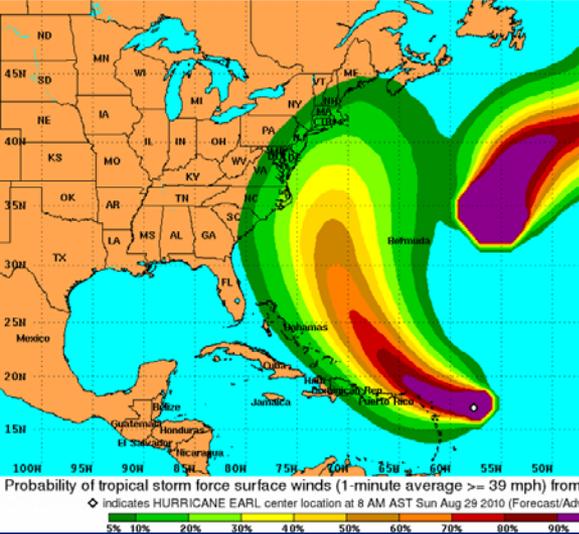




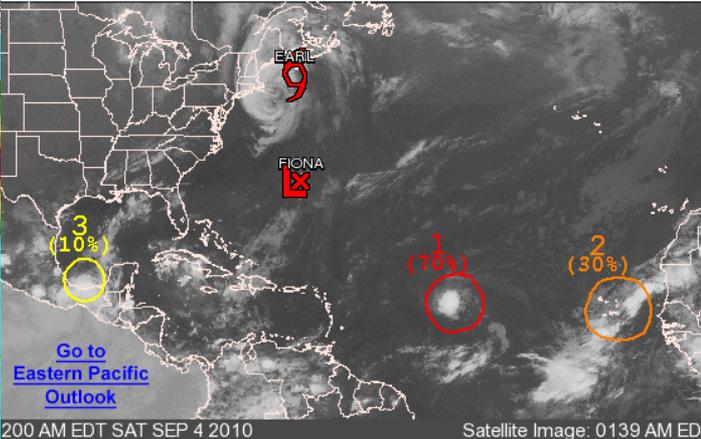
# NHC Wind Speed, Intensity, and Genesis Probabilities



Tropical Storm Force Wind Speed Probability  
For the 120 hours (5 days) from 8 AM AST Sun Aug 29 to 8 AM AST Fri 9



Graphical Tropical Weather Outlook  
National Hurricane Center Miami, Florida



Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.



Intensity (Maximum Wind Speed) Probability Table  
Hurricane Danielle Advisory Number 16  
11:00 AM AST Aug 25 2010

Forecast Time	Forecast Time						
	12 hour for 8 PM Wed	24 hour for 8 AM Thu	36 hour for 8 PM Thu	48 hour for 8 AM Fri	72 hour for 8 AM Sat	96 hour for 8 AM Sun	120 hour for 8 AM Mon
Category 1 (74-95)	<1%	<1%	<1%	<1%	<1%	1%	1%
Category 2 (96-110)	<1%	<1%	1%	1%	1%	2%	6%
Category 3 (111-130)	8%	12%	19%	17%	14%	17%	38%
Category 4 (131-155)	92%	88%	81%	82%	85%	81%	55%
Category 5 (>155)	76%	57%	49%	41%	31%	32%	32%
Forecast Maximum Wind	13%	22%	21%	23%	24%	24%	14%
	2%	7%	8%	14%	21%	19%	7%
	<1%	1%	2%	3%	7%	5%	2%
	<1%	<1%	<1%	1%	1%	1%	<1%
Forecast Maximum Wind	85 mph	90 mph	90 mph	100 mph	110 mph	110 mph	100 mph

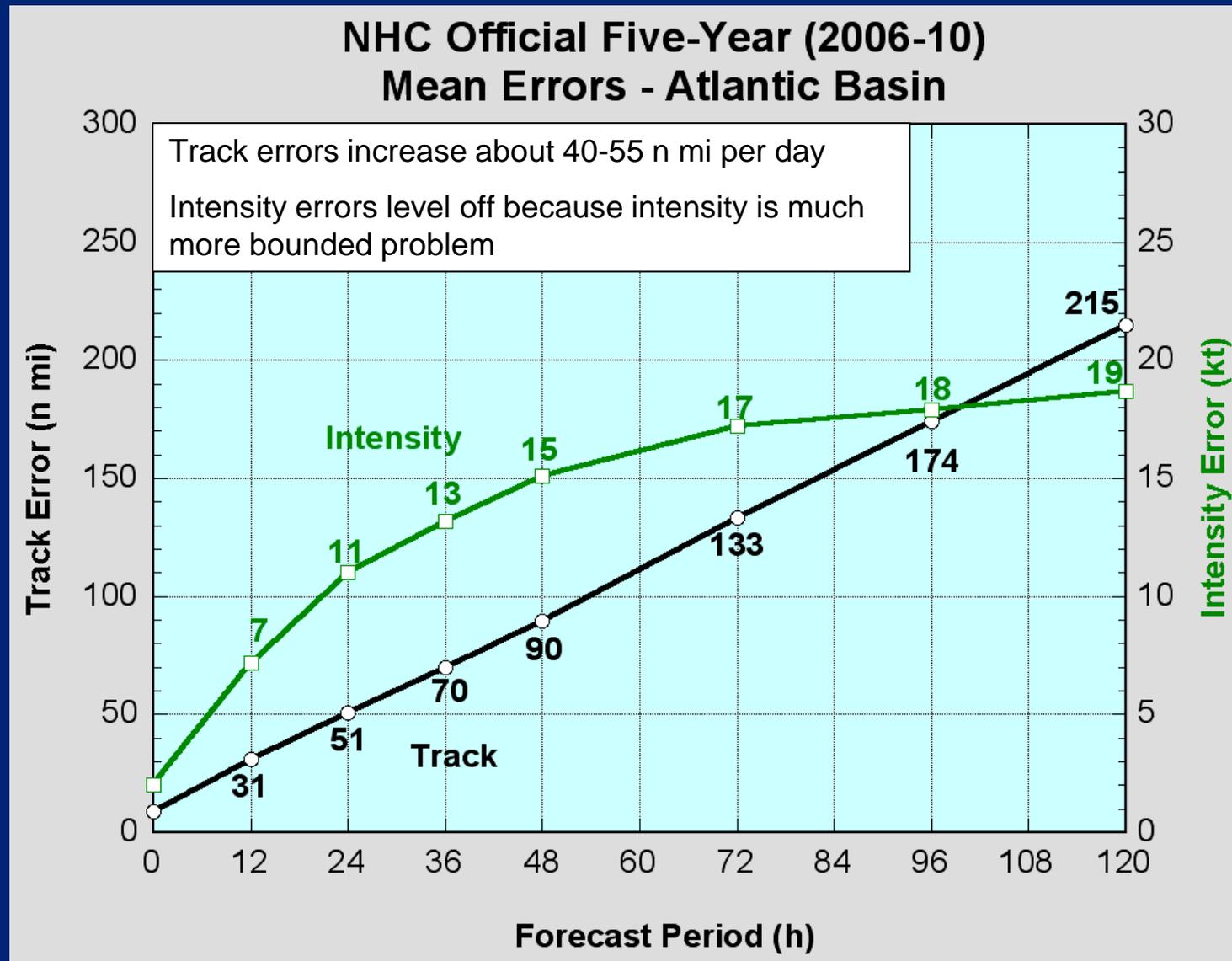
Michael J. Brennan  
National Hurricane Center

2011 National Hurricane Conference  
21 April 2011

# Outline

- Why probabilistic products?
- Wind speed probability products
- Intensity probability products
- Genesis probabilities

