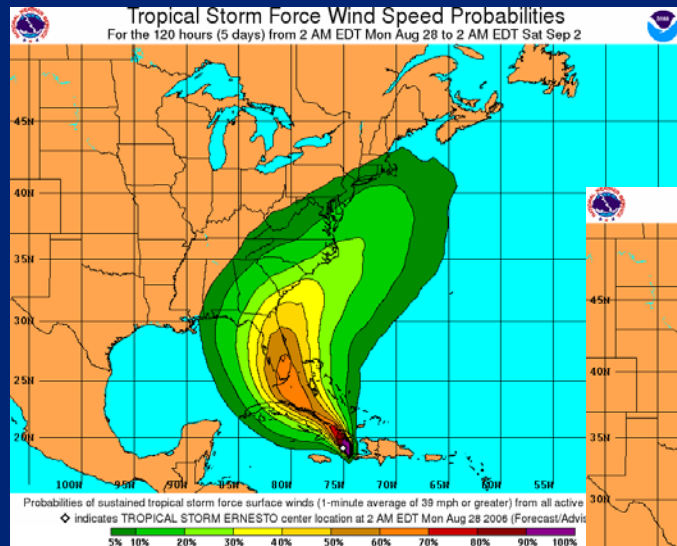
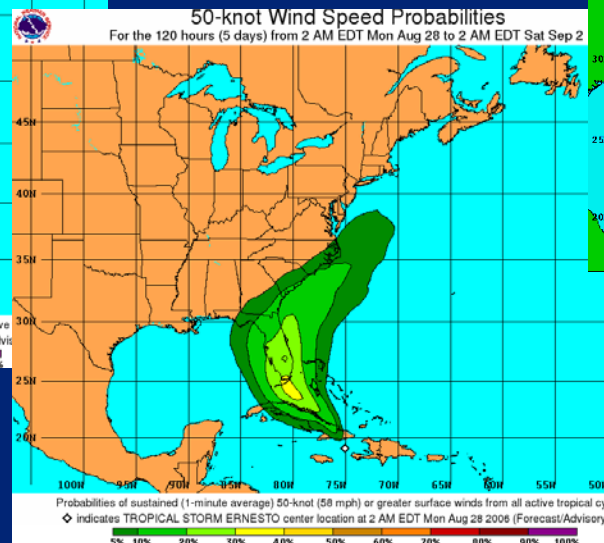




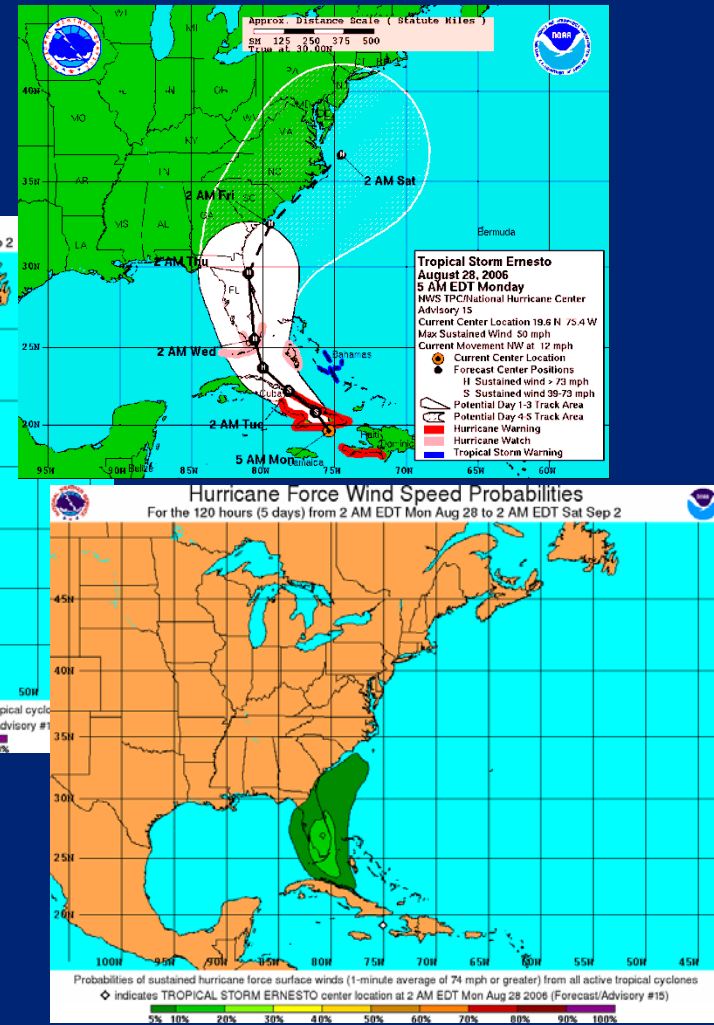
# Wind Speed and Intensity Probabilities

Tropical Storm Force



50-kt



Hurricane Force

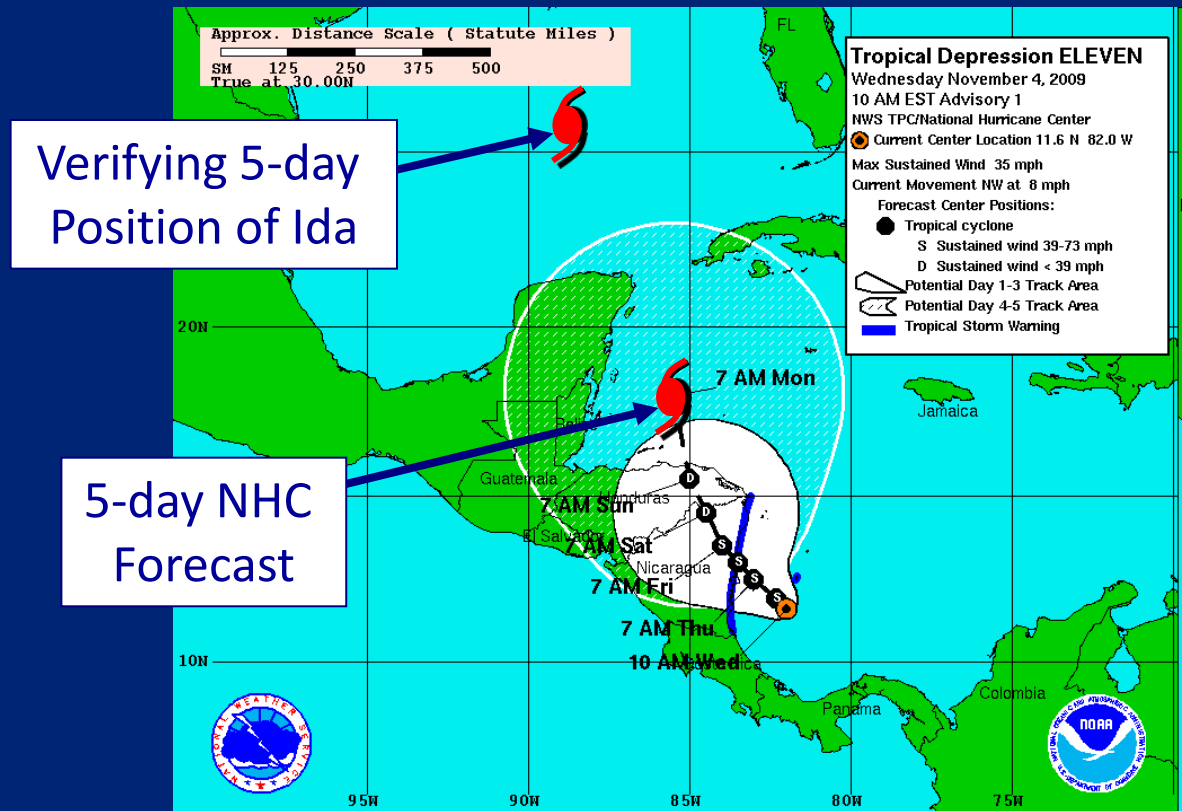
Michael J. Brennan  
National Hurricane Center

2010 Florida Governor's Hurricane Conference  
TS EM13 – Tropical Meteorology 2  
24 May 2010

# How can You, as Decision Makers, Deal with Forecast Uncertainties?

TD 11 (later  
Hurricane Ida)  
Advisory Number 1  
Issued 10:00 AM EST  
4 November 2009

5-day position error  
about 600 miles



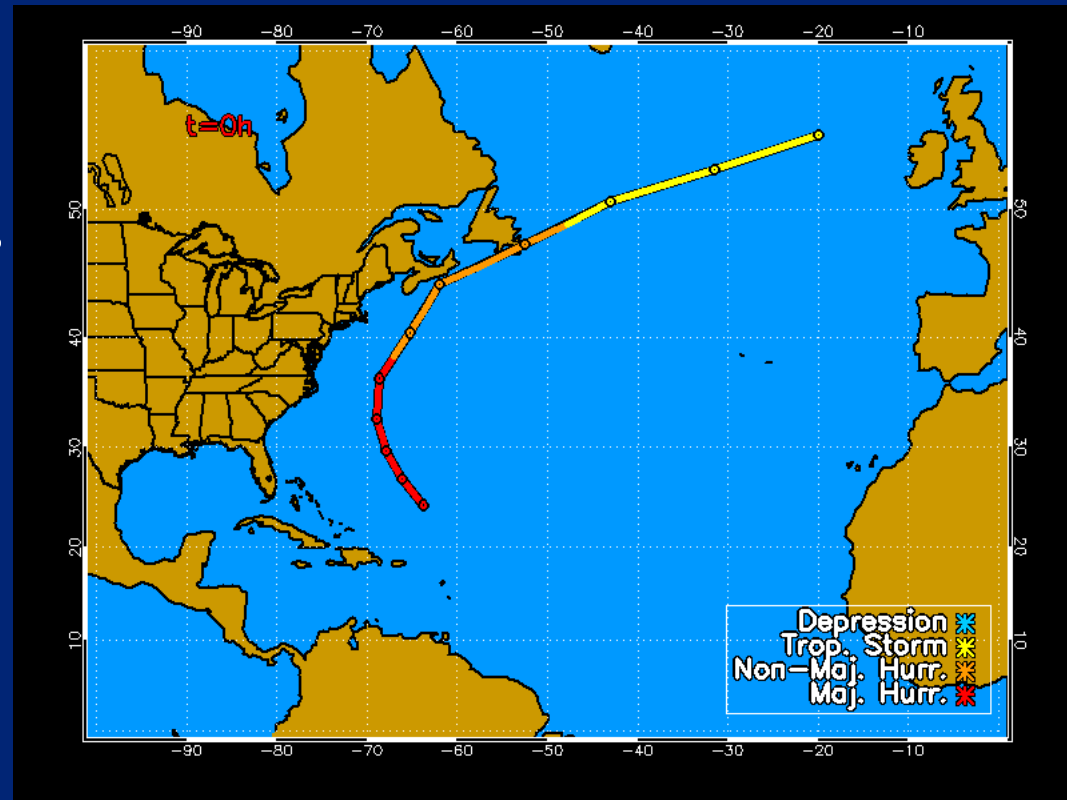
NHC probability products can help

# Available Probability Products

1. Wind Speed Probability Product
  - Text and Graphics
  - Depict *location-specific* probabilities for wind events (tropical storm force, 50 kt [58 mph], and hurricane force)
2. Intensity Probability Table
  - Graphical Table
  - Shows probability of tropical cyclone intensity (maximum wind) falling in various categories
    - Tropical depression, tropical storm, hurricane, and hurricane categories 1-5

# How the Probabilities are Created

- 1,000 realistic alternative scenarios created using
  - Official NHC track, intensity and size (wind radii) forecasts
  - Historical NHC track and intensity forecast errors
  - Climatology and persistence wind radii model
- Probability of exceeding 34, 50, and 64 kt wind thresholds computed
- Accounts for inland wind decay



# Wind Speed Probabilities

ZCZC MIAPWSAT4 ALL  
TTAA00 KNHC DDHMM  
HURRICANE WILMA PROBABILITIES NUMBER 20  
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL  
0900Z THU OCT 20 2005

...THIS IS AN EXPERIMENTAL PRODUCT FOR 2005...

AT 0900Z THE CENTER OF HURRICANE  
WILMA WAS LOCATED NEAR LATITUDE 18.3 NORTH...  
LONGITUDE 85.0 WEST WITH  
MAXIMUM SUSTAINED WINDS NEAR 130 KTS...150 MPH...240 KM/HR.

CHANCES OF EXPERIENCING WIND SPEEDS OF AT LEAST

...34 KT (39 MPH... 63 KPH)...

...50 KT (58 MPH... 93 KPH)...

...64 KT (74 MPH...119 KPH)...

