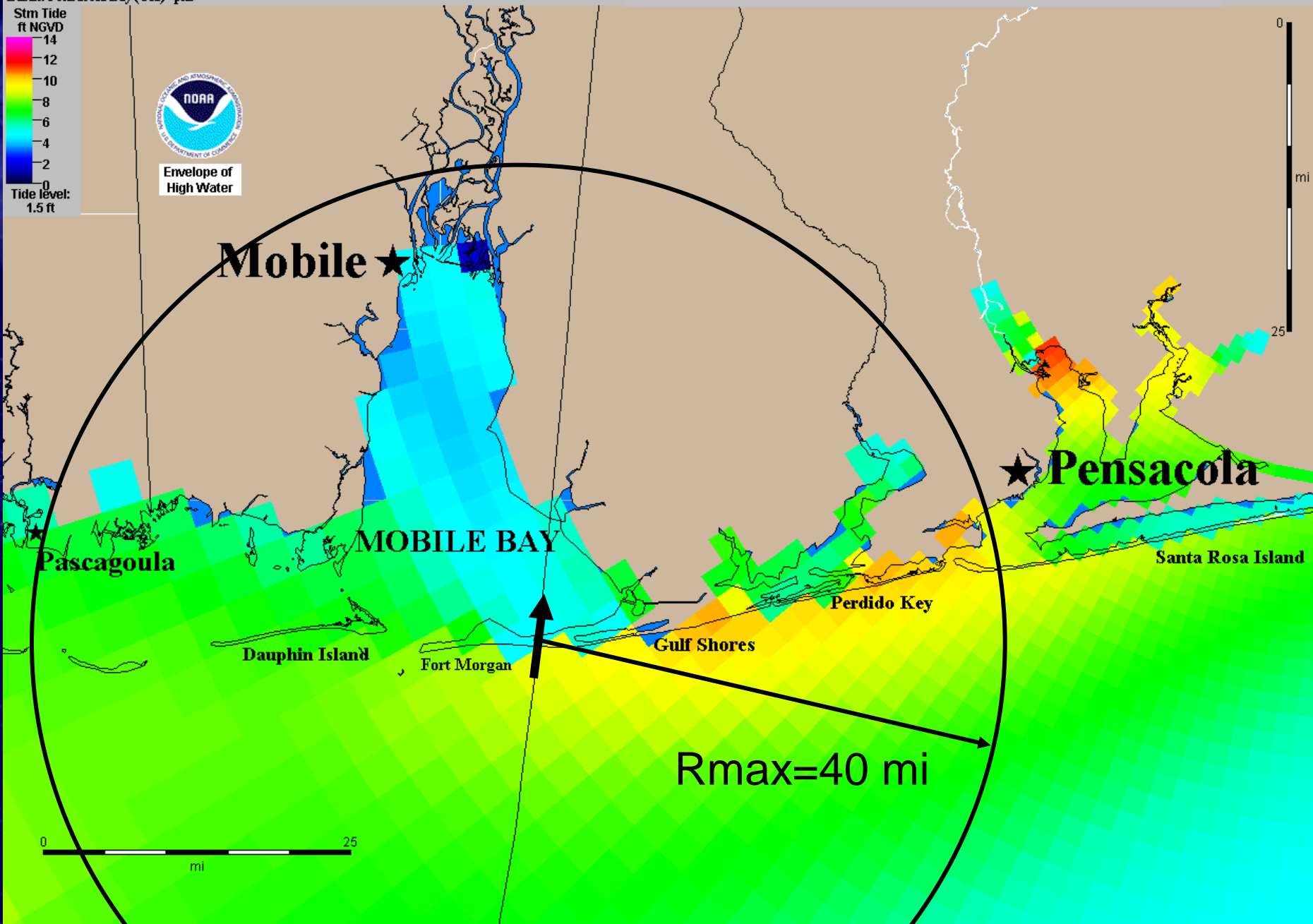
- Hurricane
- ▲ Tropical Storm
- Tropical Depression