# Atlantic 5-Year Mean NHC Forecast Errors



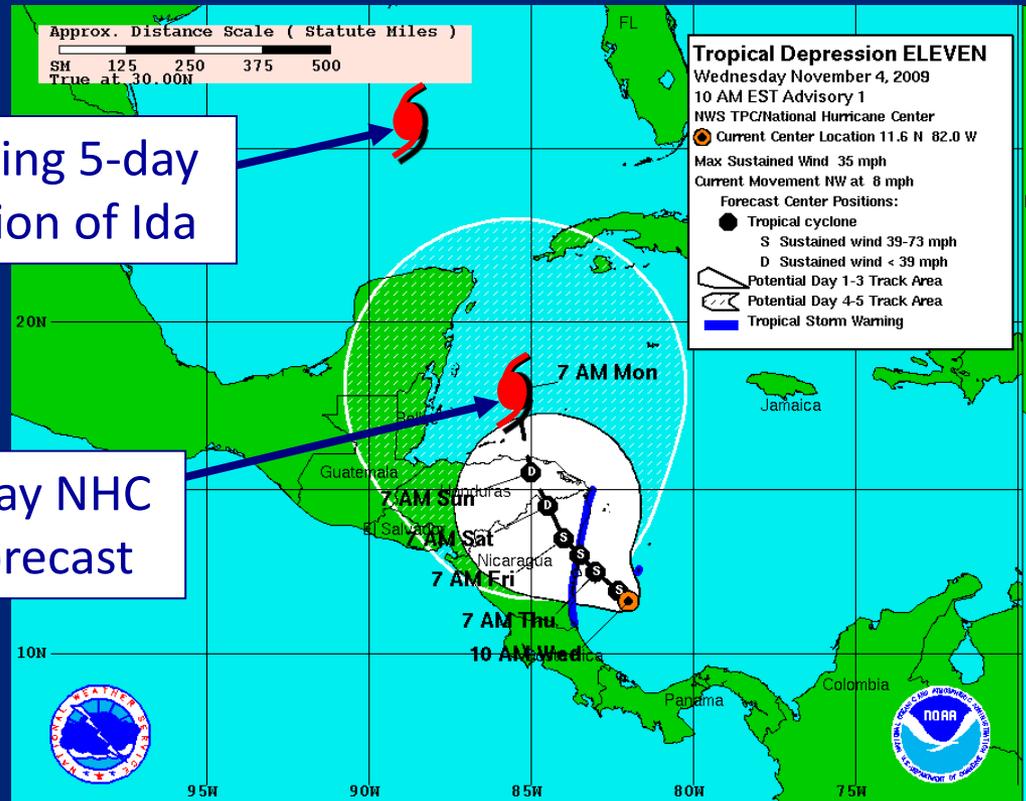
# All Forecasts Have Errors

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

5-day position error  
about 600 miles

Verifying 5-day  
Position of Ida

5-day NHC  
Forecast

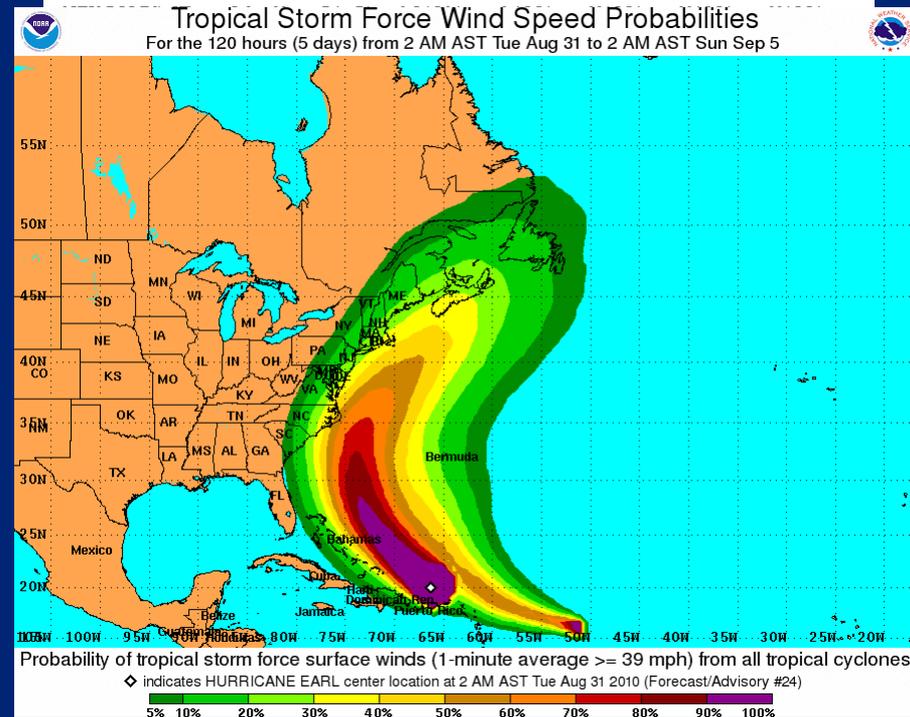


NHC probability products can help

# Wind Speed Probability Products

- Depicts location-specific probabilities for 34-kt (TS-force), 50-kt (58-mph), and 64-kt (hurricane-force) winds
- Text product contains cumulative and individual time period onset probabilities for a fixed set of locations
- Graphic depicts cumulative probabilities for points over a large domain

NEW YORK CITY	34	X	1( 1)	32(33)	11(44)	X(44)	X(44)	X(44)
NEW YORK CITY	50	X	X( X)	3( 3)	6( 9)	X( 9)	X( 9)	X( 9)
NEW YORK CITY	64	X	X( X)	1( 1)	1( 2)	X( 2)	X( 2)	X( 2)
NEWARK NJ	34	X	X( X)	26(26)	9(35)	X(35)	X(35)	X(35)
NEWARK NJ	50	X	X( X)	2( 2)	3( 5)	X( 5)	X( 5)	X( 5)
TRENTON NJ	34	X	1( 1)	25(26)	6(32)	X(32)	X(32)	X(32)
TRENTON NJ	50	X	X( X)	3( 3)	1( 4)	X( 4)	X( 4)	X( 4)
ATLANTIC CITY	34	X	4( 4)	44(48)	3(51)	X(51)	X(51)	X(51)
ATLANTIC CITY	50	X	X( X)	9( 9)	2(11)	X(11)	X(11)	X(11)
ATLANTIC CITY	64	X	X( X)	3( 3)	1( 4)	X( 4)	X( 4)	X( 4)
BALTIMORE MD	34	X	3( 3)	14(17)	1(18)	X(18)	X(18)	X(18)
DOVER DE	34	X	7( 7)	29(36)	2(38)	X(38)	X(38)	X(38)
DOVER DE	50	X	X( X)	6( 6)	1( 7)	X( 7)	X( 7)	X( 7)
DOVER DE	64	X	X( X)	1( 1)	X( 1)	X( 1)	X( 1)	X( 1)



# How the Wind Speed/Intensity Probabilities are Created

- 1,000 realistic alternative scenarios created using
  - Official NHC track, intensity and 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



# Influence of Track Model Spread on Probabilities

- Wind speed and intensity probability products can account for situational track forecast uncertainty
- Methodology samples different historical NHC track forecast 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

# 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 warned point **25%**

# Wind Speed Probability Text Product

ZCZC MIAPWSAT2 ALL  
 TTA000 KNHC DDHMM  
 HURRICANE EARL WIND SPEED PROBABILITIES NUMBER 24  
 NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL072010  
 0900 UTC TUE AUG 31 2010

AT 0900Z THE CENTER OF HURRICANE EARL WAS LOCATED NEAR LATITUDE 20.5  
 NORTH...LONGITUDE 66.7 WEST WITH MAXIMUM SUSTAINED WINDS NEAR 115  
 KTS...135 MPH...215 KM/HR.

Z INDICATES COORDINATED UNIVERSAL TIME (GREENWICH)  
 ATLANTIC STANDARD TIME (AST)...SUBTRACT 4 HOURS FROM Z TIME  
 EASTERN DAYLIGHT TIME (EDT)...SUBTRACT 4 HOURS FROM Z TIME  
 CENTRAL DAYLIGHT TIME (CDT)...SUBTRACT 5 HOURS FROM Z TIME

## I. MAXIMUM WIND SPEED (INTENSITY) PROBABILITY TABLE

CHANCES THAT THE MAXIMUM SUSTAINED (1-MINUTE AVERAGE) WIND SPEED OF  
 THE TROPICAL CYCLONE WILL BE WITHIN ANY OF THE FOLLOWING CATEGORIES  
 AT EACH OFFICIAL FORECAST TIME DURING THE NEXT 5 DAYS.  
 PROBABILITIES ARE GIVEN IN PERCENT. X INDICATES PROBABILITIES LESS  
 THAN 1 PERCENT.

### - - - MAXIMUM WIND SPEED (INTENSITY) PROBABILITIES - - -

VALID TIME	18Z TUE	06Z WED	18Z WED	06Z THU	06Z FRI	06Z SAT	06Z SUN
FORECAST HOUR	12	24	36	48	72	96	120
DISSIPATED	X	X	X	X	X	3	21
TROP DEPRESSION	X	X	X	X	1	8	29
TROPICAL STORM	X	X	1	2	13	39	40
HURRICANE	99	99	99	98	86	50	10
HUR CAT 1	X	2	4	12	30	33	9
HUR CAT 2	2	7	12	25	25	11	1
HUR CAT 3	38	48	45	38	22	5	1
HUR CAT 4	57	38	33	19	8	1	X
HUR CAT 5	3	5	5	4	1	X	X
FCST MAX WIND	120KT	120KT	120KT	115KT	105KT	85KT	60KT

## II. WIND SPEED PROBABILITY TABLE FOR SPECIFIC LOCATIONS

CHANCES OF SUSTAINED (1-MINUTE AVERAGE) 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