FOR LOCATIONS AND TIME PERIODS DURING THE NEXT 5 DAYS

PROBABILITIES FOR LOCATIONS ARE GIVEN AS IP(CP) WHERE

IP IS THE PROBABILITY OF THE EVENT BEGINNING DURING  
AN INDIVIDUAL TIME PERIOD (INDIVIDUAL PROBABILITY)

(CP) IS THE PROBABILITY OF THE EVENT OCCURRING BETWEEN  
06Z THU AND THE FORECAST HOUR (CUMULATIVE PROBABILITY)

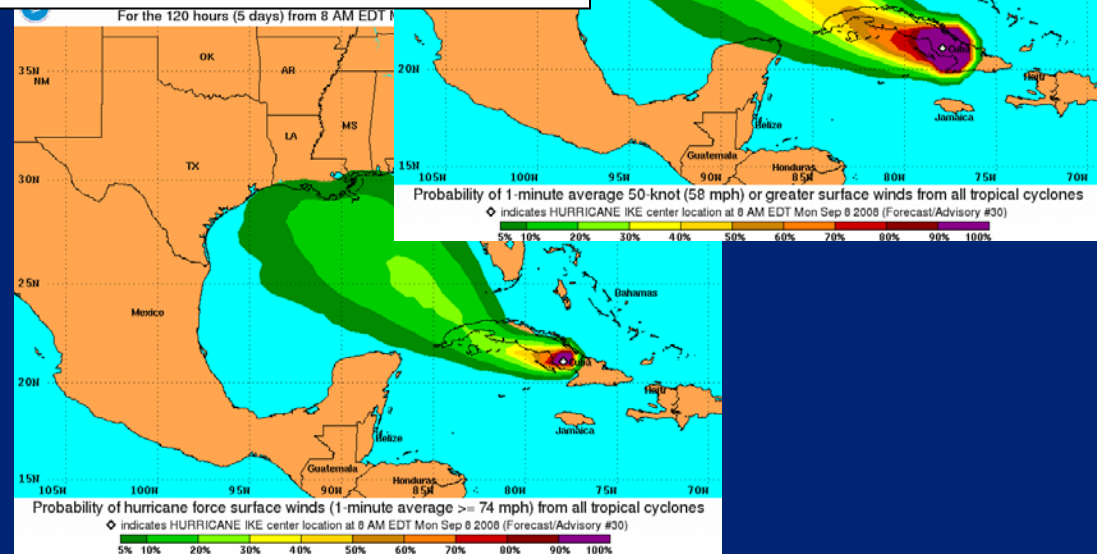
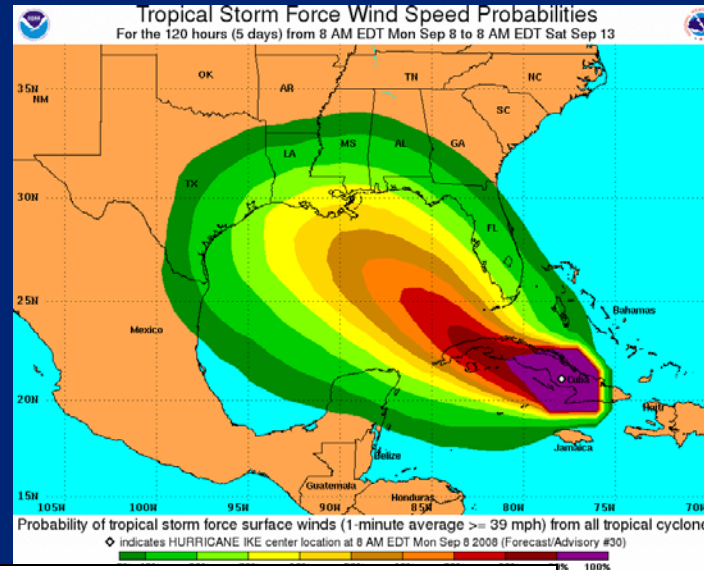
PROBABILITIES ARE GIVEN IN PERCENT  
X INDICATES PROBABILITIES LESS THAN 1%  
LOCATIONS SHOWN WHEN THEIR TOTAL  
PROBABILITY IS AT LEAST 2.5 PERCENT

Z INDICATES UNIVERSAL COORDINATE

Show the chance of a particular  
event occurring at a specific location

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

TIME PERIODS	FROM 06Z THU TO 18Z THU	FROM 18Z THU TO 06Z FRI	FROM 06Z FRI TO 18Z FRI	FROM 18Z FRI TO 06Z SAT	FROM 06Z SAT TO 18Z SUN	FROM 18Z SUN TO 06Z MON	FROM 06Z MON TO 18Z TUE
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
MIAMI FL	34 X	X ( X )	X ( X )	2 ( 2 )	16 ( 18 )	23 ( 41 )	5 ( 46 )
MIAMI FL	50 X	X ( X )	X ( X )	X ( X )	6 ( 6 )	11 ( 17 )	3 ( 20 )
MIAMI FL	64 X	X ( X )	X ( X )	X ( X )	2 ( 2 )	5 ( 7 )	1 ( 8 )
KEY WEST FL	34 X	X ( X )	2 ( 2 )	7 ( 9 )	26 ( 35 )	18 ( 53 )	3 ( 56 )
KEY WEST FL	50 X	X ( X )	X ( X )	1 ( 1 )	14 ( 15 )	11 ( 26 )	1 ( 27 )
KEY WEST FL	64 X	X ( X )	X ( X )	X ( X )	8 ( 8 )	5 ( 13 )	1 ( 14 )
MARCO ISLAND	34 X	X ( X )	X ( X )	5 ( 5 )	20 ( 25 )	23 ( 48 )	4 ( 52 )
MARCO ISLAND	50 X	X ( X )	X ( X )	1 ( 1 )	10 ( 11 )	12 ( 23 )	2 ( 25 )
MARCO ISLAND	64 X	X ( X )	X ( X )	X ( X )	5 ( 5 )	6 ( 11 )	X ( 11 )



# Intensity Probability Table

- Probability of cyclone intensity falling into various categories

- Valid for the cyclone at a particular time but **not** at any particular location



Intensity (Maximum Wind Speed) Probability Table  
Hurricane Ike Advisory Number 30  
11:00 AM EDT Sep 8 2008



Wind Range (mph)	Forecast Time						
	12 hour for 8 PM Mon	24 hour for 8 AM Tue	36 hour for 8 PM Tue	48 hour for 8 AM Wed	72 hour for 8 AM Thu	96 hour for 8 AM Fri	120 hour for 8 AM Sat
Dissipated	<1%	3%	2%	2%	3%	11%	26%
Tropical Depression (<39)	5%	9%	5%	3%	3%	8%	14%
Tropical Storm (39-73)	26%	31%	42%	25%	15%	15%	21%
Hurricane (all categories)	69%	57%	51%	70%	79%	66%	40%
-- Category 1 (74-95)	61%	46%	40%	41%	27%	19%	13%
-- Category 2 (96-110)	7%	9%	7%	18%	22%	17%	10%
-- Category 3 (111-130)	1%	2%	3%	9%	21%	20%	10%
-- Category 4 (131-155)	<1%	<1%	1%	2%	7%	9%	5%
-- Category 5 (>155)	<1%	<1%	<1%	<1%	1%	1%	1%
Forecast Maximum Wind	85 mph	85 mph	80 mph	90 mph	110 mph	115 mph	115 mph

# U.S. Hurricane **Watch** and **Warning** Statistics (2000-2008)

- Average storm-total **watch** length 477 miles
- Average storm-total length w/ hurricane winds for cases when **watch** issued 89 miles
- Probability of hurricane winds at point under **watch** 19%
- Average storm-total **warning** length 403 miles
- Average storm-total length w/ hurricane winds for cases when **warning** issued 99 miles
- Probability of hurricane winds at point under **warning** 25%

# **Reading and Interpreting the Wind Speed Probability Products**

LOCATIONS SHOWN WHEN THEIR TOTAL CONCEALED 3 DAY  
PROBABILITY IS AT LEAST 2.5 PERCENT

Z INDICATES UNIVERSAL COORDINATED TIME (GREENWICH)

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

TIME PERIODS	FROM 06Z THU TO 18Z THU	FROM 18Z THU TO 06Z FRI	FROM 06Z FRI TO 18Z FRI	FROM 18Z FRI TO 06Z SAT	FROM 06Z SAT TO 06Z SUN	FROM 06Z SUN TO 06Z MON	FROM 06Z MON TO 06Z TUE
--------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------

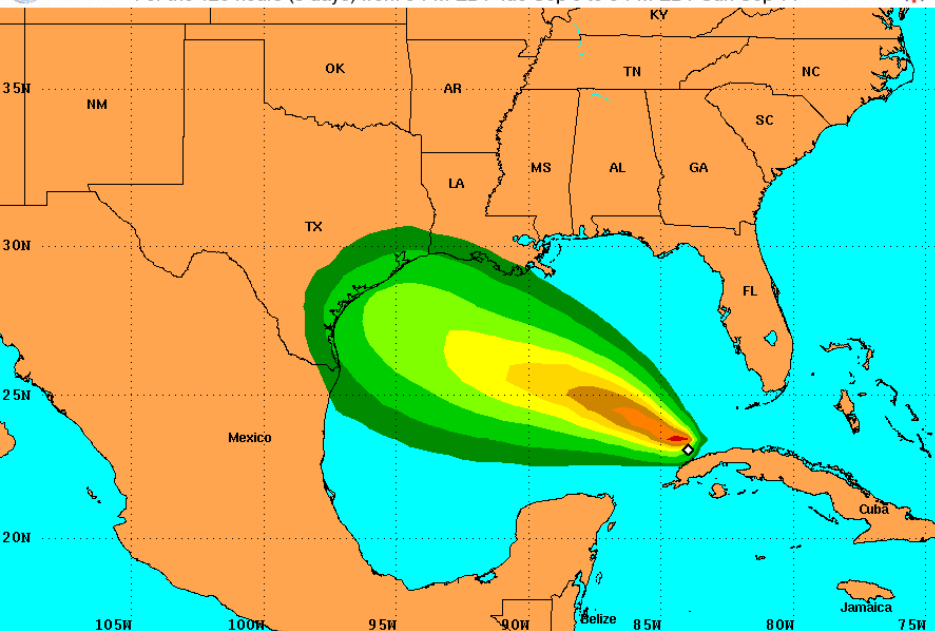
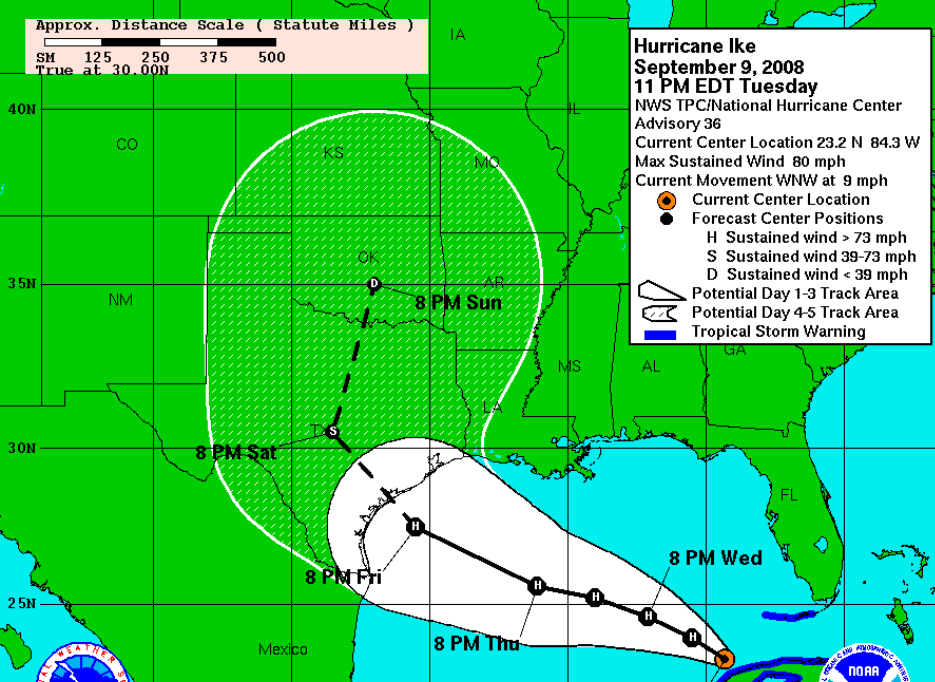
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
---------------	------	------	------	------	------	------	-------

- - - - -  
LOCATION KT

MIAMI FL	34	X	X( X)	X( X)	2( 2)	16(18)	23(41)	5(46)
MIAMI FL	50	X	X( X)	X( X)	X( X)	6( 6)	11(17)	3(20)
MIAMI FL	64	X	X( X)	X( X)	X( X)	2( 2)	5( 7)	1( 8)

KEY WEST FL	34	X	X( X)	2( 2)	7( 9)	26(35)	18(53)	3(56)
KEY WEST FL	50	X	X( X)	X( X)	1( 1)	14(15)	11(26)	1(27)
KEY WEST FL	64	X	X( X)	X( X)	X( X)	8( 8)	5(13)	1(14)

MARCO ISLAND	34	X	X( X)	X( X)	5( 5)	20(25)	23(48)	4(52)
MARCO ISLAND	50	X	X( X)	X( X)	1( 1)	10(11)	12(23)	2(25)



ZZCZ MIAFWSAT4 ALL

TTAA00 KNHC DDHHMM

HURRICANE IKE WIND SPEED PROBABILITIES NUMBER 36

NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL092008

0300 UTC WED SEP 10 2008

AT 0300Z THE CENTER OF HURRICANE IKE WAS LOCATED NEAR LATITUDE 23.2 NORTH...LONGITUDE 84.3 WEST WITH MAXIMUM SUSTAINED WINDS NEAR 70 KTS ...80 MPH...130 KM/HR.