Basin: Pensacola Bay (Old) <pns>



Envelope of
High Water

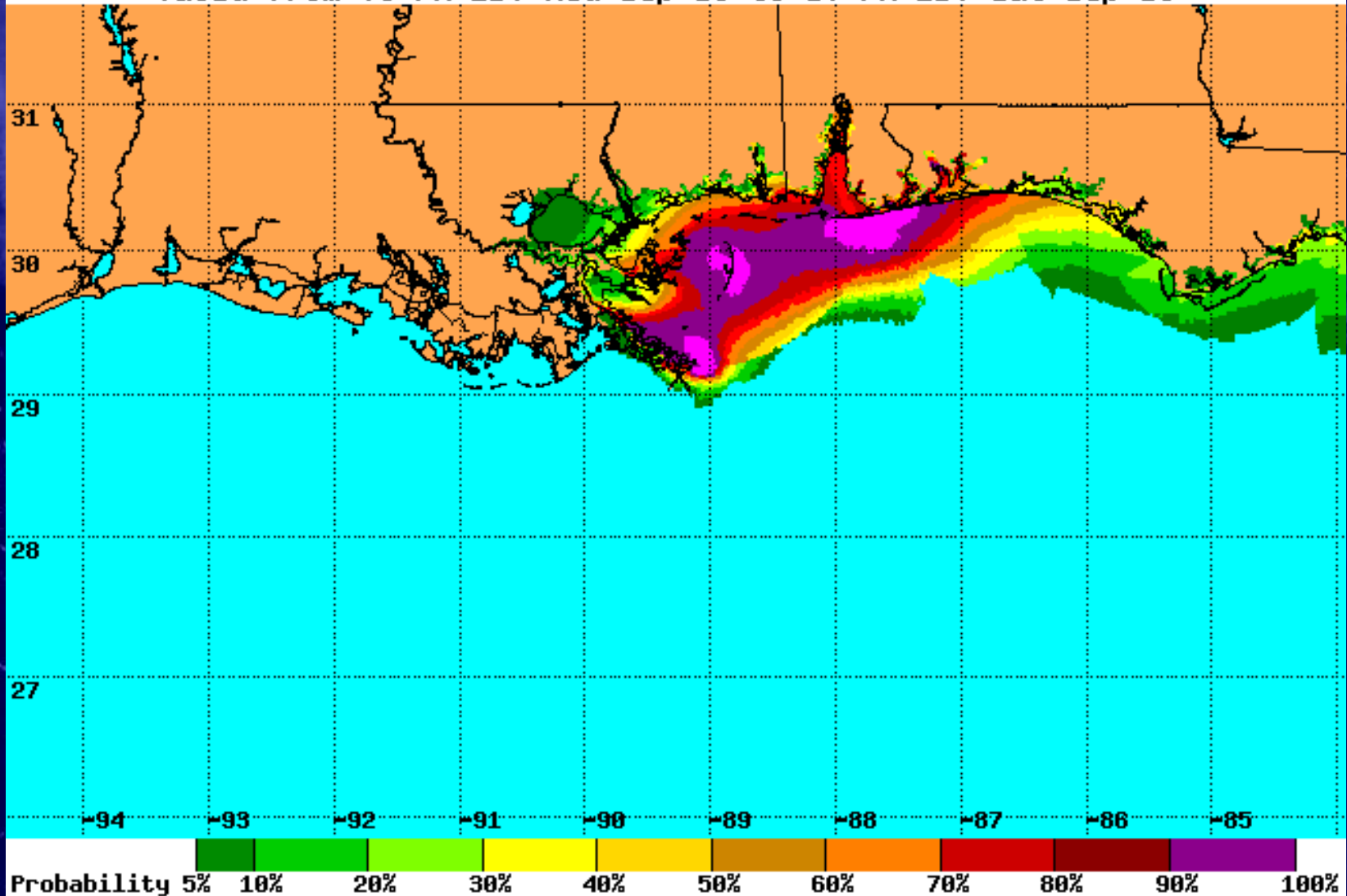


Surge based on NHC storm best track

Storm Surge Probabilities



Experimental Tropical Cyclone Storm Surge Probabilities
Chance of Storm Surge \geq 5 feet at Individual Locations
Hurricane Ivan (2004) Advisory 54
Valid from 05 PM EDT Wed Sep 15 to 10 PM EDT Sat Sep 18



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National Hurricane Center

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305-229-4487