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

TIME PERIODS	FROM						
	06Z TUE TO 18Z TUE	18Z TUE TO 06Z WED	06Z WED TO 18Z WED	18Z WED TO 06Z THU	06Z THU TO 06Z FRI	06Z FRI TO 06Z SAT	06Z SAT TO 06Z SUN
FORECAST HOUR	(12)	(24)	(36)	(48)	(72)	(96)	(120)
LOCATION	KT						
EASTPORT ME	34 X	X( X)	X( X)	X( X)	X( X)	5( 5)	27(32)
EASTPORT ME	50 X	X( X)	X( X)	X( X)	X( X)	1( 1)	13(14)
EASTPORT ME	64 X	X( X)	5( 5)				
BAR HARBOR ME	34 X	X( X)	X( X)	X( X)	X( X)	7( 7)	22(29)
BAR HARBOR ME	50 X	X( X)	X( X)	X( X)	X( X)	1( 1)	10(11)
BAR HARBOR ME	64 X	X( X)	5( 5)				
AUGUSTA ME	34 X	X( X)	X( X)	X( X)	X( X)	7( 7)	15(22)
AUGUSTA ME	50 X	X( X)	8( 8)				
AUGUSTA ME	64 X	X( X)	2( 2)				
PORTLAND ME	34 X	X( X)	X( X)	X( X)	X( X)	10(10)	11(21)
PORTLAND ME	50 X	X( X)	X( X)	X( X)	X( X)	2( 2)	5( 7)
PORTLAND ME	64 X	X( X)	3( 3)				
CONCORD NH	34 X	X( X)	X( X)	X( X)	X( X)	11(11)	7(18)
CONCORD NH	50 X	X( X)	X( X)	X( X)	X( X)	2( 2)	3( 5)
CONCORD NH	64 X	X( X)	1( 1)				
BOSTON MA	34 X	X( X)	X( X)	X( X)	X( X)	18(18)	9(27)
BOSTON MA	50 X	X( X)	X( X)	X( X)	X( X)	5( 5)	6(11)
BOSTON MA	64 X	X( X)	X( X)	X( X)	X( X)	2( 2)	2( 4)
HYANNIS MA	34 X	X( X)	X( X)	X( X)	X( X)	29(29)	9(38)
HYANNIS MA	50 X	X( X)	X( X)	X( X)	X( X)	10(10)	7(17)
HYANNIS MA	64 X	X( X)	X( X)	X( X)	X( X)	4( 4)	4( 8)
NANTUCKET MA	34 X	X( X)	X( X)	X( X)	X( X)	33(33)	10(43)
NANTUCKET MA	50 X	X( X)	X( X)	X( X)	X( X)	13(13)	8(21)
NANTUCKET MA	64 X	X( X)	X( X)	X( X)	X( X)	5( 5)	5(10)

# 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?

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%

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?

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)
<b>CHARLOTTE NC</b>	<b>34 X</b>	<b>X( X)</b>	<b>X( X)</b>	<b>3( 3)</b>	<b>18(21)</b>	<b>12(33)</b>	<b>9(42)</b>
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?

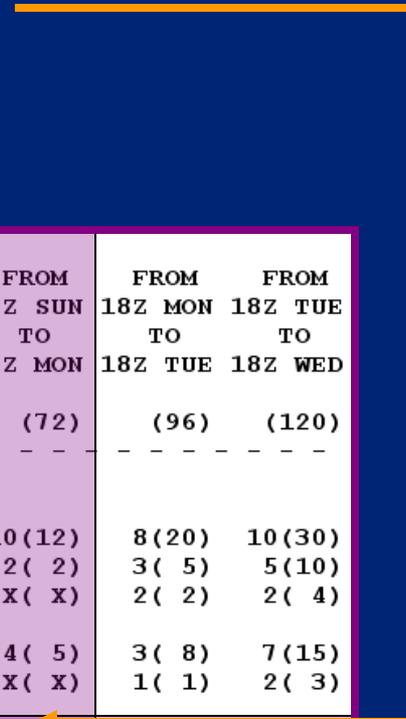
**42%**

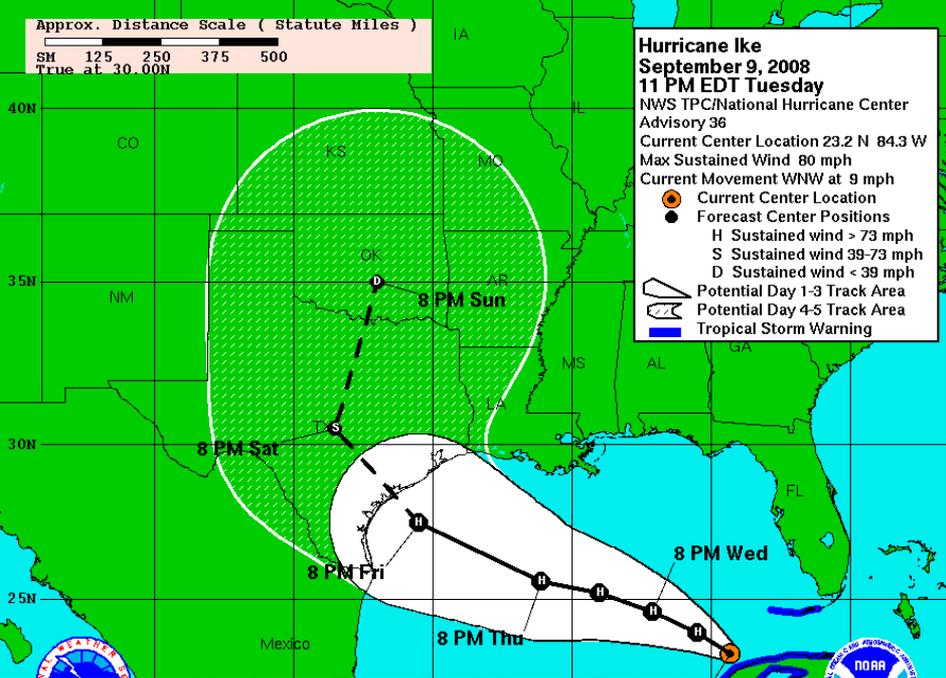
When are these winds most likely to start?

**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)

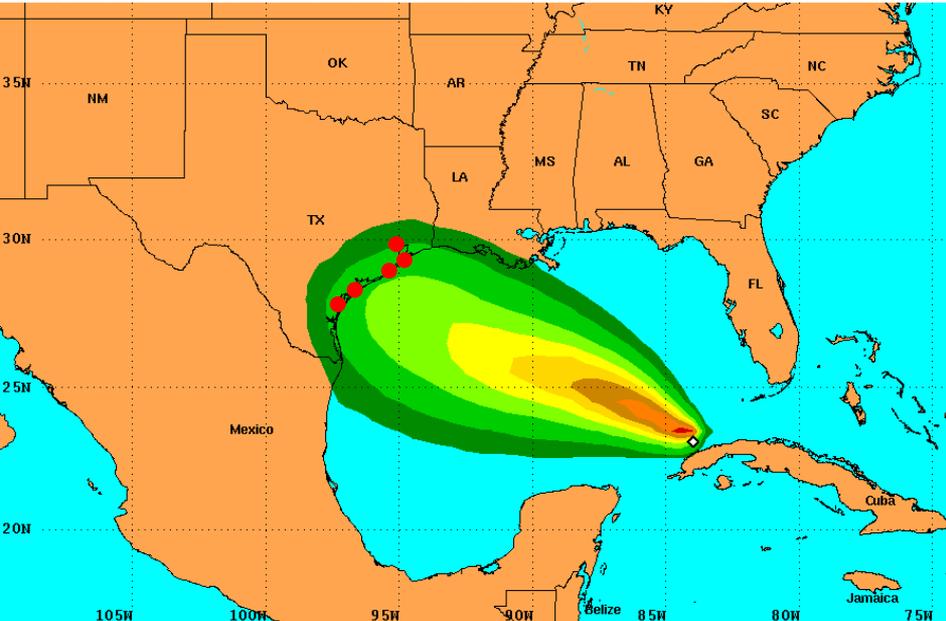
34 kt  
probabilities  
at Charlotte  
NC





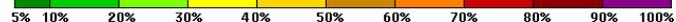
**Hurricane Force Wind Speed Probabilities**

For the 120 hours (5 days) from 8 PM EDT Tue Sep 9 to 8 PM EDT Sun Sep 14



Probability of hurricane force surface winds (1-minute average >= 74 mph) from all tropical cyclones

◇ indicates HURRICANE IKE center location at 8 PM EDT Tue Sep 9 2008 (Forecast/Advisory #36)