PORT ARTHUR TX	34	X	X( X )	X( X )	6( 6 )	32(38)	8(46)	1(47)
PORT ARTHUR TX	50	X	X( X )	X( X )	1( 1 )	12(13)	5(18)	1(19)
PORT ARTHUR TX	64	X	X( X )	X( X )	X( X )	5( 5 )	3( 8 )	X( 8 )

GALVESTON TX	34	X	X( X )	1( 1 )	6( 7 )	38(45)	11(56)	2(58)
GALVESTON TX	50	X	X( X )	X( X )	1( 1 )	20(21)	7(28)	2(30)
GALVESTON TX	64	X	X( X )	X( X )	X( X )	9( 9 )	5(14)	X(14)

HOUSTON TX	34	X	X( X )	X( X )	4( 4 )	33(37)	13(50)	2(52)
HOUSTON TX	50	X	X( X )	X( X )	X( X )	14(14)	8(22)	1(23)
HOUSTON TX	64	X	X( X )	X( X )	X( X )	5( 5 )	4( 9 )	1(10)

AUSTIN TX	34	X	X( X )	X( X )	X( X )	17(17)	17(34)	2(36)
AUSTIN TX	50	X	X( X )	X( X )	X( X )	2( 2 )	6( 8 )	1( 9 )
AUSTIN TX	64	X	X( X )	X( X )	X( X )	1( 1 )	1( 2 )	X( 2 )

SAN ANTONIO TX	34	X	X( X )	X( X )	X( X )	16(16)	18(34)	3(37)
SAN ANTONIO TX	50	X	X( X )	X( X )	X( X )	4( 4 )	7(11)	X(11)
SAN ANTONIO TX	64	X	X( X )	X( X )	X( X )	X( X )	2( 2 )	X( 2 )

FREEPORT TX	34	X	X( X )	X( X )	7( 7 )	40(47)	12(59)	2(61)
FREEPORT TX	50	X	X( X )	X( X )	1( 1 )	22(23)	10(33)	2(35)
FREEPORT TX	64	X	X( X )	X( X )	X( X )	10(10)	5(15)	1(16)

GFMX 280N 950W	34	X	X( X )	1( 1 )	13(14)	44(58)	10(68)	2(70)
GFMX 280N 950W	50	X	X( X )	X( X )	3( 3 )	29(32)	8(40)	3(43)
GFMX 280N 950W	64	X	X( X )	X( X )	1( 1 )	16(17)	6(23)	2(25)

PORT O CONNOR	34	X	X( X )	X( X )	5( 5 )	38(43)	16(59)	4(63)
PORT O CONNOR	50	X	X( X )	X( X )	1( 1 )	19(20)	10(30)	4(34)
PORT O CONNOR	64	X	X( X )	X( X )	X( X )	9( 9 )	8(17)	1(18)

CORPUS CHRISTI	34	X	X( X )	X( X )	3( 3 )	29(32)	16(48)	3(51)
CORPUS CHRISTI	50	X	X( X )	X( X )	X( X )	12(12)	10(22)	3(25)
CORPUS CHRISTI	64	X	X( X )	X( X )	X( X )	5( 5 )	5(10)	1(11)

GFMX 270N 960W	34	X	X( X )	1( 1 )	9(10)	38(48)	12(60)	4(64)
GFMX 270N 960W	50	X	X( X )	X( X )	2( 2 )	24(26)	9(35)	3(38)

# Example Interpretation of Output

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

**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)

# Example Interpretation of Output

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**

# Example Interpretation of Output

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		FORECAST HOUR		FORECAST HOUR		FORECAST HOUR		FORECAST HOUR		FORECAST HOUR		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)						

# Example Interpretation of Output

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%**

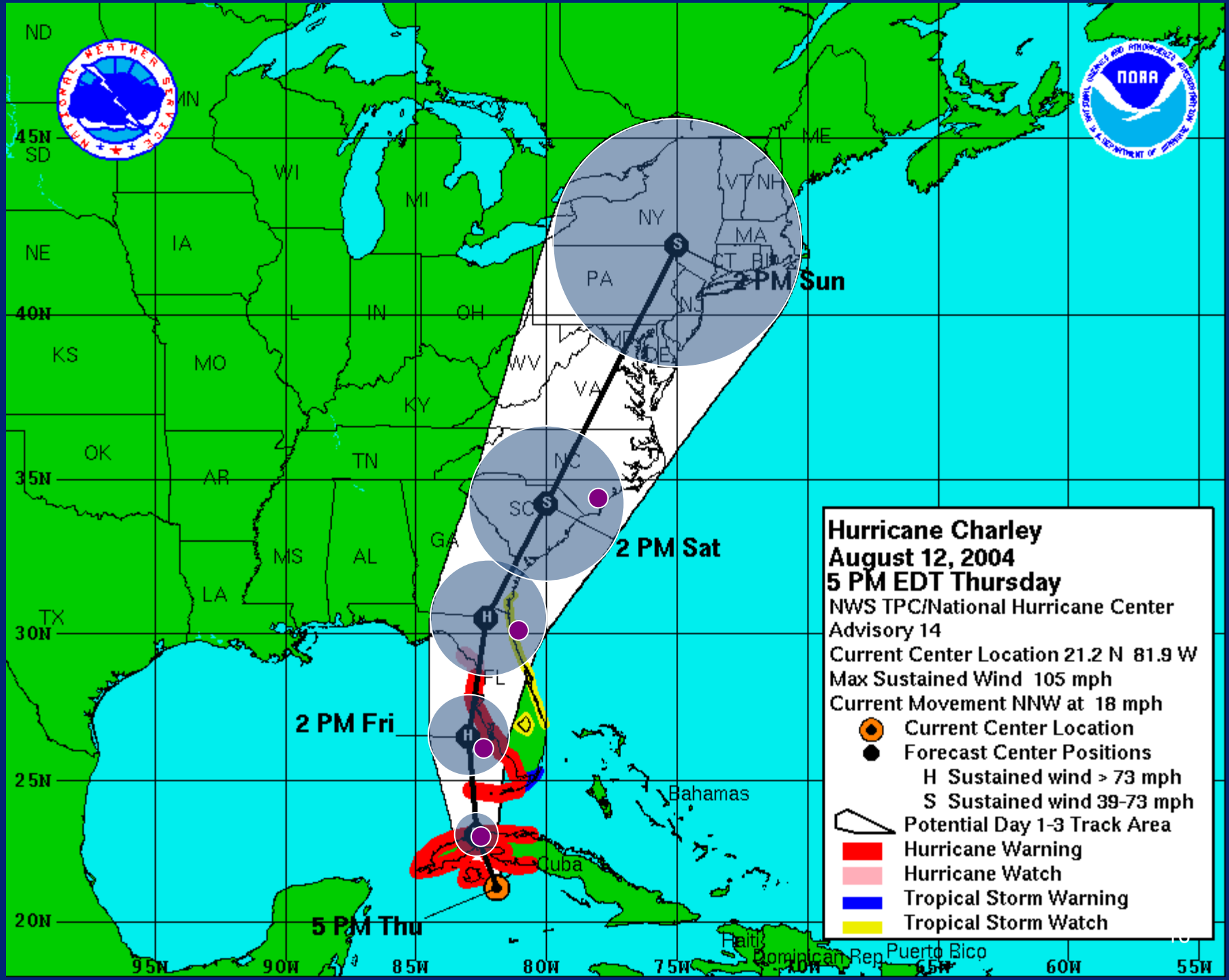
When are these winds most likely to start?

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

**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)

**What the Probabilities can tell  
you that that the Error Cone  
doesn't**



### 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

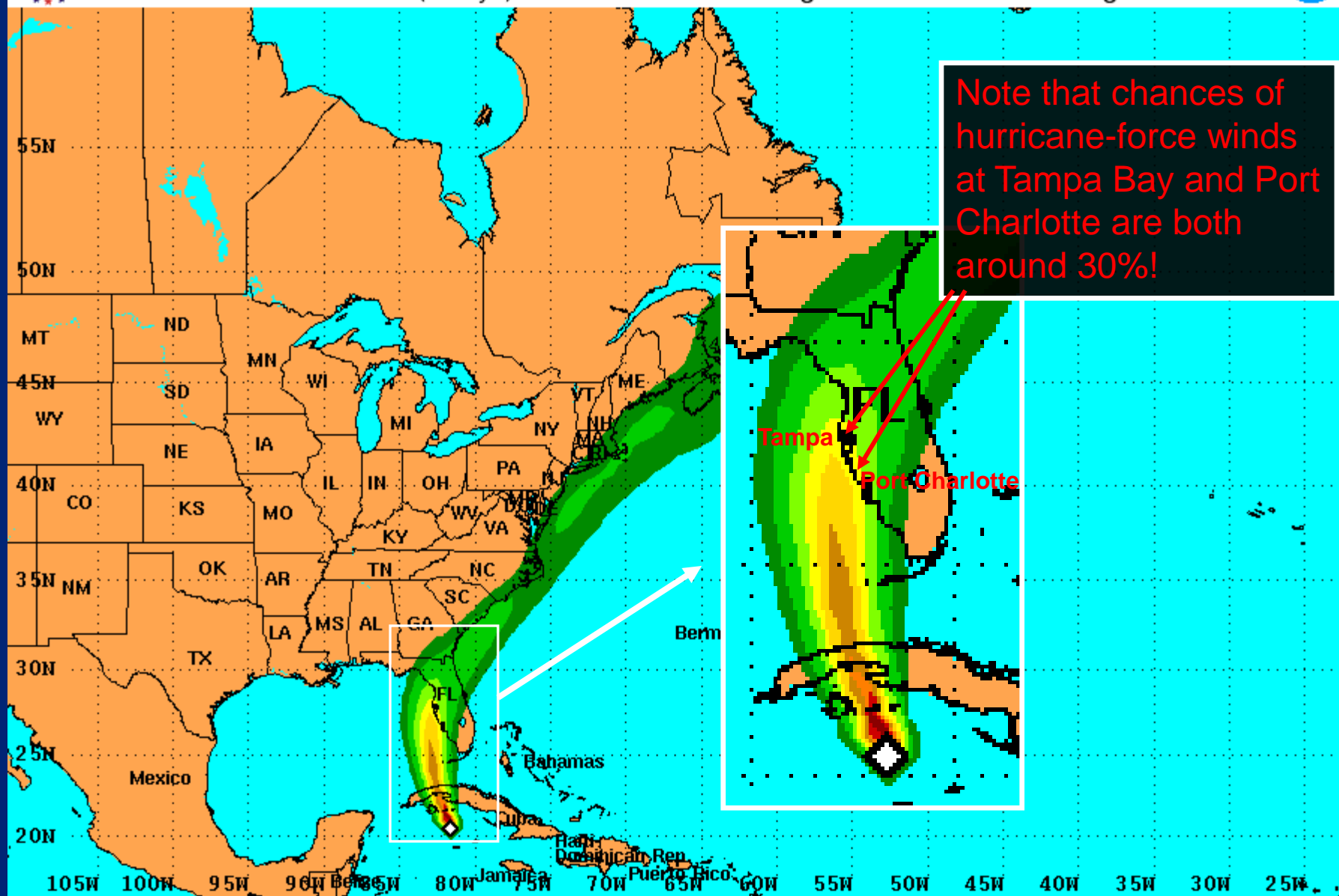
■ Hurricane Watch

■ Tropical Storm Warning

■ Tropical Storm Watch



# 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



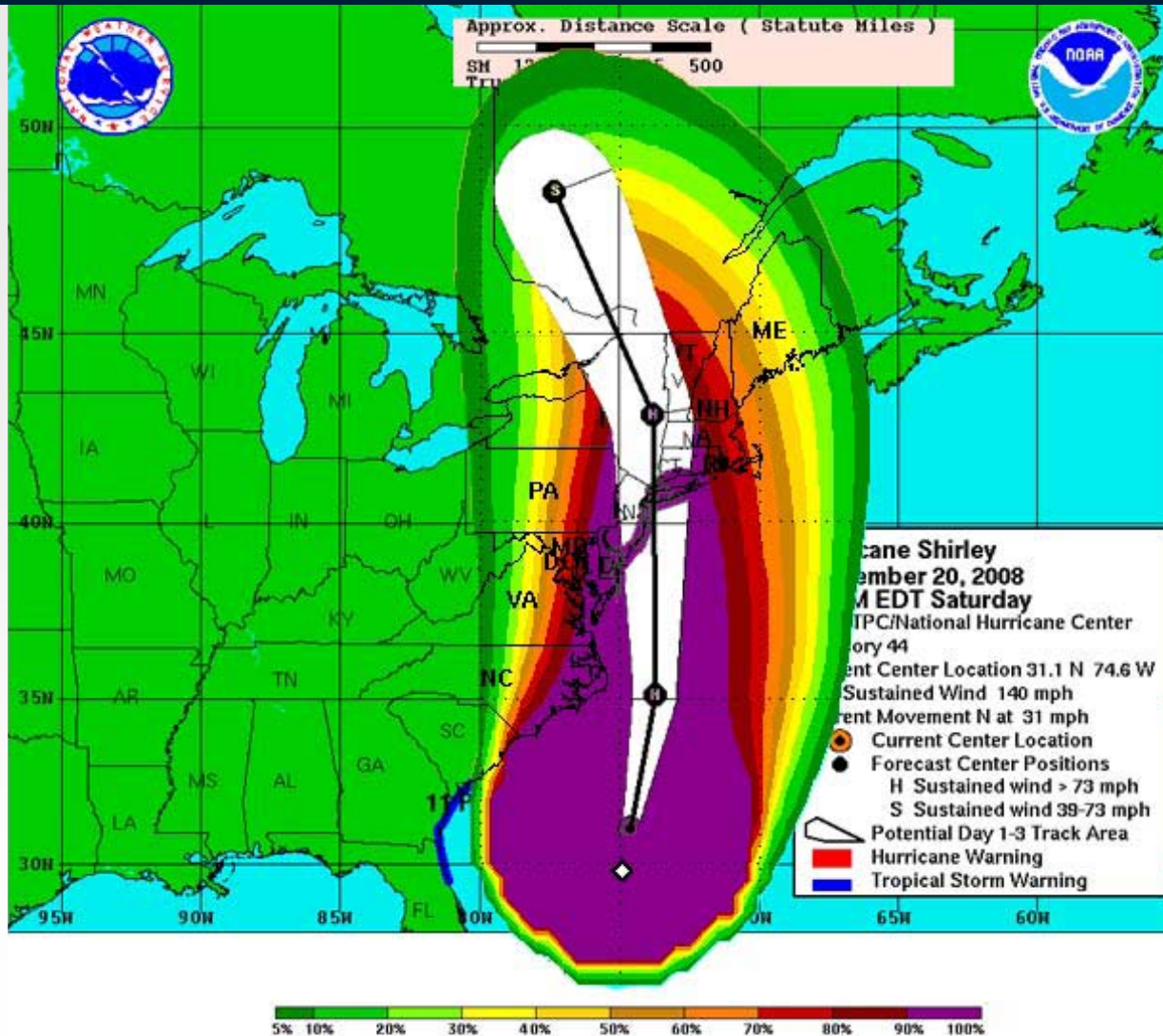
Note that chances of hurricane-force winds at Tampa Bay and Port Charlotte are both around 30%!