ZCZC MIAPWSAT4 ALL

TTAA00 KNHC DDHMM

HURRICANE IKE WIND SPEED PROBABILITIES NUMBER 36

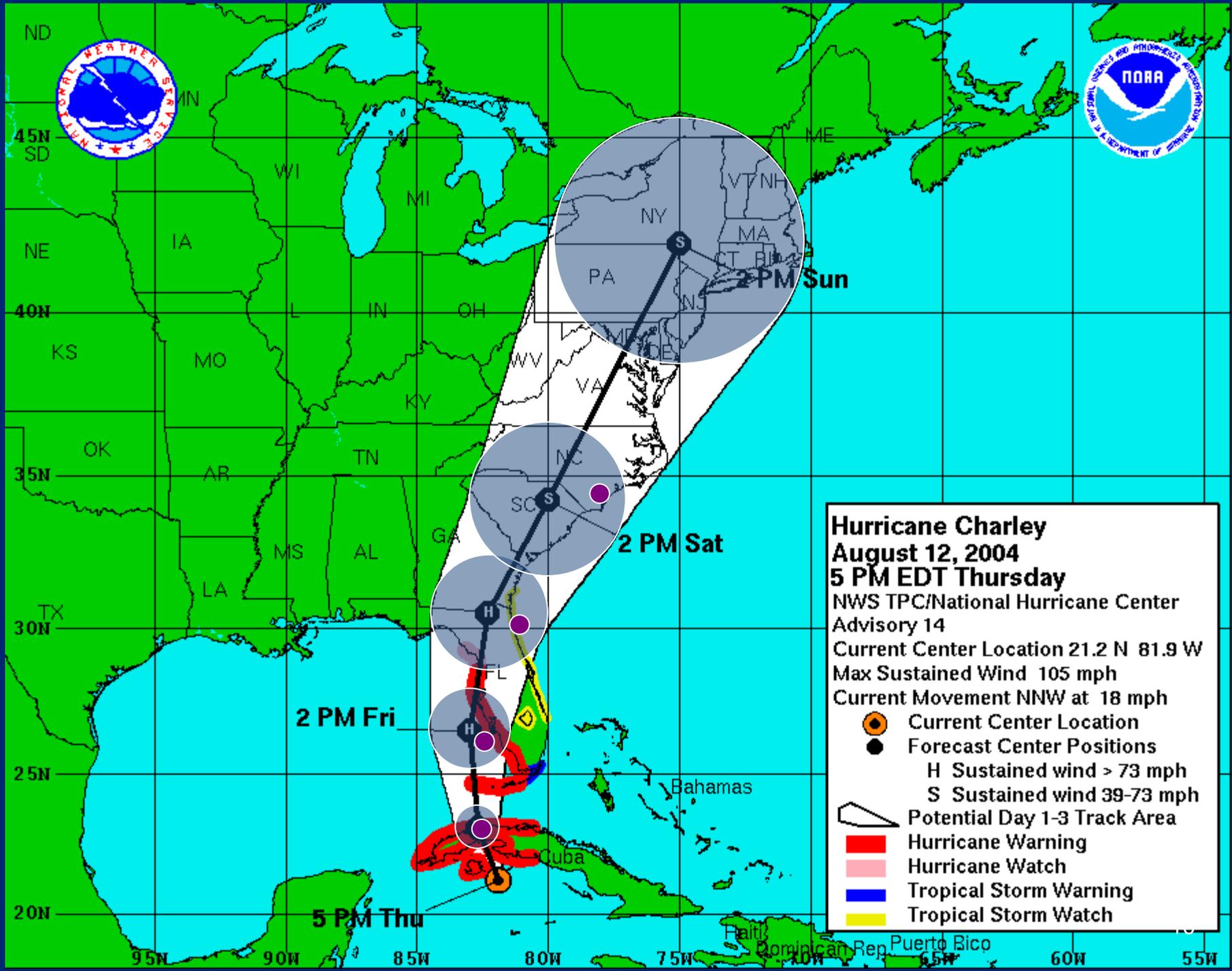
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL092008

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.

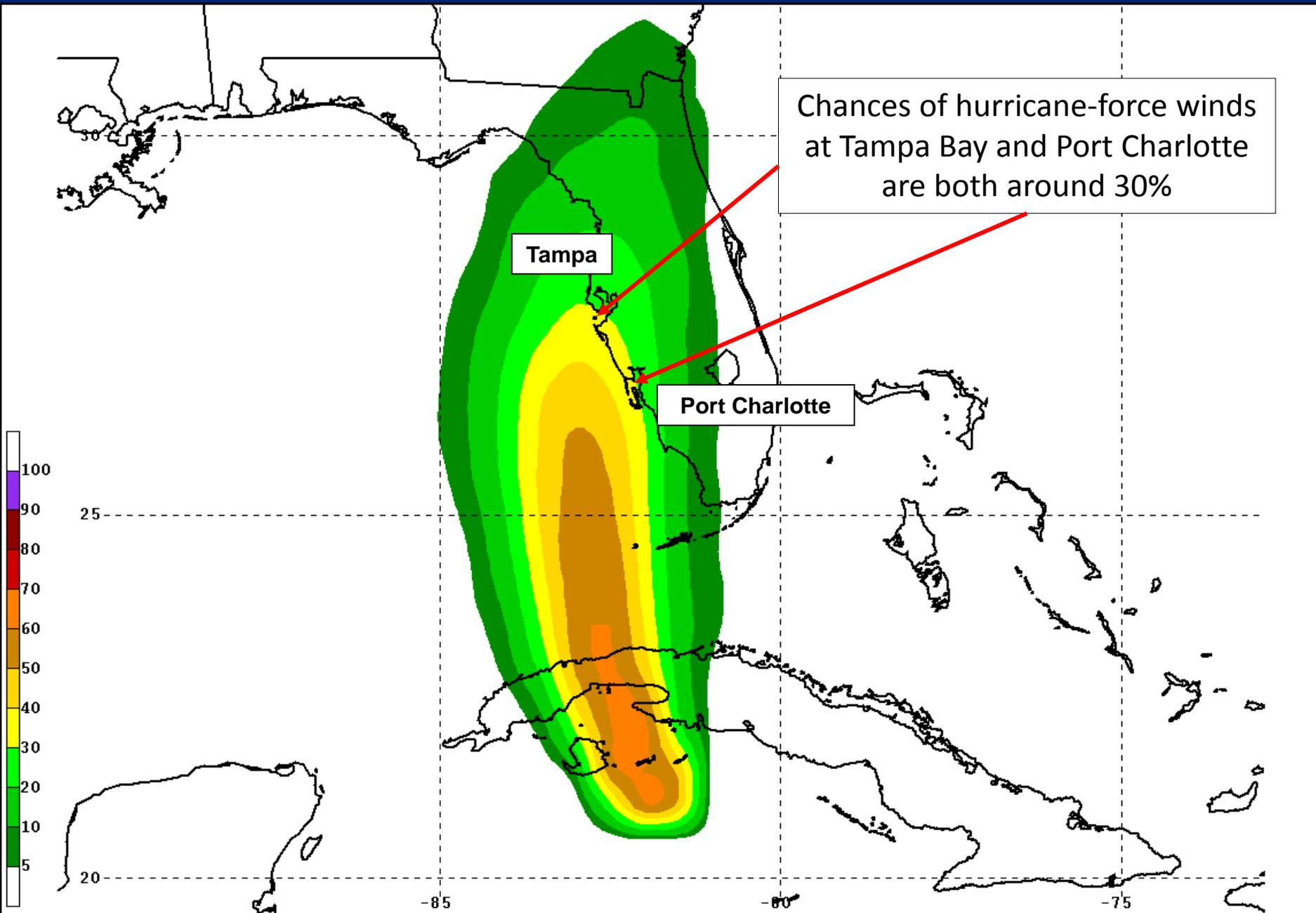
PORT ARTHUR TX 34	X	X( X)	X( X)	6( 6)	32(38)	8(46)	1(47)
PORT ARTHUR TX 50	X	X( X)	X( X)	1( 1)	12(13)	5(18)	1(19)
PORT ARTHUR TX 64	X	X( X)	X( X)	X( X)	5( 5)	3( 8)	X( 8)
GALVESTON TX 34	X	X( X)	1( 1)	6( 7)	38(45)	11(56)	2(58)
GALVESTON TX 50	X	X( X)	X( X)	1( 1)	20(21)	7(28)	2(30)
GALVESTON TX 64	X	X( 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)

# What the Probabilities Tell You That the Cone of Uncertainty Can'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



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

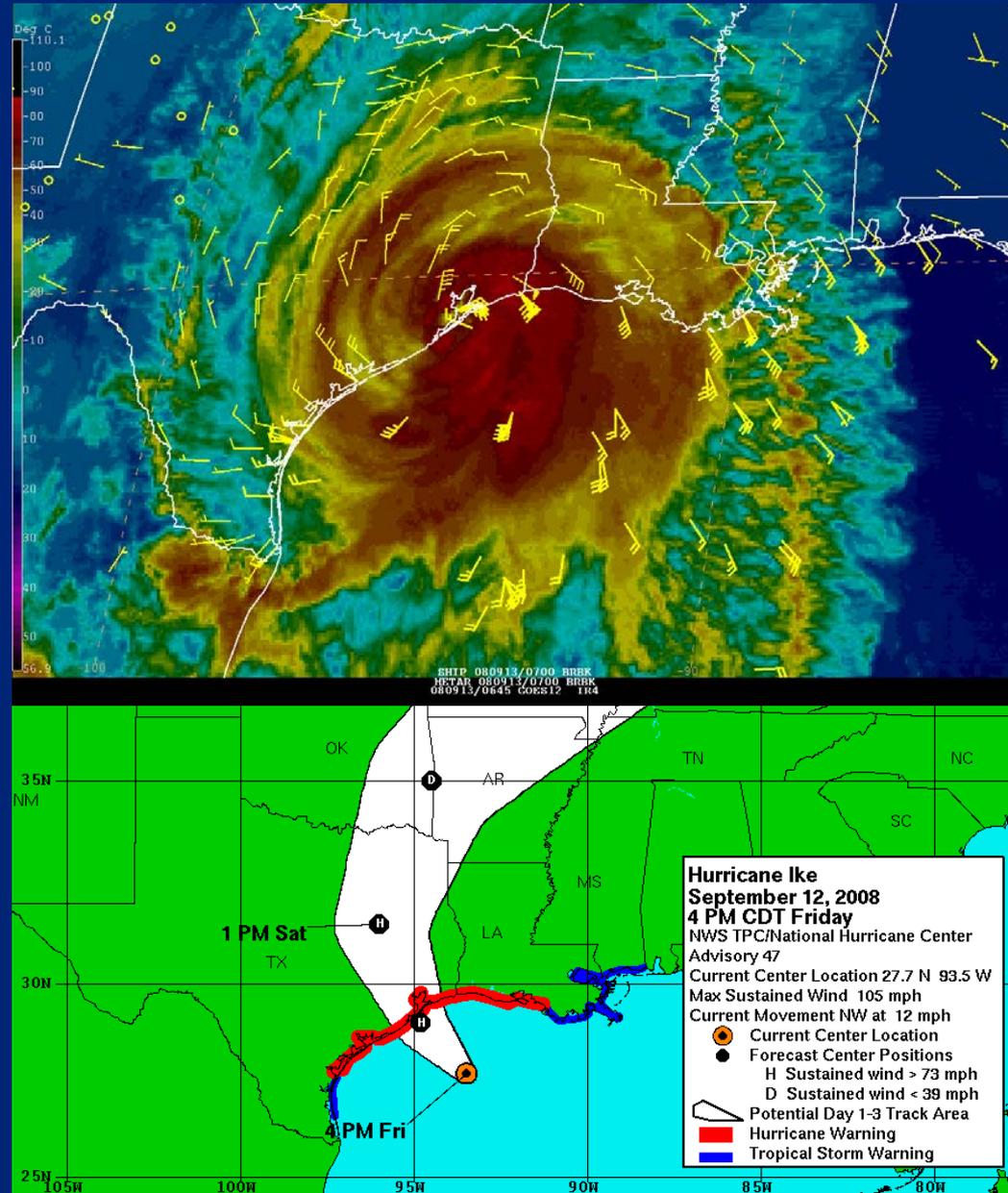
Tampa

Port Charlotte

HURRICANE CHARLEY 64-KT WIND PROBABILITIES FOR 5 DAYS ENDING 12 UTC 17 AUGUST 2004

# Impacts Can be Felt Well Outside the Cone

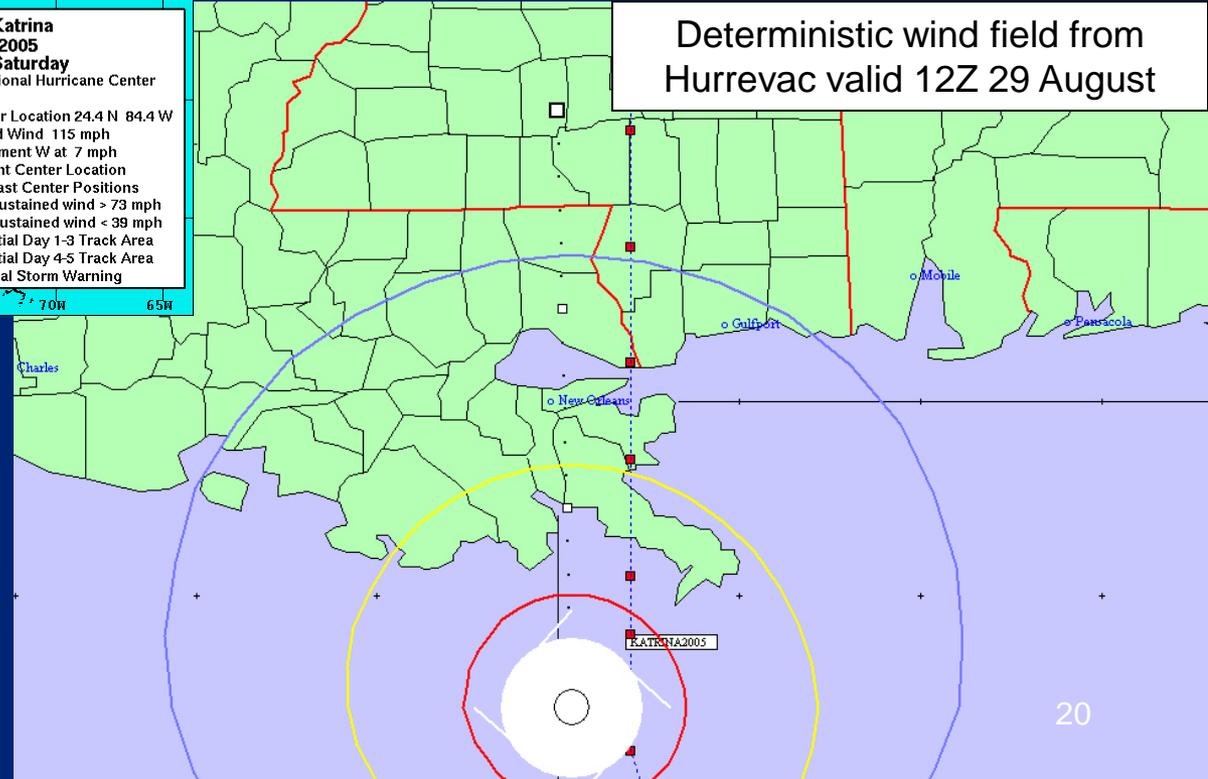
- The cone only displays information about track uncertainty
- It contains no information about specific impacts!
- TC impacts can occur well outside the area enclosed by the cone
  - TC center is expected to move outside the cone about 1/3 of the time
  - Cone narrows near the time of greatest impact due to smaller official track forecast errors



# Timing Information About Wind Onset

# Onset of 34-kt Winds Katrina (2005)

- Onset of 34-kt winds based on deterministic forecast issued with Advisory 16
  - New Orleans, LA – 8/29 (Mon.) 08Z
  - Gulfport, MS – 8/29 (Mon.) 11Z



# 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	06Z TUE	06Z WED	06Z WED	06Z WED
PERIODS		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		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)

Most likely period of onset of 34-kt winds at New Orleans and Gulfport is between 06Z Monday 8/29 and 06Z Tuesday 8/30

# Wind Speed Probabilities

## Katrina (2005) Advisory 16

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

	FROM						
TIME PERIODS	06Z SAT	18Z SAT	06Z SUN	18Z SUN	06Z MON	06Z TUE	06Z WED
	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)

However, the probability that 34-kt winds will start **prior to** 06Z Monday 8/29 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 at New Orleans
  - At least **5 hours** earlier than shown at Gulfport

# Intensity Probability Table

- Shows probability of tropical cyclone intensity (maximum wind) falling in various categories
- Tropical depression, tropical storm, hurricane, and Saffir-Simpson Hurricane Wind Scale categories 1-5
- Available at the top of the wind speed probability text product and as a stand-alone graphic

## I. MAXIMUM WIND SPEED (INTENSITY) PROBABILITY TABLE

CHANCES THAT THE MAXIMUM SUSTAINED (1-MINUTE AVERAGE) WIND SPEED OF THE TROPICAL CYCLONE WILL BE WITHIN ANY OF THE FOLLOWING CATEGORIES AT EACH OFFICIAL FORECAST TIME DURING THE NEXT 5 DAYS. PROBABILITIES ARE GIVEN IN PERCENT. X INDICATES PROBABILITIES LESS THAN 1 PERCENT.