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

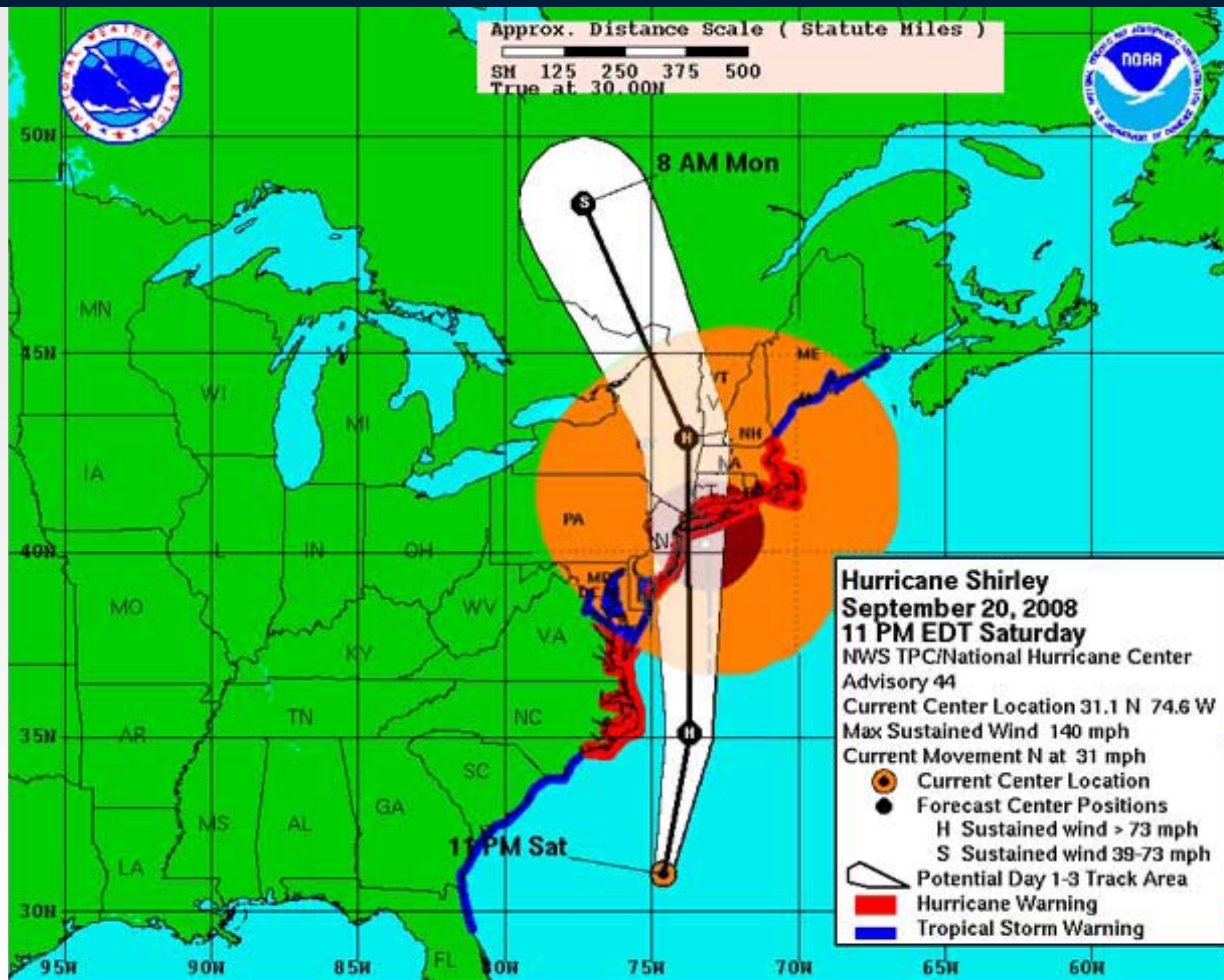
◇ indicates HURRICANE CHARLEY center location at 2 PM EDT Thu Aug 12 2004 (Forecast/Advisory #14)



# Impacts can Occur Well Outside the Cone

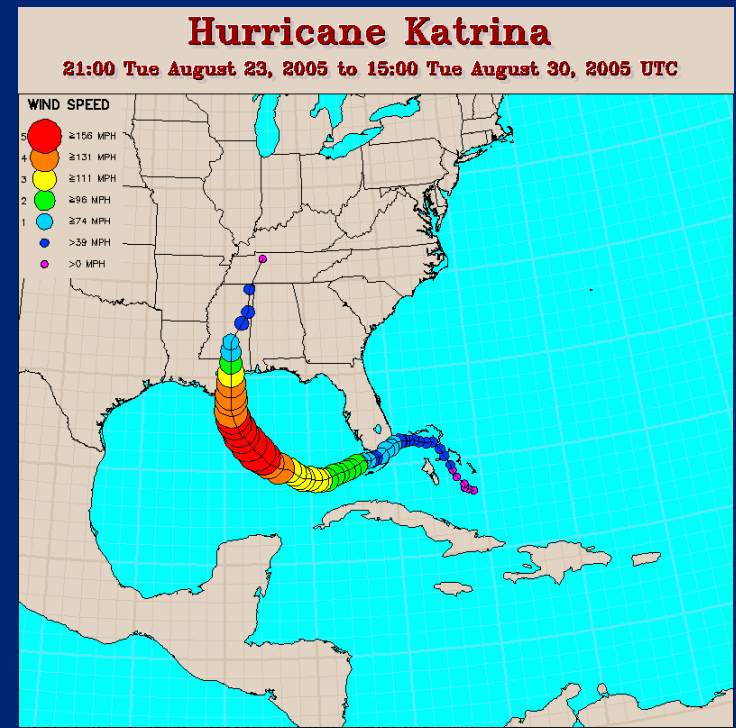


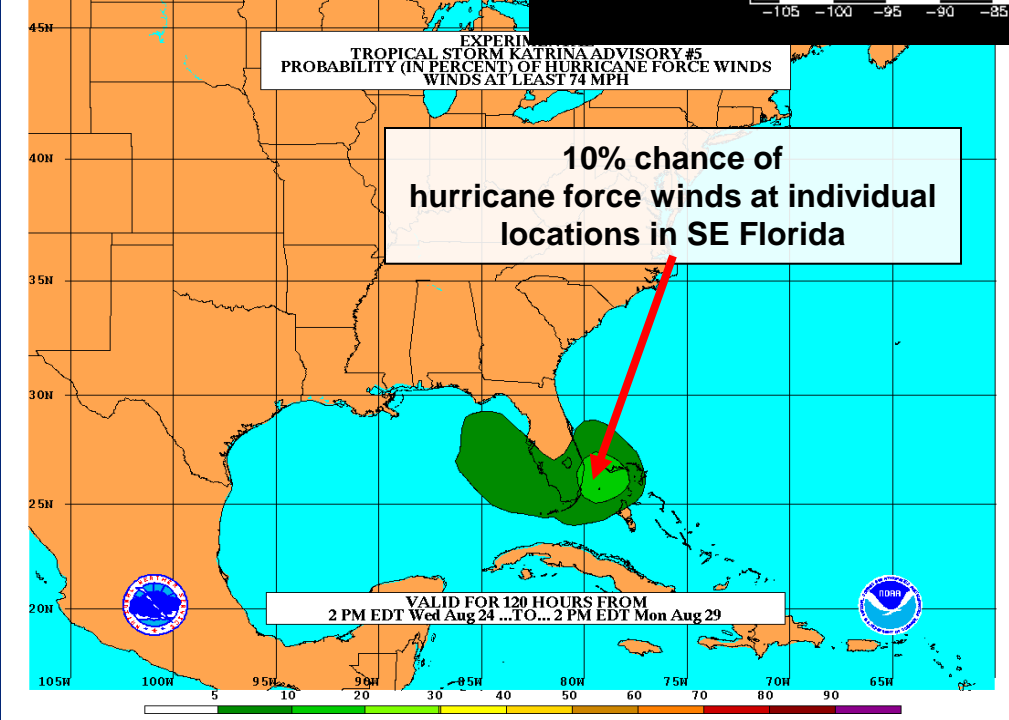
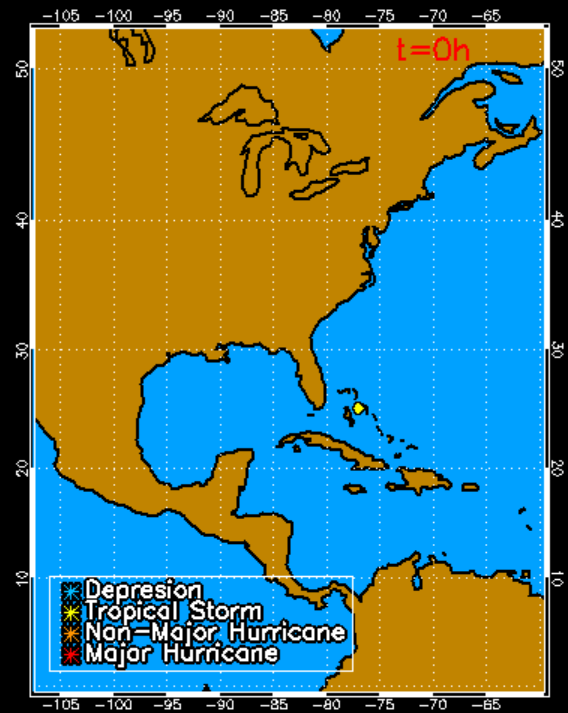
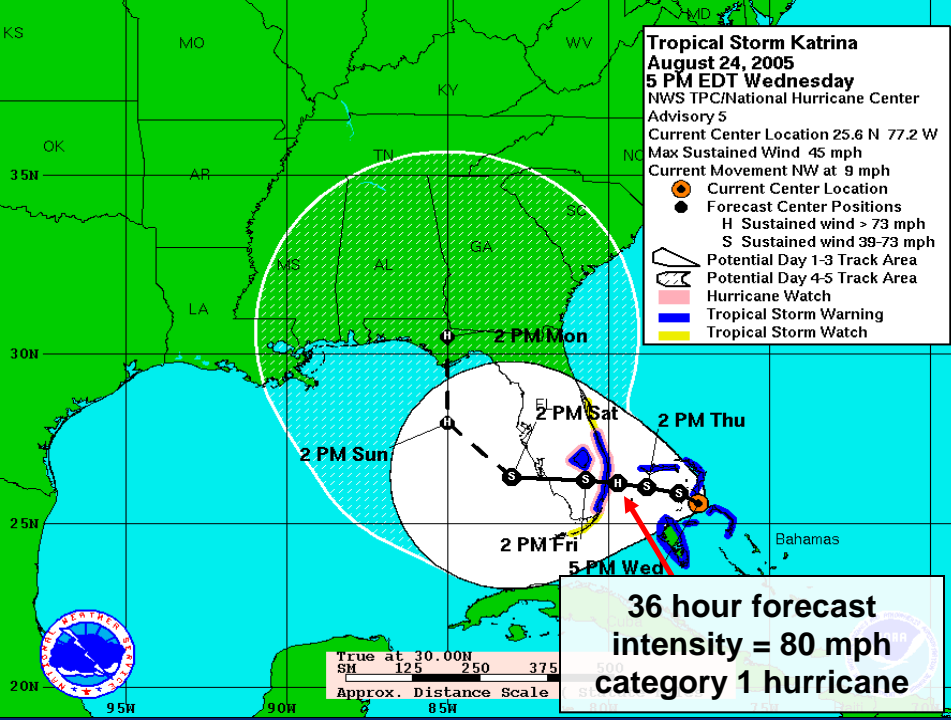
# Impacts can Occur Well Outside the Cone



# Hurricane Katrina (2005)

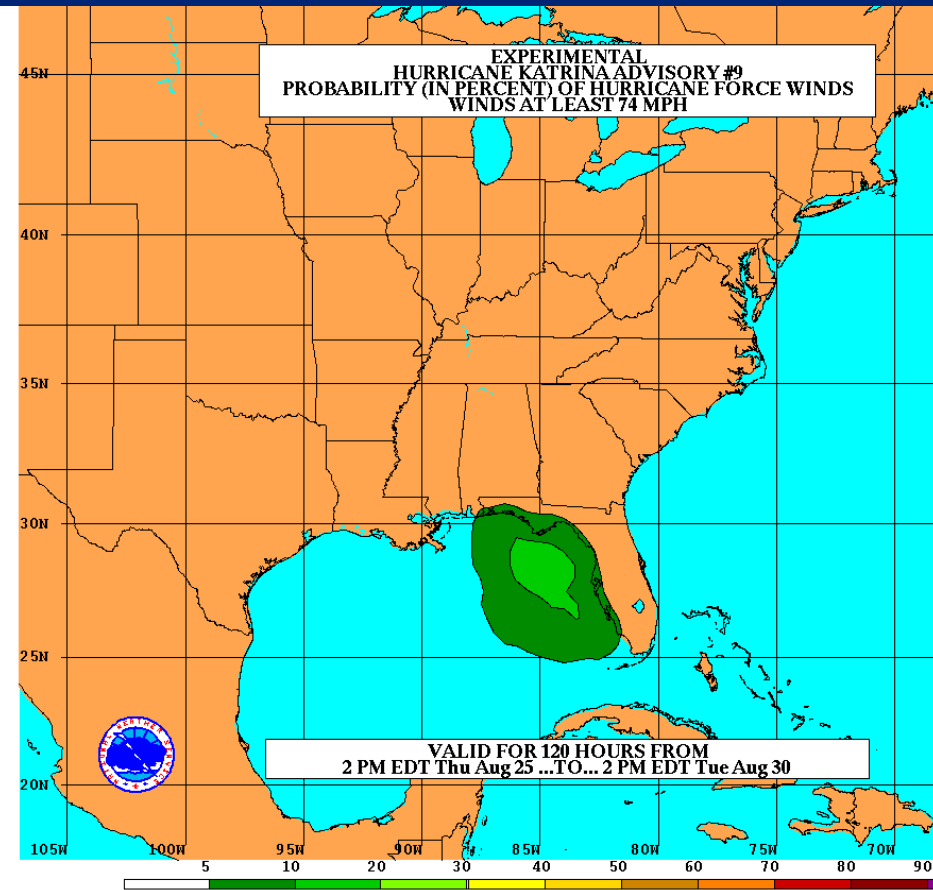
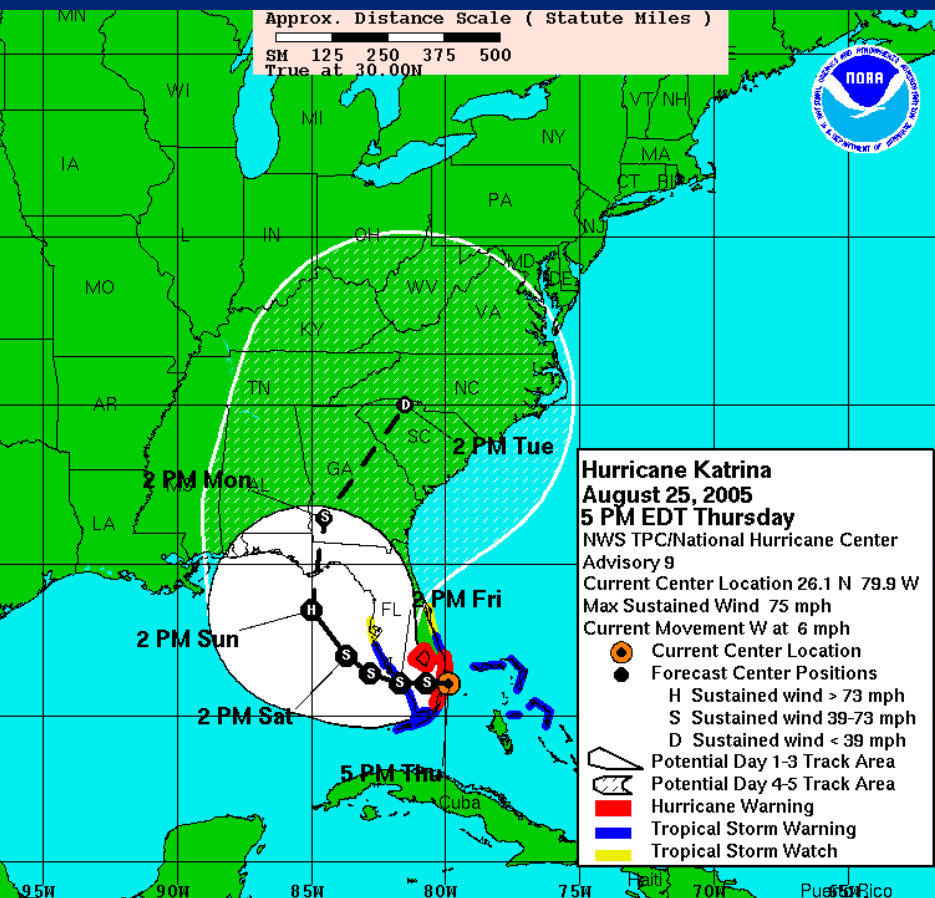
- Two examples of how probabilities evolve
  1. Landfall of a marginal hurricane in South Florida
    - Small probabilities of hurricane force winds over much of south FL due to uncertainty in track and intensity
  2. Landfall of a major hurricane along the Gulf Coast
    - Initially small probabilities at locations along the Gulf Coast increase markedly along the track of Katrina as landfall approaches
    - Hurricane conditions are almost a certainty *somewhere*





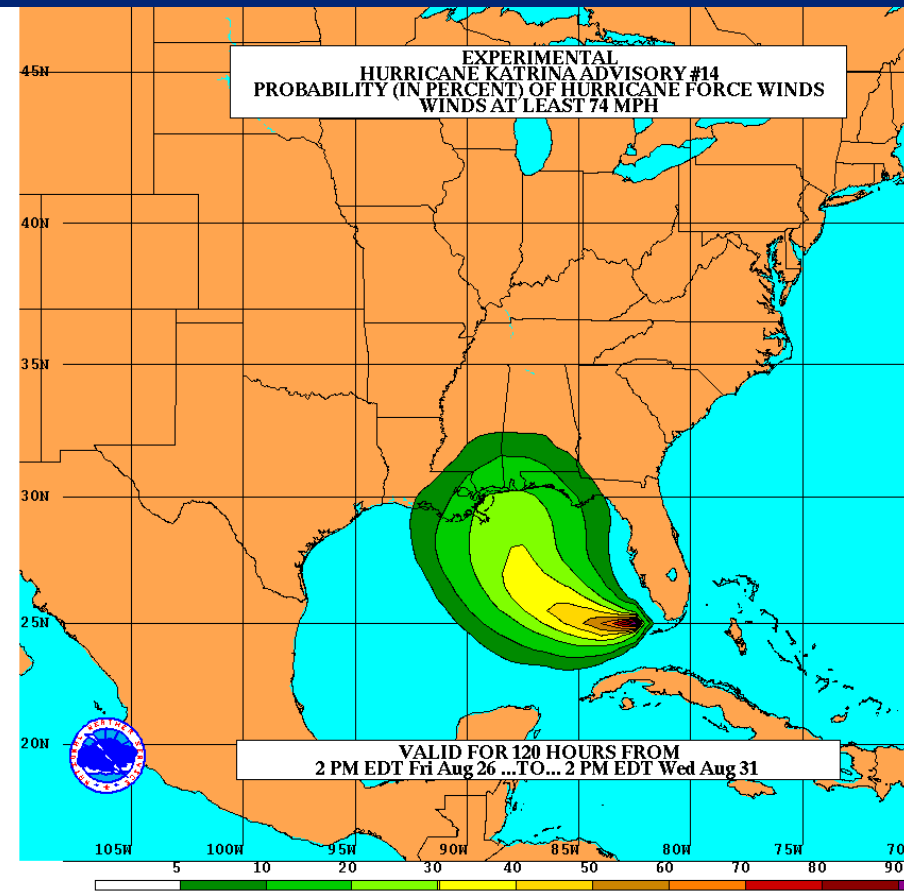
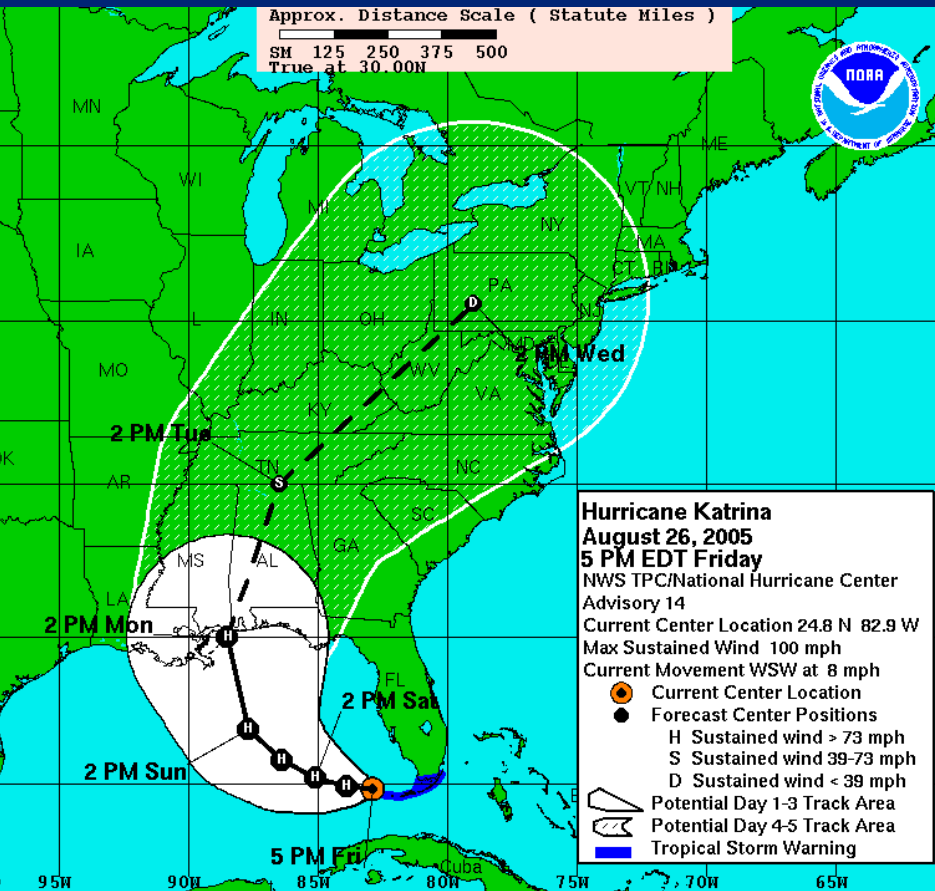
# Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

## Katrina Advisory #9



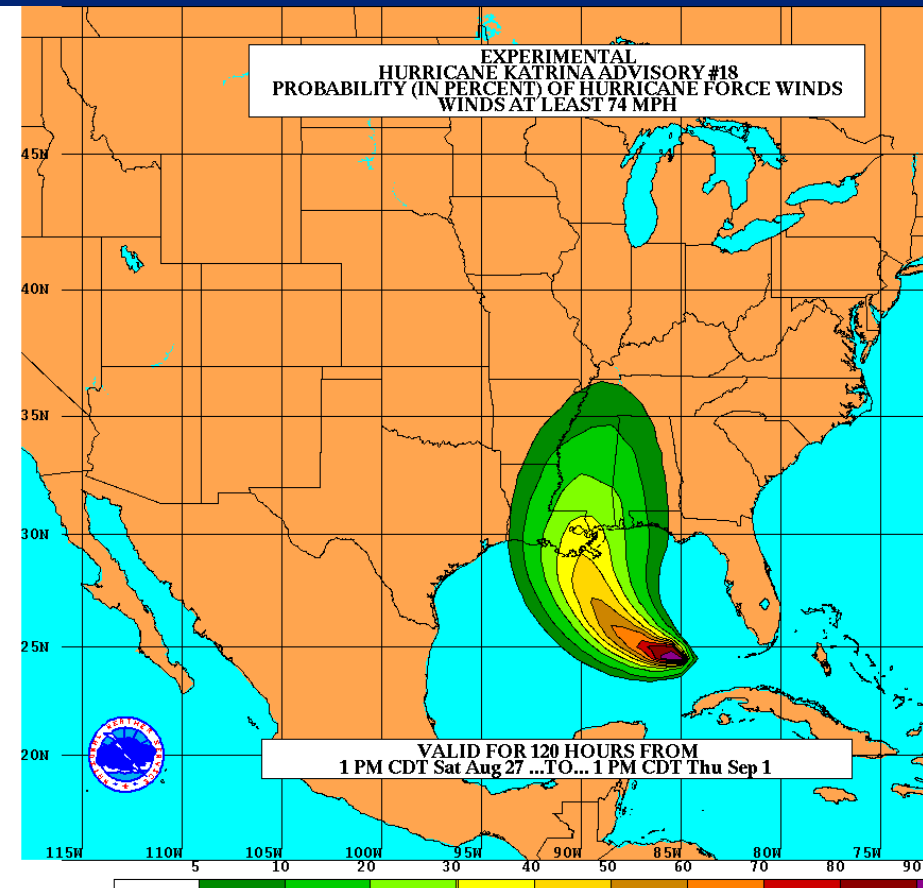
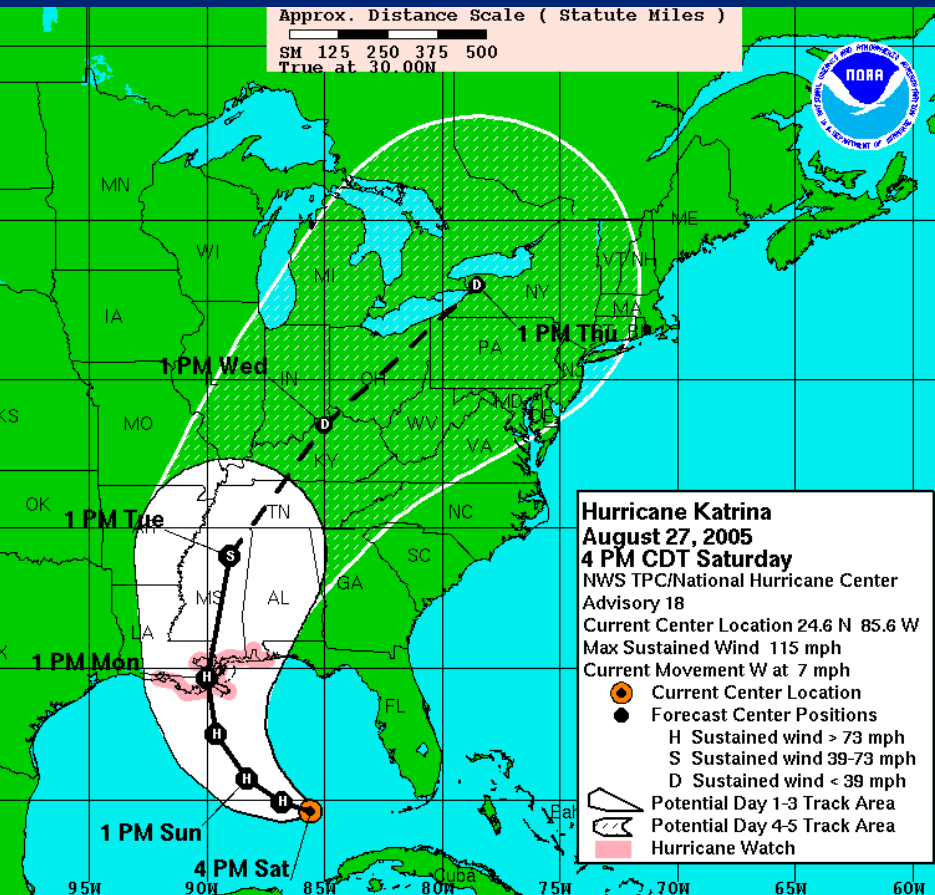
# Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