### --- MAXIMUM WIND SPEED (INTENSITY) PROBABILITIES ---

VALID TIME	06Z THU	18Z THU	06Z FRI	18Z FRI	18Z SAT	18Z SUN	18Z MON
FORECAST HOUR	12	24	36	48	72	96	120
DISSIPATED	X	X	X	X	9	26	NA
TROP DEPRESSION	X	X	X	1	17	33	NA
TROPICAL STORM	X	X	3	17	53	36	NA
HURRICANE	99	99	97	81	20	4	NA
HUR CAT 1	X	5	23	42	16	4	NA
HUR CAT 2	2	21	37	23	3	1	NA
HUR CAT 3	63	56	30	12	1	X	NA
HUR CAT 4	34	17	7	3	X	X	NA
HUR CAT 5	1	1	1	X	X	X	NA
FCST MAX WIND	115KT	110KT	100KT	90KT	60KT	40KT	NA



Intensity (Maximum Wind Speed) Probability Table  
Hurricane Earl Advisory Number 25  
11:00 AM AST Aug 31 2010



Wind Range (mph)	Forecast Time						
	12 hour for 8 PM Tue	24 hour for 8 AM Wed	36 hour for 8 PM Wed	48 hour for 8 AM Thu	72 hour for 8 AM Fri	96 hour for 8 AM Sat	120 hour for 8 AM Sun
Dissipated	<1%	<1%	<1%	<1%	1%	6%	15%
Tropical Depression (<39)	<1%	<1%	<1%	<1%	2%	11%	13%
Tropical Storm (39-73)	<1%	<1%	1%	2%	19%	44%	43%
Hurricane (all categories)	99%	99%	99%	98%	78%	39%	30%
-- Category 1 (74-95)	<1%	2%	6%	12%	33%	27%	20%
-- Category 2 (96-110)	3%	7%	17%	24%	24%	8%	7%
-- Category 3 (111-130)	60%	47%	48%	39%	16%	3%	2%
-- Category 4 (131-155)	35%	40%	24%	20%	5%	1%	1%
-- Category 5 (>155)	2%	5%	4%	4%	1%	<1%	<1%
Forecast Maximum Wind	135 mph	140 mph	135 mph	135 mph	115 mph	90 mph	65 mph

# Hurricane Danielle Intensity Probability Table

Advisory 16 – 11 AM EDT 25 Aug. 2010



Intensity (Maximum Wind Speed) Probability Table  
Hurricane Danielle Advisory Number 16  
11:00 AM AST Aug 25 2010



- Official NHC 48-h intensity forecast: 100 MPH (Category 2)
- Verifying intensity: 135 MPH (Category 4)

Wind Range (mph)	Forecast Time						
	12 hour for 8 PM Wed	24 hour for 8 AM Thu	36 hour for 8 PM Thu	48 hour for 8 AM Fri	72 hour for 8 AM Sat	96 hour for 8 AM Sun	120 hour for 8 AM Mon
Dissipated	<1%	<1%	<1%	<1%	<1%	1%	1%
Tropical Depression (<39)	<1%	<1%	1%	1%	1%	2%	6%
Tropical Storm (39-73)	8%	12%	19%	17%	14%	17%	38%
Hurricane (all categories)	92%	88%	81%	82%	85%	81%	55%
-- Category 1 (74-95)	76%	57%	49%	41%	31%	32%	32%
-- Category 2 (96-110)	13%	22%	21%	23%	24%	24%	14%
-- Category 3 (111-130)	2%	7%	8%	14%	21%	19%	7%
-- Category 4 (131-155)	<1%	1%	2%	<b>3%</b>	7%	5%	2%
-- Category 5 (>155)	<1%	<1%	<1%	1%	1%	1%	<1%
Forecast Maximum Wind	85 mph	90 mph	90 mph	100 mph	110 mph	110 mph	100 mph

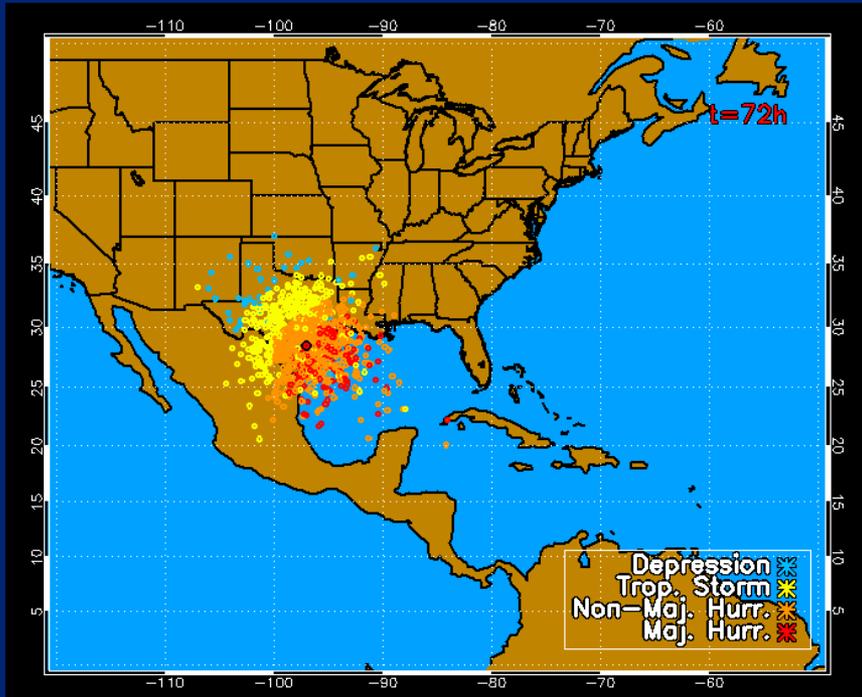
**3% chance of category 4 hurricane in 48 h verifies**

# Impact of Land Interaction on Intensity Probabilities

- The intensity probability table CANNOT be used to estimate the intensity of a TC at the time of landfall
- Probabilities are valid at a specific TIME – not location
  - Some realizations will move faster than the official forecast and already be inland at the time of landfall in the official forecast
  - These inland realizations will be weaker and contribute to lower intensity probabilities at the forecast time period closest to landfall
- We are working with a new tool that computes the probability of landfall occurring in specific categories

# Hurricane Ike

## Advisory 38 – 10 AM CDT 10 Sep 2008

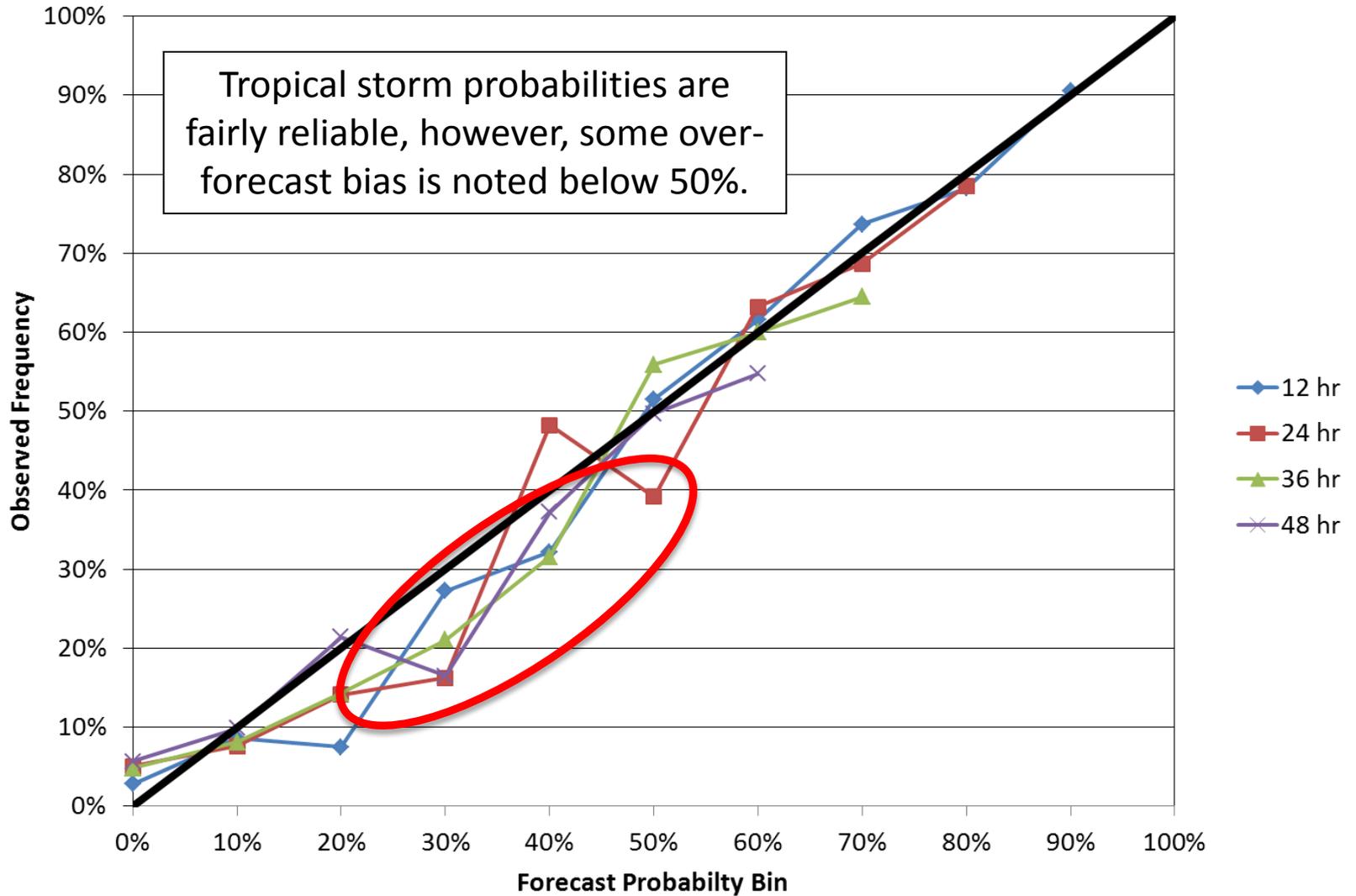


Intensity (Maximum Wind Speed) Probability Table  
Hurricane Ike Advisory Number 38  
10:00 AM CDT Sep 10 2008