## Katrina Advisory #14



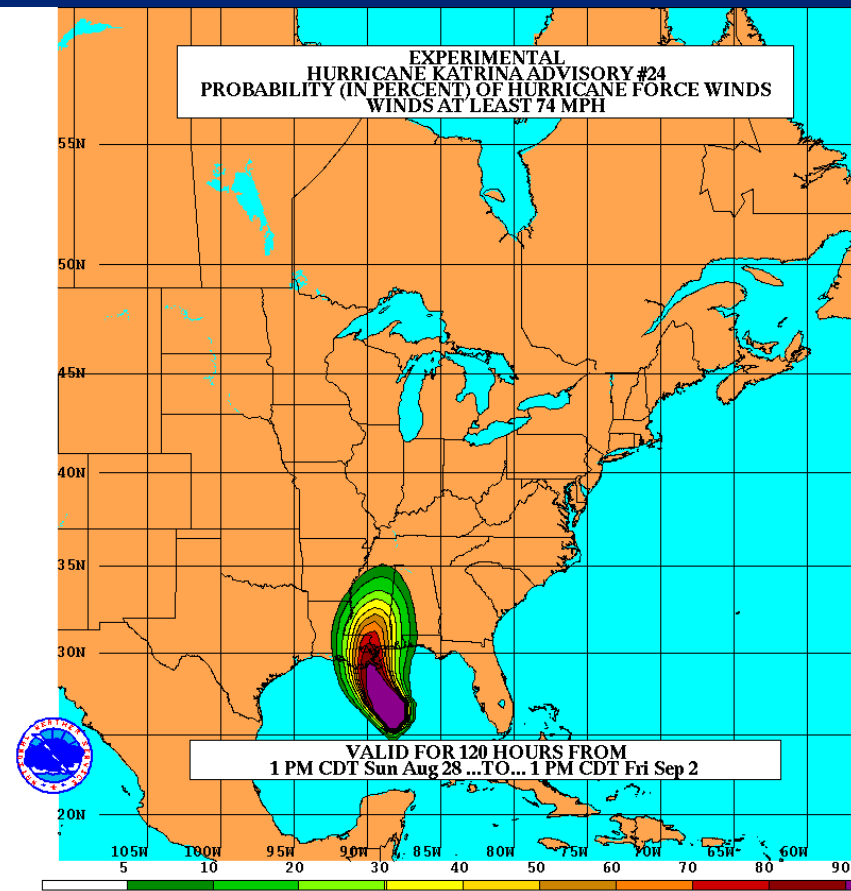
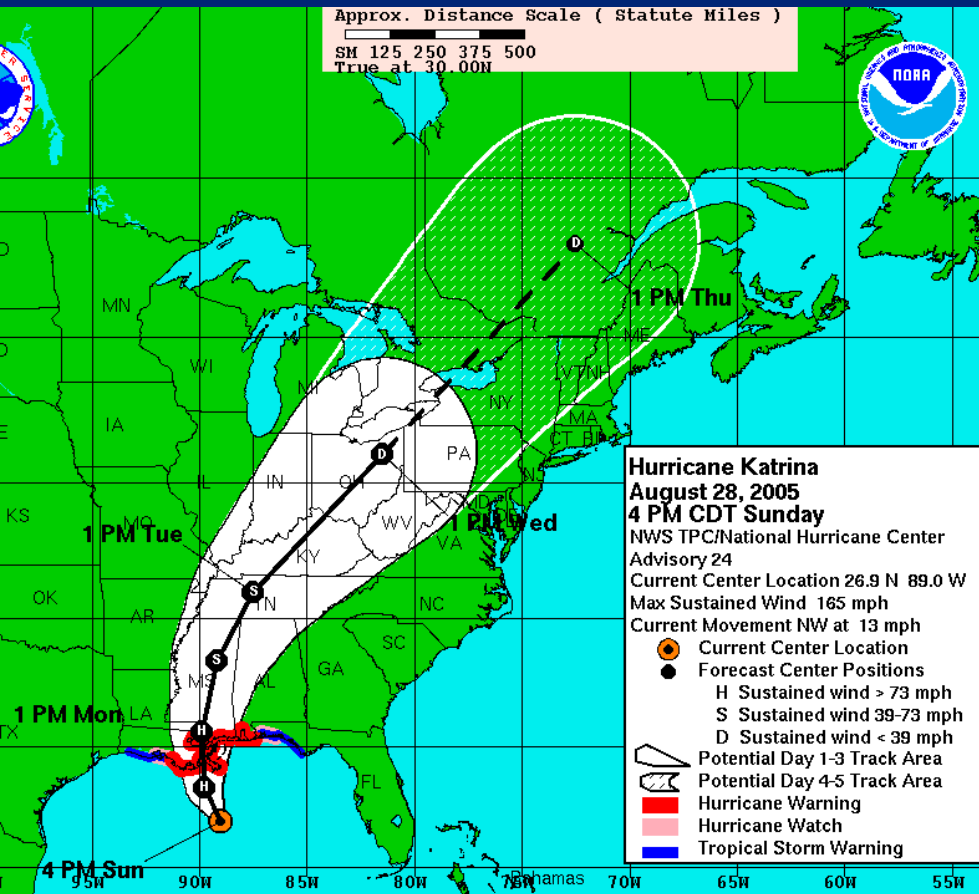
# Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

## Katrina Advisory #18



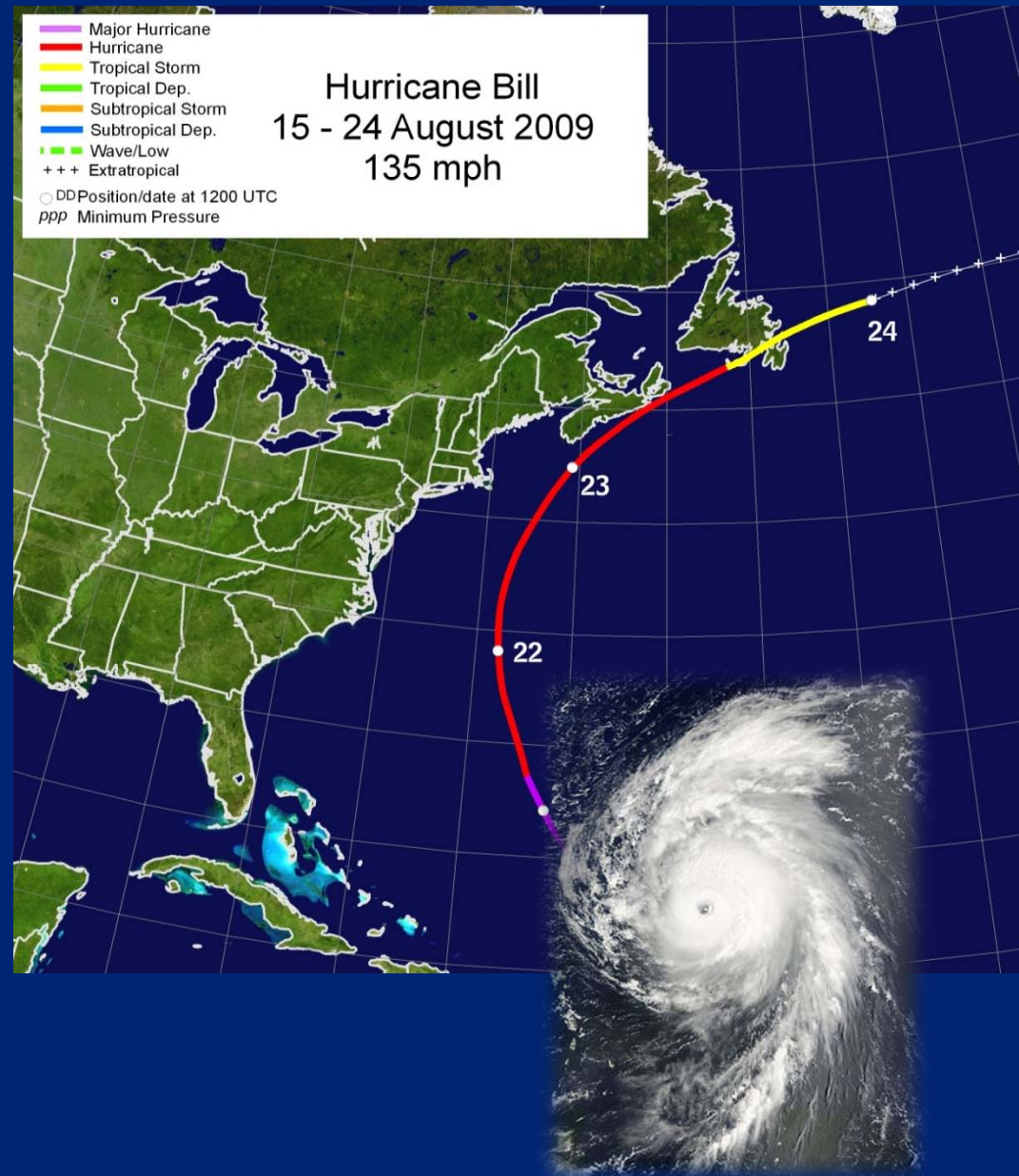
# Magnitudes of Cumulative Probabilities Vary Greatly But Realistically

## Katrina Advisory #24



# Hurricane Bill (2009)

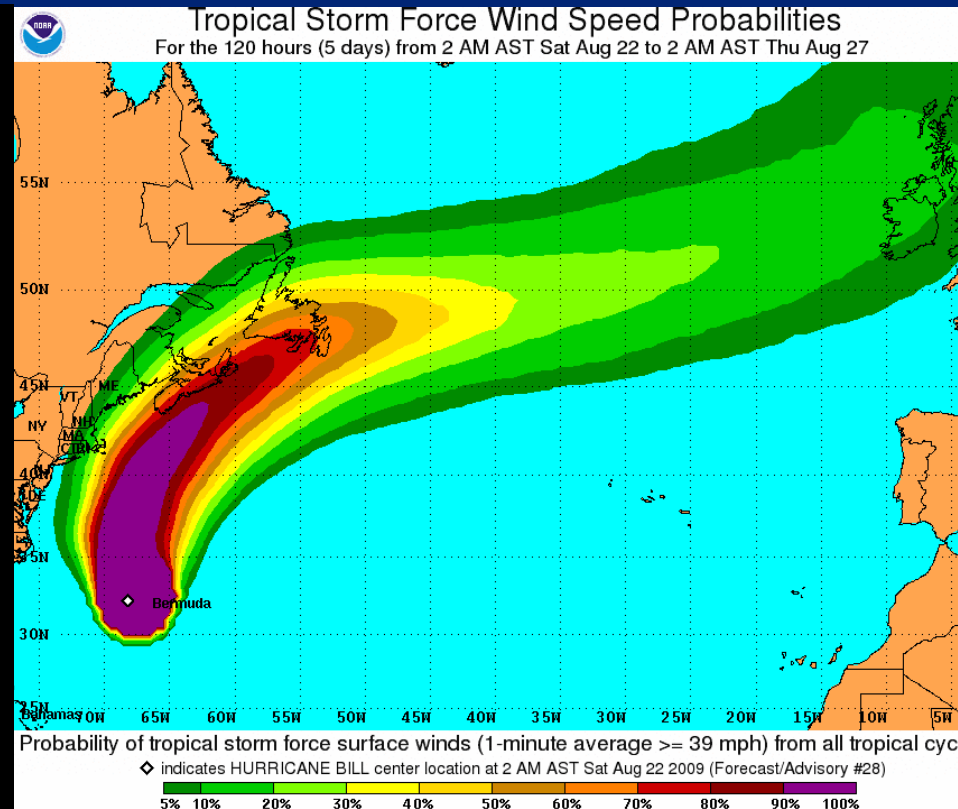
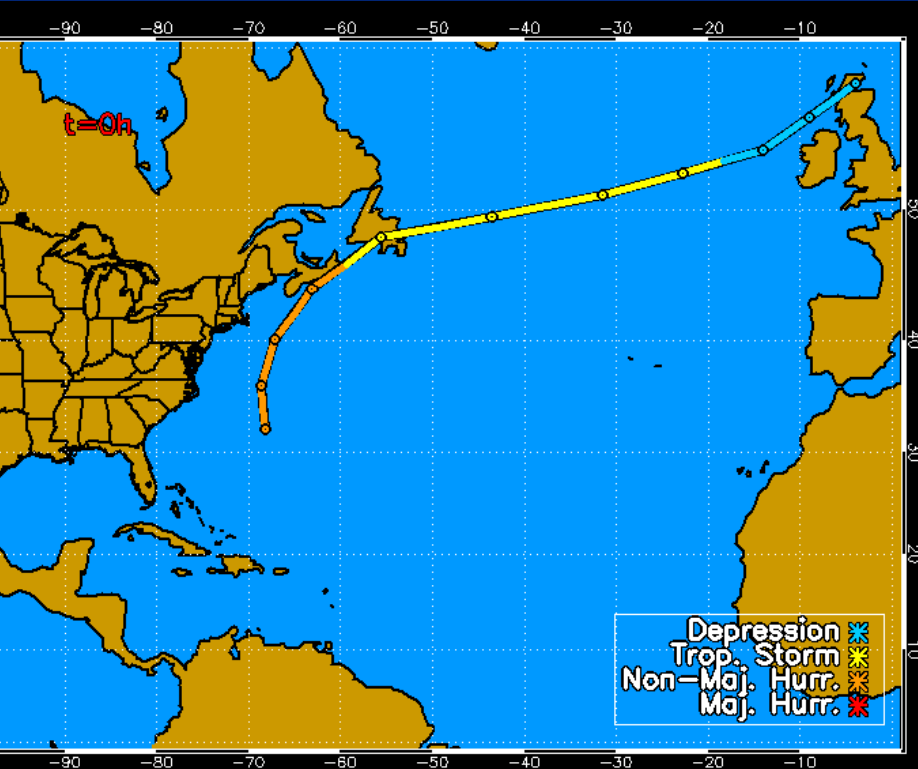
- Strong hurricane approaching the coast of New England but not expected to make landfall
- A “hit or miss” scenario, where some coastal areas could see tropical storm force winds, or nobody would (at least in the northeastern U.S.)
- Small changes in the forecast track or wind field in the western semicircle resulted in large changes in the wind speed probabilities



# Hurricane Bill

Advisory 28 – Issued 5 am EDT 22 Aug 2009

Tropical Storm Warning Issued



Cumulative 120-h 34-kt wind probabilities

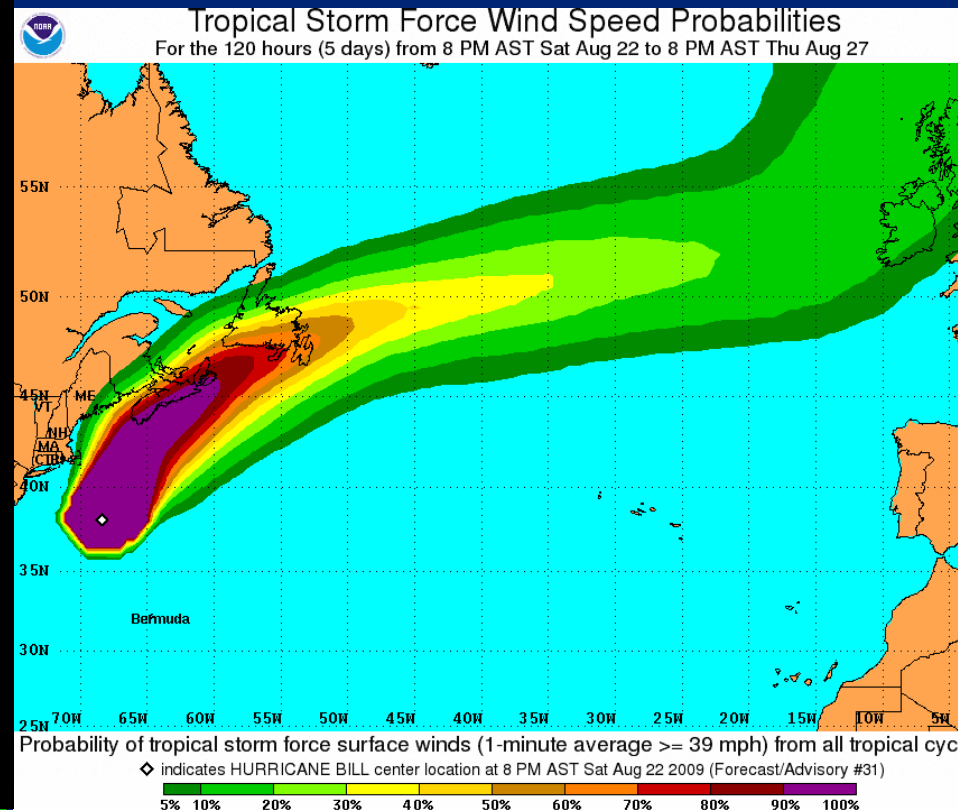
Nantucket: 40%

Hyannis: 29%

# Hurricane Bill

Advisory 31 – Issued 11 pm EDT 22 Aug 2009

## Tropical Storm Warning



Cumulative 120-h 34-kt wind probabilities

Nantucket: 10%

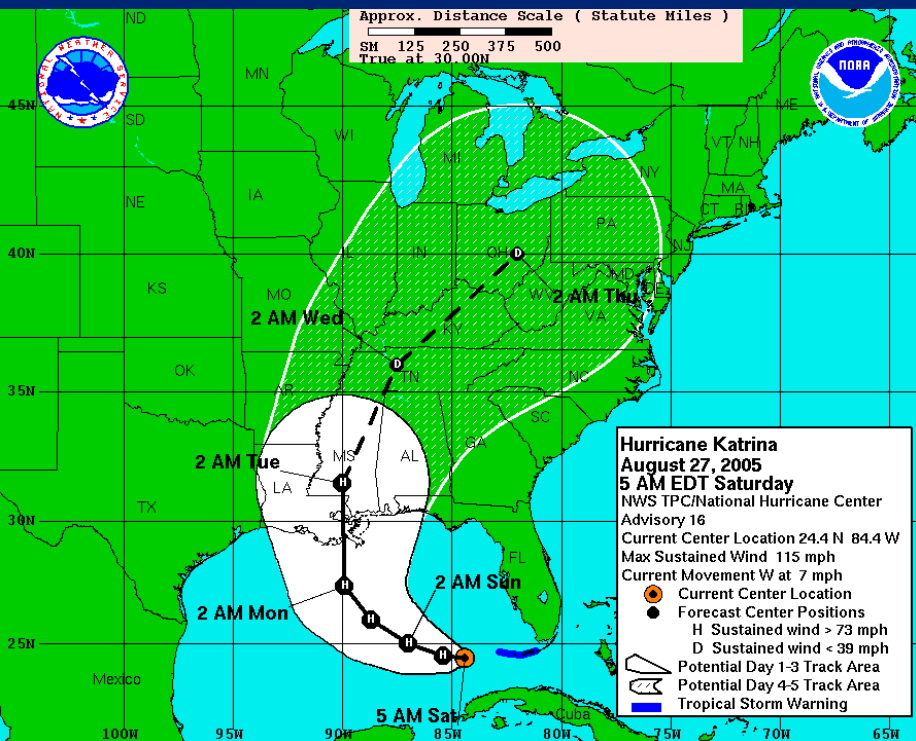
Hyannis: 5%

# Lesson

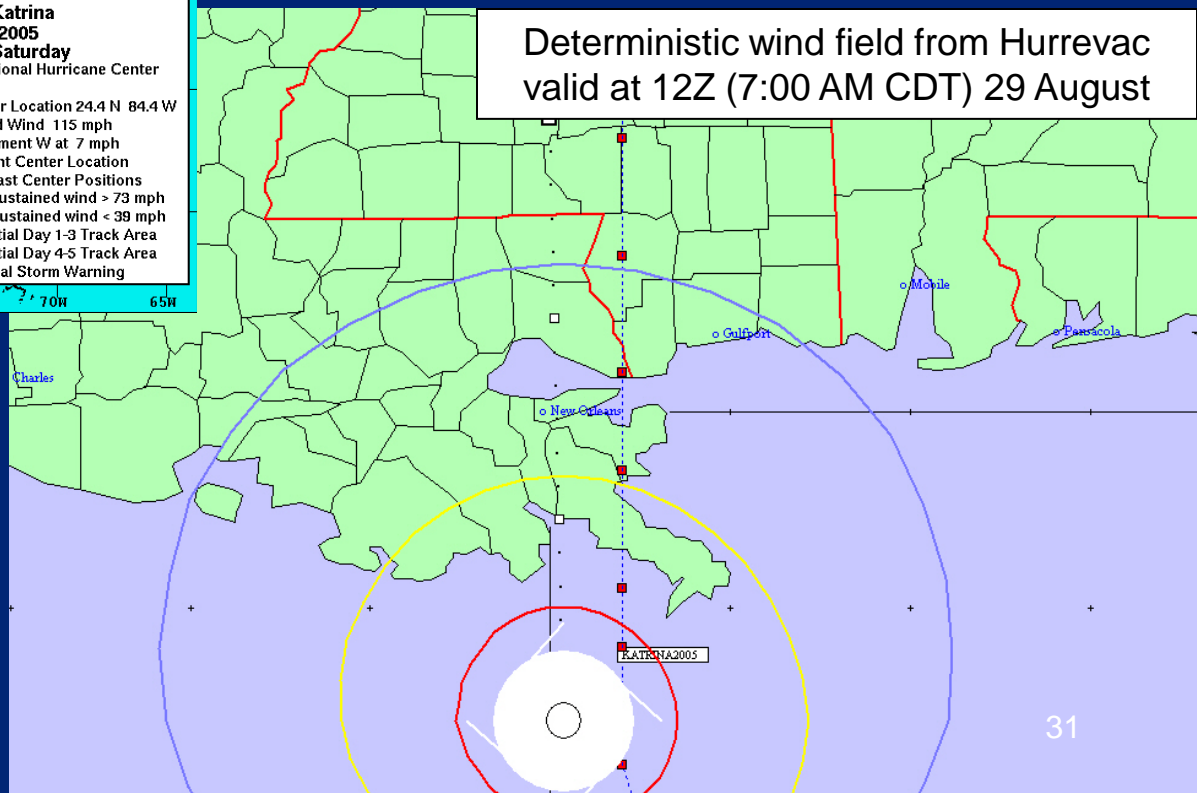
- Recurving storms can result in an “all or nothing” scenario
  - Some area may receive winds (e.g., NC Outer Banks, SE Massachusetts) or winds may not impact any land areas
- Small changes in the track forecast may result in large changes in the probabilities for any given location
  - “Small” probabilities are important!
  - Be prepared to act quickly if the forecast changes and threat increases for your area

# Using the Probabilities for Timing Uncertainty

# Onset of 34-kt Winds Katrina (2005)



- Onset of 34-kt winds based on deterministic forecast from Advisory 16
  - New Orleans, LA – Monday 29 Aug. 08Z (3:00 AM CDT)
  - Gulfport, MS – Monday 29 Aug. 11Z (6:00 AM CDT)



# Wind Speed Probabilities

## Katrina (2005) Advisory 16

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -										
			FROM		FROM		FROM		FROM	
TIME			06Z SAT	18Z SAT	06Z SUN	18Z SUN	06Z MON	06Z TUE	06Z WED	
PERIODS			TO	TO	TO	TO	TO	TO	TO	
			18Z SAT	06Z SUN	18Z SUN	06Z MON	06Z TUE	06Z WED	06Z THU	
FORECAST HOUR			(12)	(24)	(36)	(48)	(72)	(96)	(120)	
NEW ORLEANS LA			34 X	1( 1)	9(10)	28(38)	34(72)	5(77)	X(77)	
GULFPORT MS			34 X	1( 1)	8( 9)	23(32)	35(67)	5(72)	1(73)	

# Wind Speed Probabilities

## Katrina (2005) Advisory 16

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -									
	FROM		FROM		FROM		FROM		FROM
TIME	06Z SAT	18Z SAT	06Z SUN	18Z SUN	06Z MON	18Z MON	06Z TUE	18Z TUE	06Z WED
PERIODS	TO	TO	TO	TO	TO	TO	TO	TO	TO
	18Z SAT	06Z SUN	18Z SUN	06Z MON	06Z TUE	06Z WED	06Z THU		
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)		
NEW ORLEANS LA	34 X	1( 1)	9(10)	28(38)	34(72)	5(77)	X(77)		
GULFPORT MS	34 X	1( 1)	8( 9)	23(32)	35(67)	5(72)	1(73)		

Most likely period of onset of 34-kt winds at New Orleans and Gulfport is between 06Z (1:00 AM CDT) Monday 29 Aug. and 06Z (1:00 AM CDT) Tuesday 30 Aug.

# Wind Speed Probabilities

## Katrina (2005) Advisory 16

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -									
	FROM		FROM		FROM		FROM		FROM
TIME	06Z SAT	18Z SAT	06Z SAT	18Z SAT	06Z SUN	18Z SUN	06Z MON	06Z TUE	06Z WED
PERIODS	TO		TO		TO		TO	TO	TO
	18Z SAT	06Z SUN	18Z SAT	06Z SUN	18Z SUN	06Z MON	06Z TUE	06Z WED	06Z THU
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)		
NEW ORLEANS LA	34 X	1( 1)	9(10)	28(38)	34(72)	5(77)	X(77)		
GULFPORT MS	34 X	1( 1)	8( 9)	23(32)	35(67)	5(72)	1(73)		

However, the probability that 34-kt winds will start **prior to** 06Z (1:00 AM CDT) Monday 29 Aug. at both New Orleans and Gulfport is nearly as large!

# What Actually Happened?

- Onset of 34-kt winds occurred between 00Z and 06Z Monday 8/29 at New Orleans and Gulfport
  - At least **3 hours** earlier than shown by Hurrevac at New Orleans
  - At least **5 hours** earlier than shown by Hurrevac at Gulfport

# Lesson

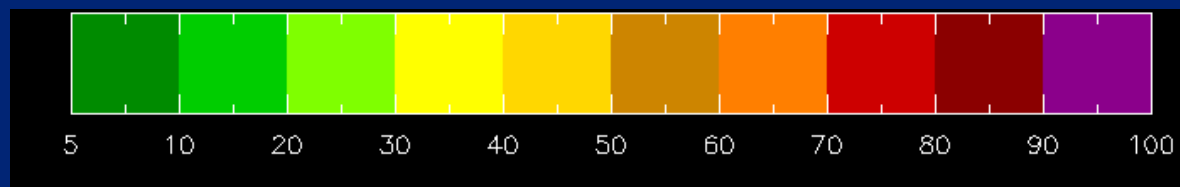
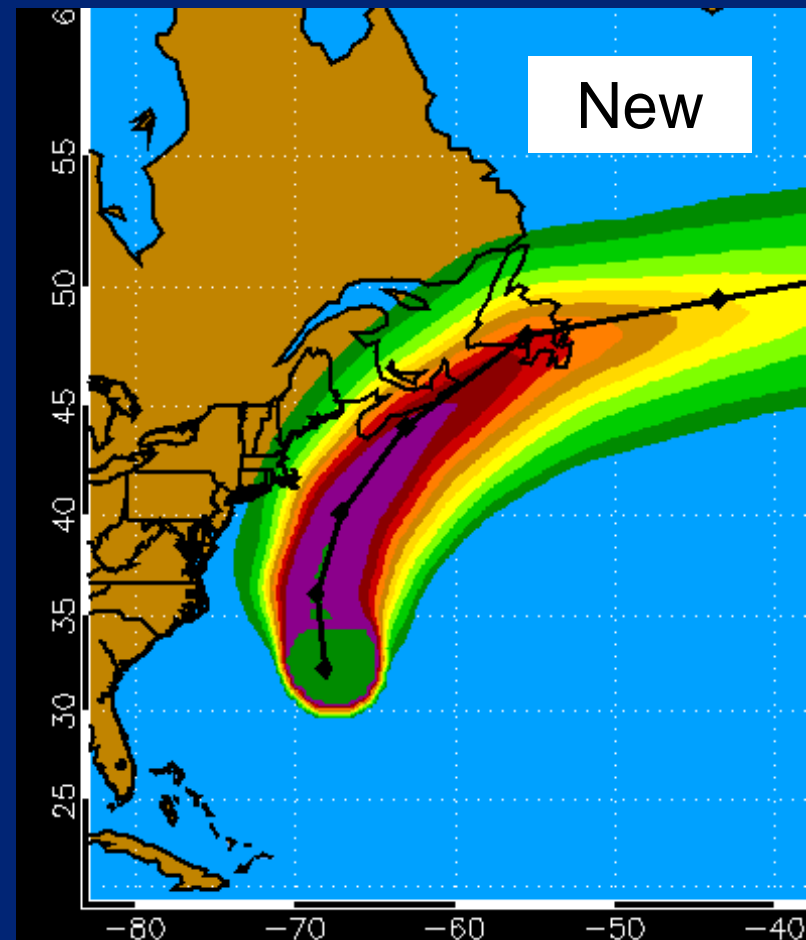
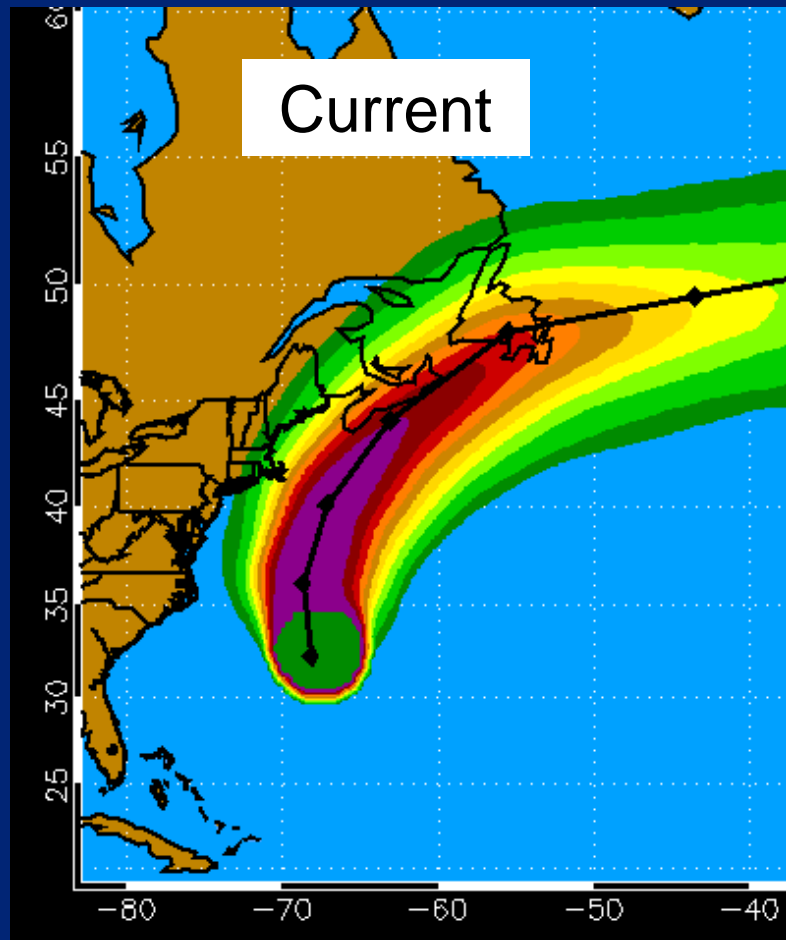
- Important information about the onset of wind conditions contained in the probabilities *beyond what you see in Hurrevac*
- Examine trends from advisory to advisory
  - How are probabilities of onset changing?
  - Are chances of onset nearly equal between two consecutive time periods?