Wind Range (mph)	Forecast Time						
	12 hour for 7 PM Wed	24 hour for 7 AM Thu	36 hour for 7 PM Thu	48 hour for 7 AM Fri	72 hour for 7 AM Sat	96 hour for 7 AM Sun	120 hour for 7 AM Mon
Dissipated	<1%	<1%	<1%	<1%	1%	55%	73%
Tropical Depression (<39)	<1%	<1%	<1%	<1%	4%	20%	16%
Tropical Storm (39-73)	1%	2%	2%	3%	26%	12%	6%
Hurricane (all categories)	99%	98%	98%	97%	69%	13%	6%
-- Category 1 (74-95)	23%	19%	11%	12%	25%	2%	<1%
-- Category 2 (96-110)	59%	43%	24%	20%	16%	2%	1%
-- Category 3 (111-130)	16%	32%	46%	38%	18%	5%	3%
-- Category 4 (131-155)	1%	4%	15%	23%	8%	3%	2%
-- Category 5 (>155)	1%	1%	2%	4%	2%	1%	<1%
Forecast Maximum Wind	105 mph	110 mph	120 mph	125 mph	120 mph	40 mph	30 mph

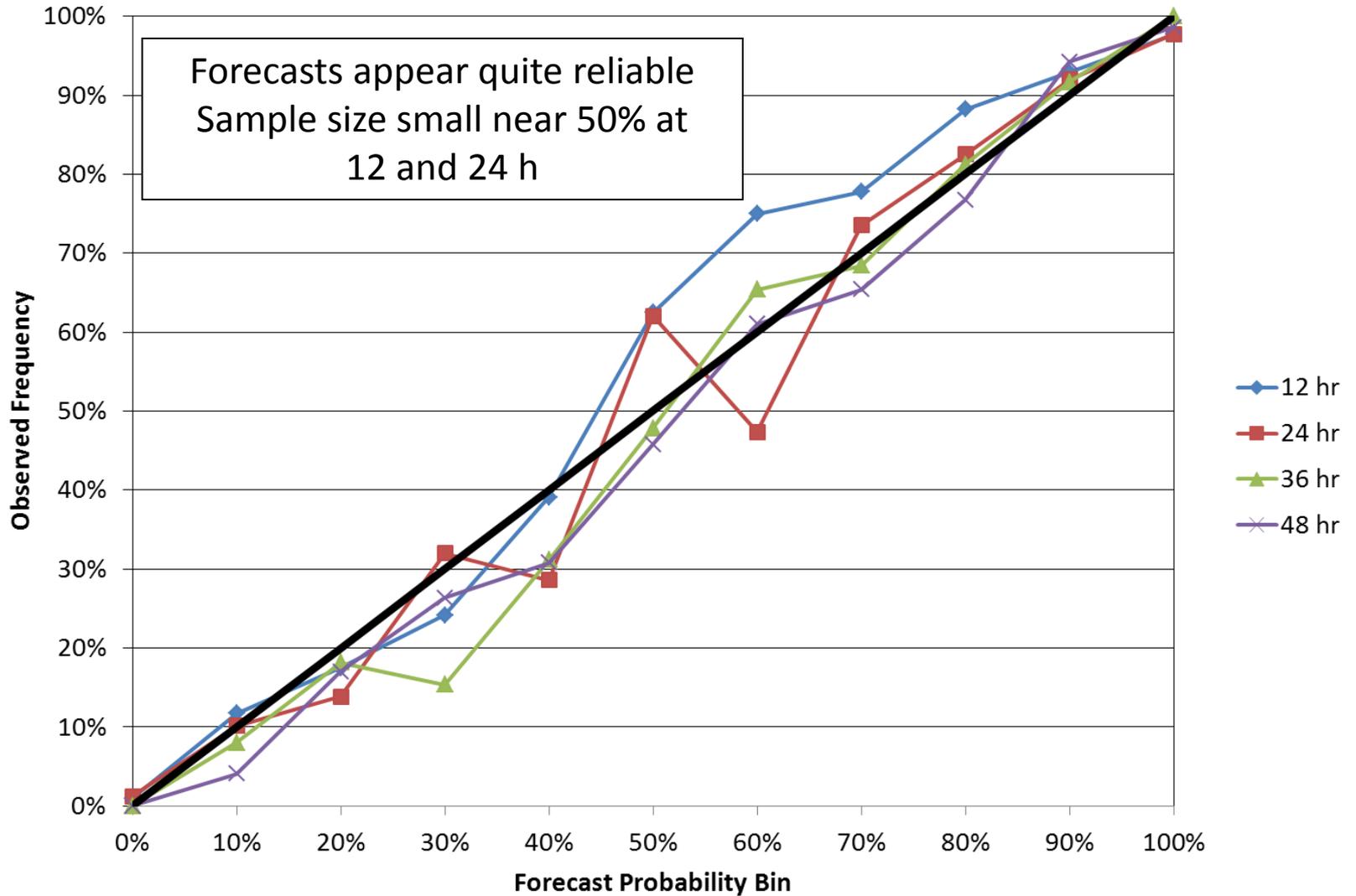
- Official Forecast shows landfall around 72 h with forecast intensity of 120 mph (Category 3)
- Intensity probabilities shows nearly equal or higher probability of category 1 or 2 at 72 h due to some realizations being faster
- Actual landfall intensity: 110 MPH (Category 2)
- Intensity at 12Z 13 September: 100 MPH (Category 1)

### 2008-2010 Atlantic Tropical Storm Forecasts 12-48 h



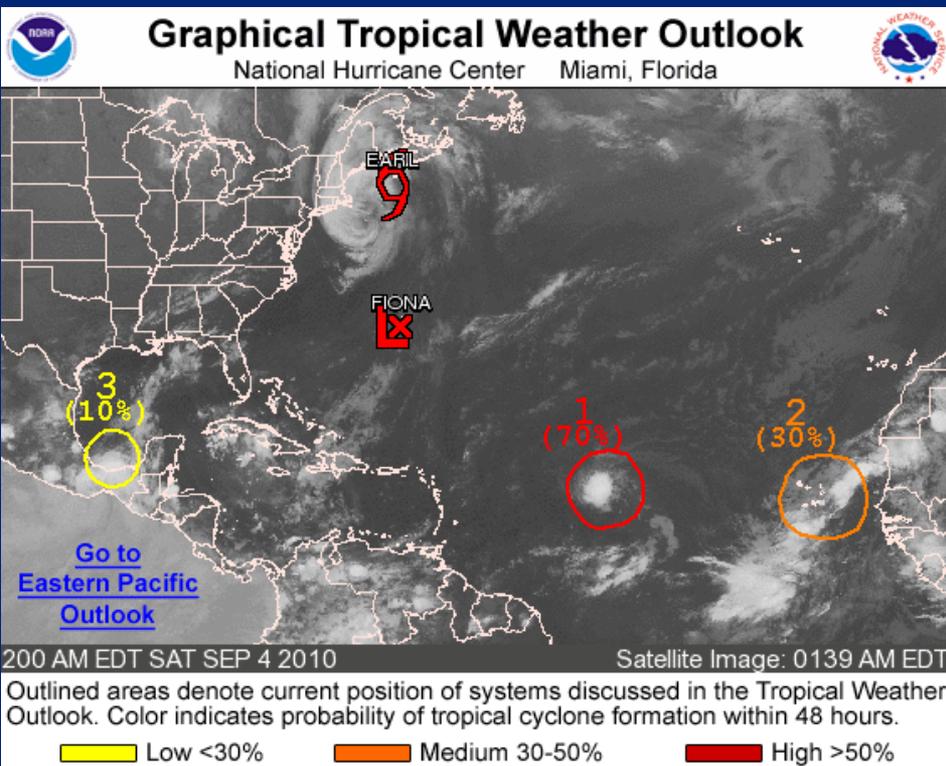
Number of Forecasts	178	70	67	44	59	33	78	76	124	223
	139	66	71	80	56	74	106	169	177	0
	104	74	98	95	76	93	155	228	0	0
	88	71	70	97	145	173	243	0	0	0

## 2008-2010 Atlantic Hurricane Forecasts (All Categories) 12-48 h



	406	128	63	29	23	8	28	18	34	42	173
<b>Number of</b>	241	217	101	25	49	29	19	34	40	50	133
<b>Forecasts</b>	195	187	110	65	61	46	26	38	48	48	99
	151	171	100	91	65	59	59	26	43	52	70

# Probabilistic Tropical Cyclone Genesis Forecasts

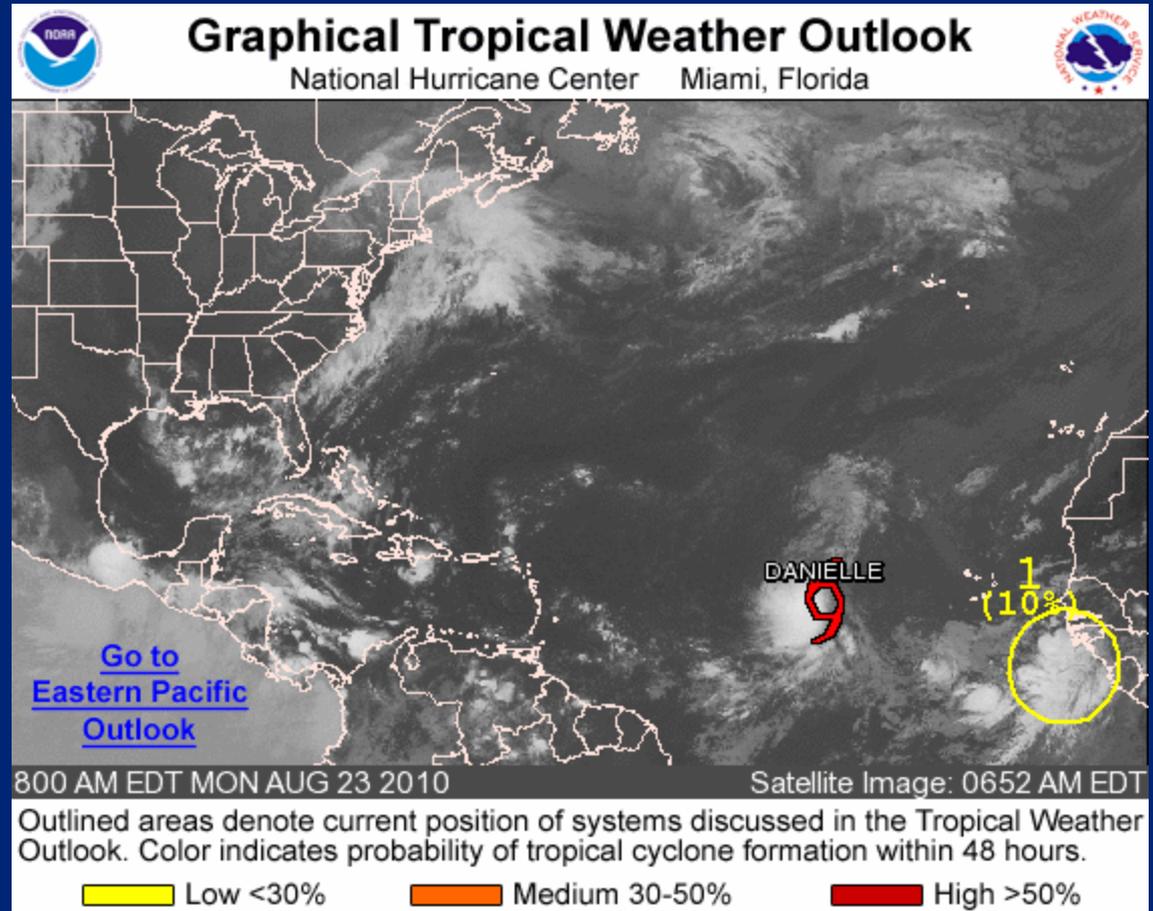


- NHC began publically issuing categorical 48-h genesis forecasts in 2008 and began including the specific percentage in 2010
- Probabilities contained in the text and graphical Tropical Weather Outlook (TWO) products issued 4 times daily (00, 06, 12, 18 UTC) along with special outlooks issued as needed
- Probability of tropical cyclone formation in the next 48 hours for individual disturbances
- Based on analysis of current state of the atmosphere, satellite imagery, and model output

2. SHOWERS AND THUNDERSTORMS ASSOCIATED WITH AN ELONGATED AREA OF LOW PRESSURE LOCATED BETWEEN THE WEST COAST OF AFRICA AND THE CAPE VERDE ISLANDS HAVE CHANGED LITTLE THIS EVENING. ENVIRONMENTAL CONDITIONS ARE MARGINALLY CONDUCTIVE FOR SOME SLOW DEVELOPMENT DURING THE NEXT COUPLE OF DAYS. THERE IS A MEDIUM CHANCE...30 PERCENT...OF THIS SYSTEM BECOMING A TROPICAL CYCLONE DURING THE NEXT 48 HOURS AS IT MOVES NORTHWESTWARD NEAR 10 MPH.

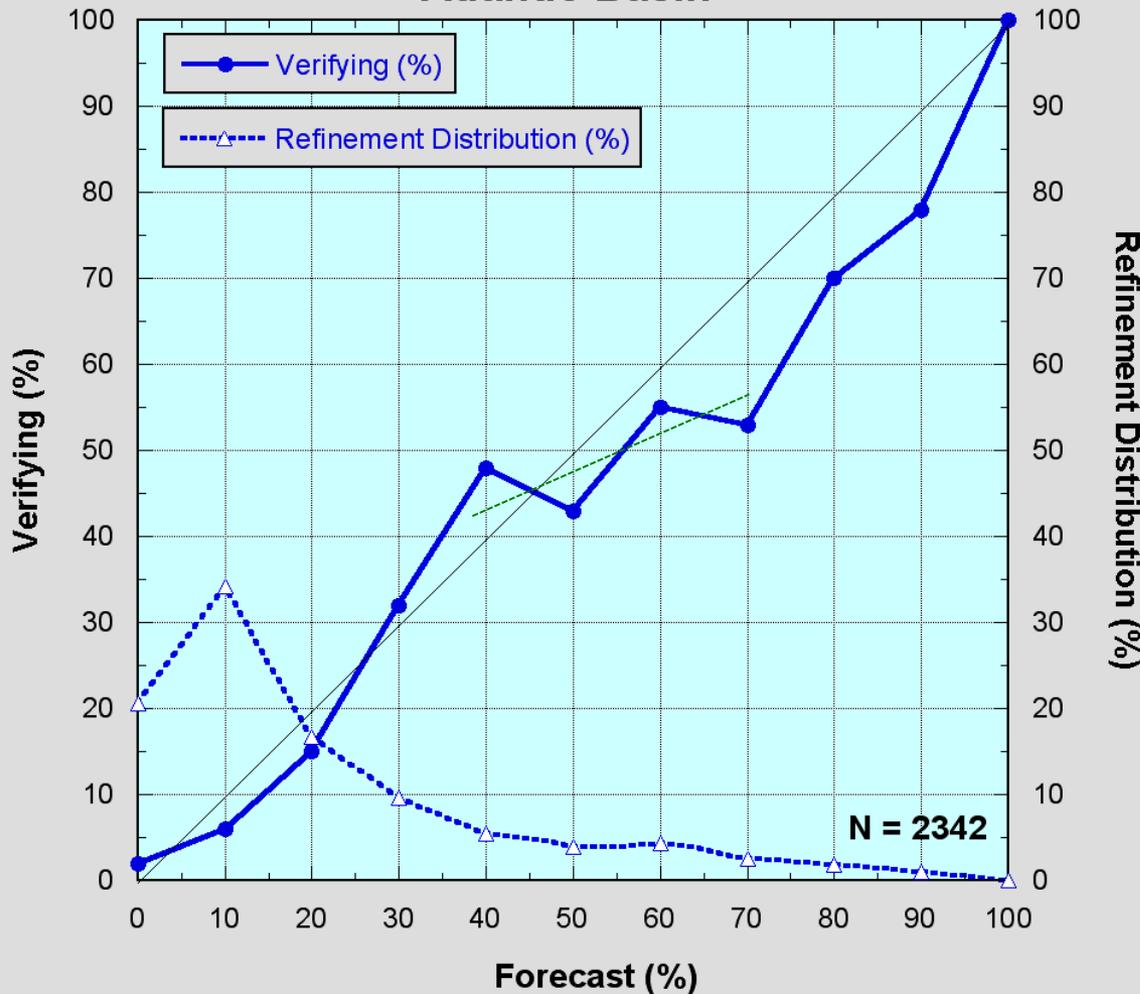
# Probabilistic Tropical Cyclone Genesis Forecasts

- Probabilities provided in 10% increments and fit into the following categories:
- **Low:** < 30%
- **Medium:** 30–50%
- **High:** > 50%



# Verification of Genesis Forecasts

2007-2010 OFCL  
48-h Genesis Forecasts  
Atlantic Basin



- Forecasts at the high and low ends are very reliable
- However forecasts in the middle range have less ability to distinguish between systems with a 40 and 70 percent chance of formation

# Summary

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