# Changes to Probability Products for 2010

- Wind speed and intensity probability products will better reflect the actual track forecast uncertainty
- Old method sampled all previous NHC track forecast errors regardless of the situation
- New method will sample different errors depending on how much spread there is in the track model guidance
- Situations where track model spread is *small* should have *narrower* probability swath
  - Larger probabilities along track forecast
  - Smaller probabilities along the edges

# How would New Probabilities Look for Bill?

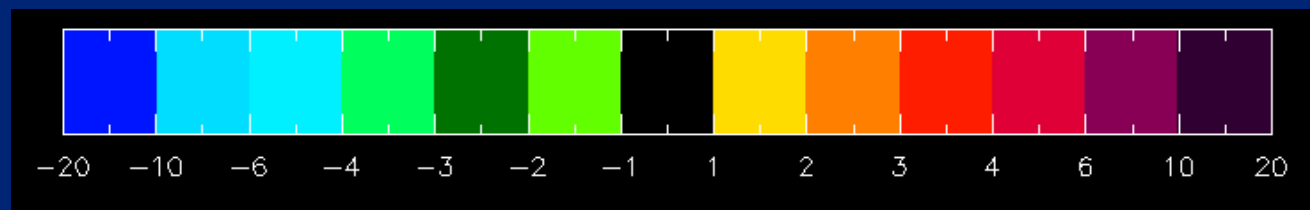
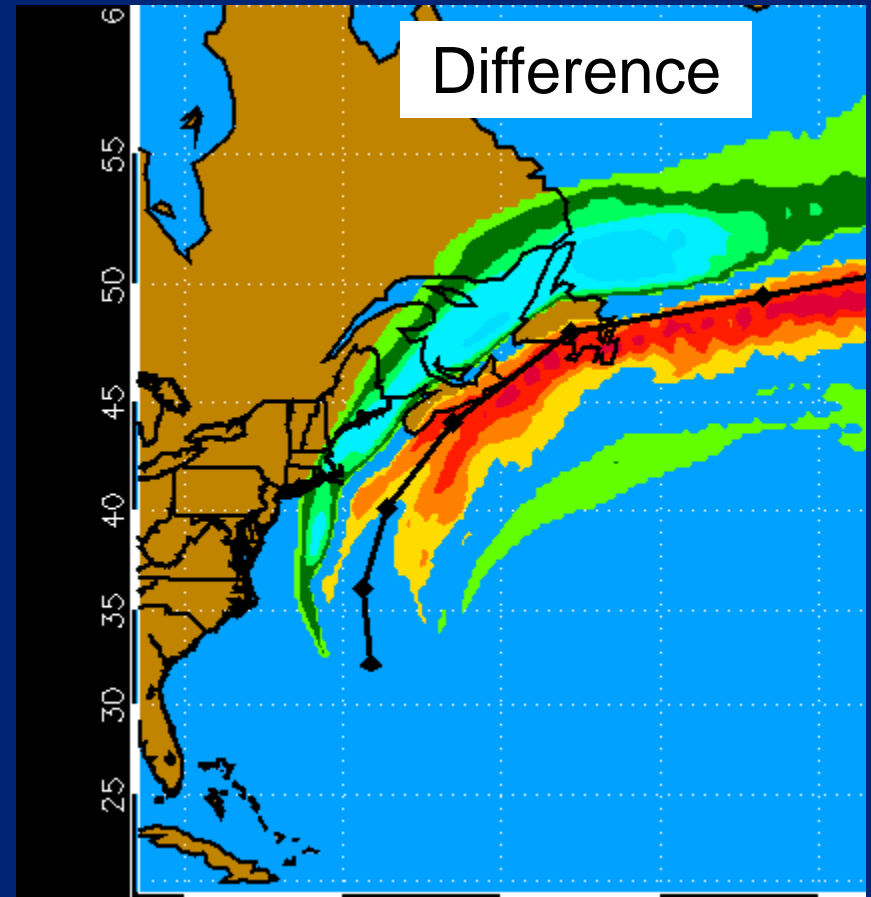
Advisory 28 – 5 am 22 Aug 2009



# How would New Probabilities Look for Bill?

Advisory 28 – 5 am 22 Aug 2009

- Reduction in probability of TS winds of 3-6% along the western flank of the track of Bill
- Increase of probability by 3-6% along Bill's forecast track
- This case had “low” track model spread



# Intensity Probability Table

- **Small Probabilities Matter**
- **Probabilities lower (realistically) for strong storms when they are forecast to be near land**
  - **Example Isabel (over water) vs. Dean (near land)**

# Hurricane Ike Intensity Probability Table



Intensity (Maximum Wind Speed) Probability Table  
Tropical Storm Ike Advisory Number 4  
5:00 AM AST Sep 2 2008



Wind Range (mph)	Forecast Time						
	12 hour for 2 PM Tue	24 hour for 2 AM Wed	36 hour for 2 PM Wed	48 hour for 2 AM Thu	72 hour for 2 AM Fri	96 hour for 2 AM Sat	120 hour for 2 AM Sun
Dissipated	<1%	<1%	<1%	<1%	<1%	1%	2%
Tropical Depression (<39)	1%	2%	2%	1%	3%	2%	3%
Tropical Storm (39-73)	82%	58%	32%	26%	23%	20%	23%
Hurricane (all categories)	17%	40%	67%	72%	74%	77%	73%
-- Category 1 (74-95)	16%	36%	48%	42%	35%	31%	27%
-- Category 2 (96-110)	1%	3%	14%	19%	21%	22%	19%
-- Category 3 (111-130)	<1%	1%	4%	9%	14%	18%	17%
-- Category 4 (131-155)	<1%	1%	1%	2%	4%	6%	7%
-- Category 5 (>155)	<1%	<1%	<1%	<1%	1%	1%	1%
Forecast Maximum Wind	65 mph	70 mph	80 mph	85 mph	90 mph	100 mph	105 mph

# Small Probabilities of Category 4 Hurricane

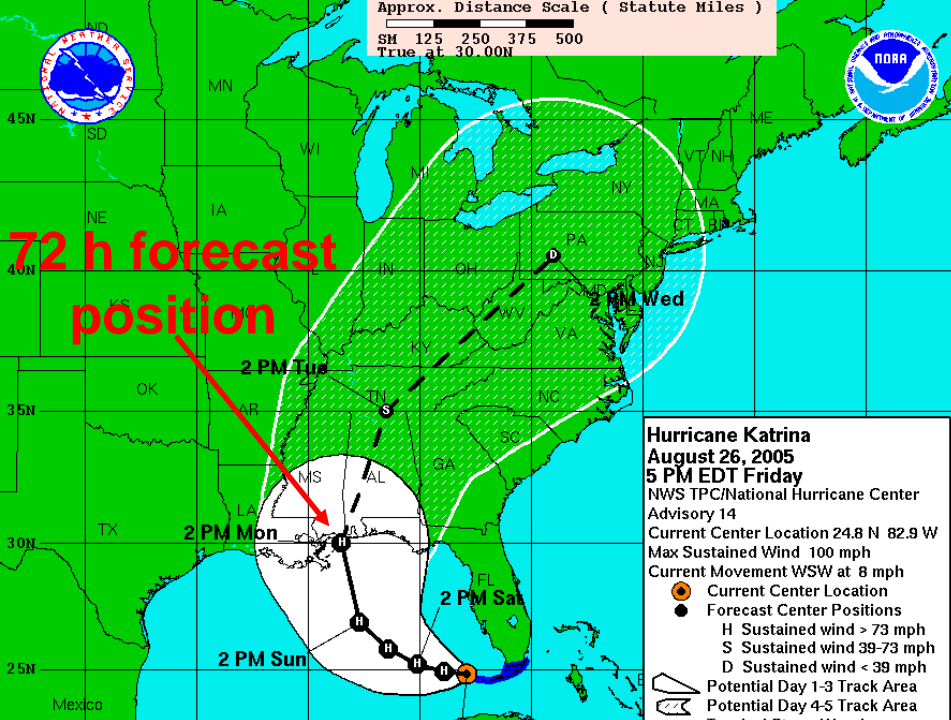


## Intensity (Maximum Wind Speed) Probability Table Tropical Storm Ike Advisory Number 4 5:00 AM AST Sep 2 2008



Wind Range (mph)	Forecast Time						
	12 hour for 2 PM Tue	24 hour for 2 AM Wed	36 hour for 2 PM Wed	48 hour for 2 AM Thu	72 hour for 2 AM Fri	96 hour for 2 AM Sat	120 hour for 2 AM Sun
Dissipated	<1%	<1%	<1%	<1%	<1%	1%	2%
Tropical Depression (<39)	1%	2%	2%	1%	3%	2%	3%
Tropical Storm (39-73)	82%	58%	32%	26%	23%	20%	23%
Hurricane (all categories)	17%	40%	67%	72%	74%	77%	73%
-- Category 1 (74-95)	16%	36%	48%	42%	35%	31%	27%
-- Category 2 (96-110)	1%	3%	14%	19%	21%	22%	19%
-- Category 3 (111-130)	<1%	1%	4%	9%	14%	18%	17%
-- Category 4 (131-155)	<1%	1%	1%	2%	4%	6%	7%
-- Category 5 (>155)	<1%	<1%	<1%	<1%	1%	1%	1%
Forecast Maximum Wind	65 mph	70 mph	80 mph	85 mph	90 mph	100 mph	105 mph

**2% chance of category 4 hurricane verifies**



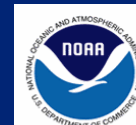
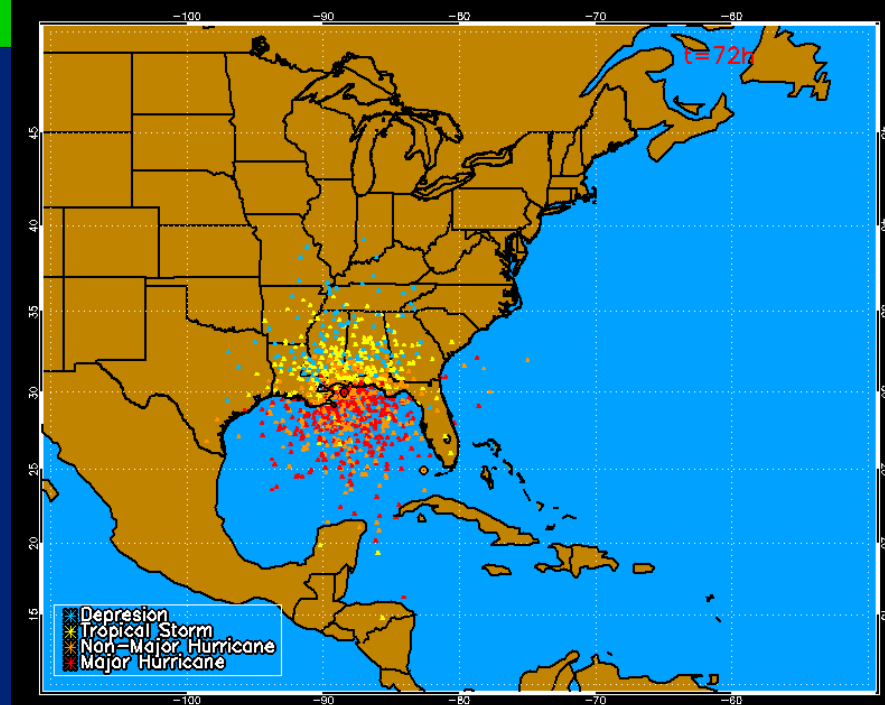
# Katrina

## Advisory 14

**Official NHC Intensity Forecast**  
 72 hour forecast- 135 mph (cat. 4)

**Verifying Intensity**  
 cat. 1

**Katrina Landfall Intensity 130 mph cat. 3**



**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%
<b>NHC Forecast</b>	<b>105</b>	<b>110</b>	<b>115</b>	<b>120</b>	<b>135</b>	<b>40</b>	<b>30</b>

# Summary

- NHC probability products help you deal with the uncertainty inherent in forecasting tropical cyclones
- Provide additional information beyond what is available in deterministic forecasts and in Hurrevac for:
  - Timing of event onset
  - Likelihood of various wind speeds occurring at your location
  - Likelihood of tropical cyclone intensity
- “Low” probabilities of extreme events often warrant action!