WRC HURRICANE DAMAGE POTENTIAL SCALE

GULF OF MEXICO HURRICANES

PAST – PRESENT – FUTURE

MMS ITM

6 January 2009

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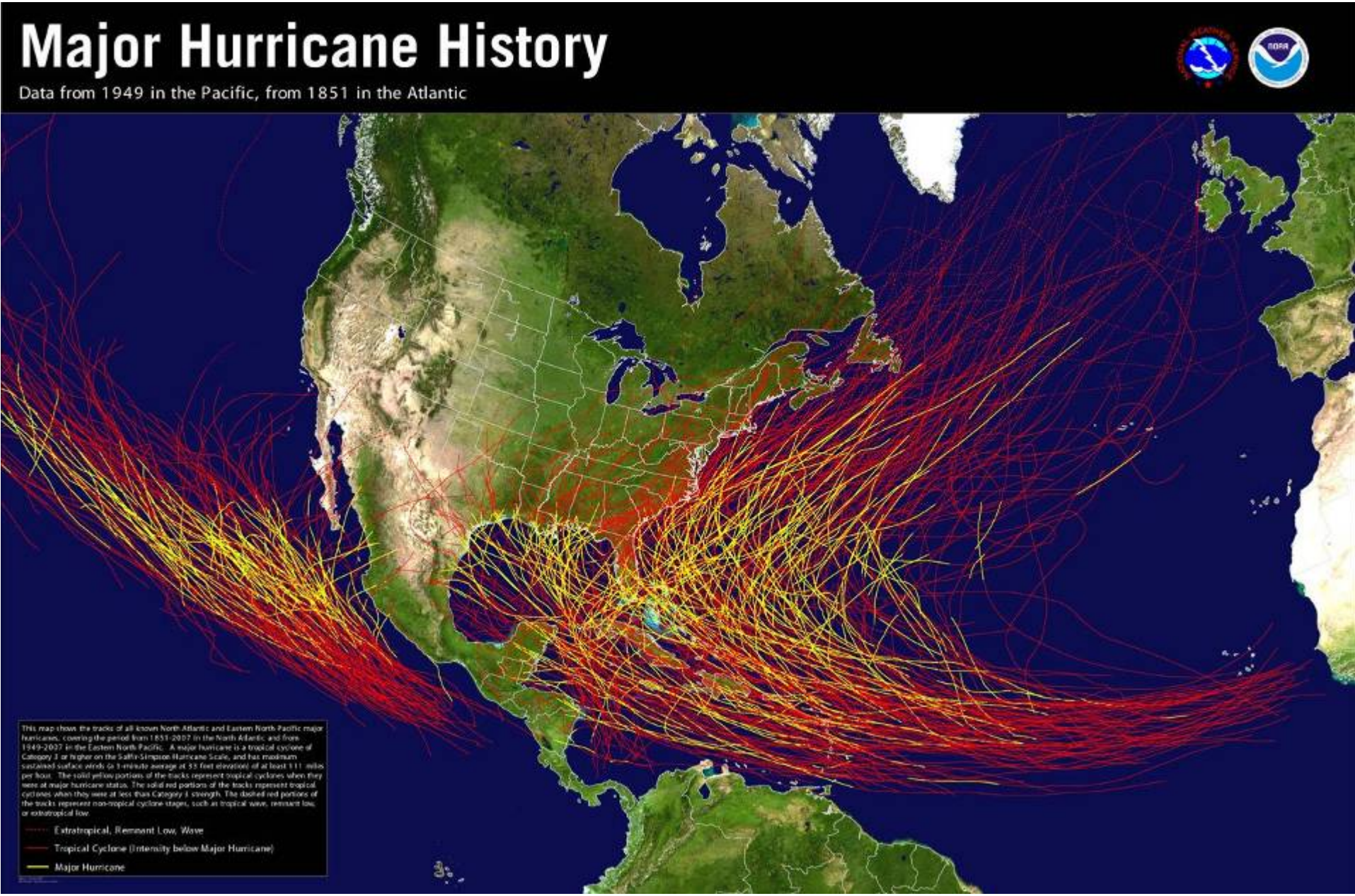
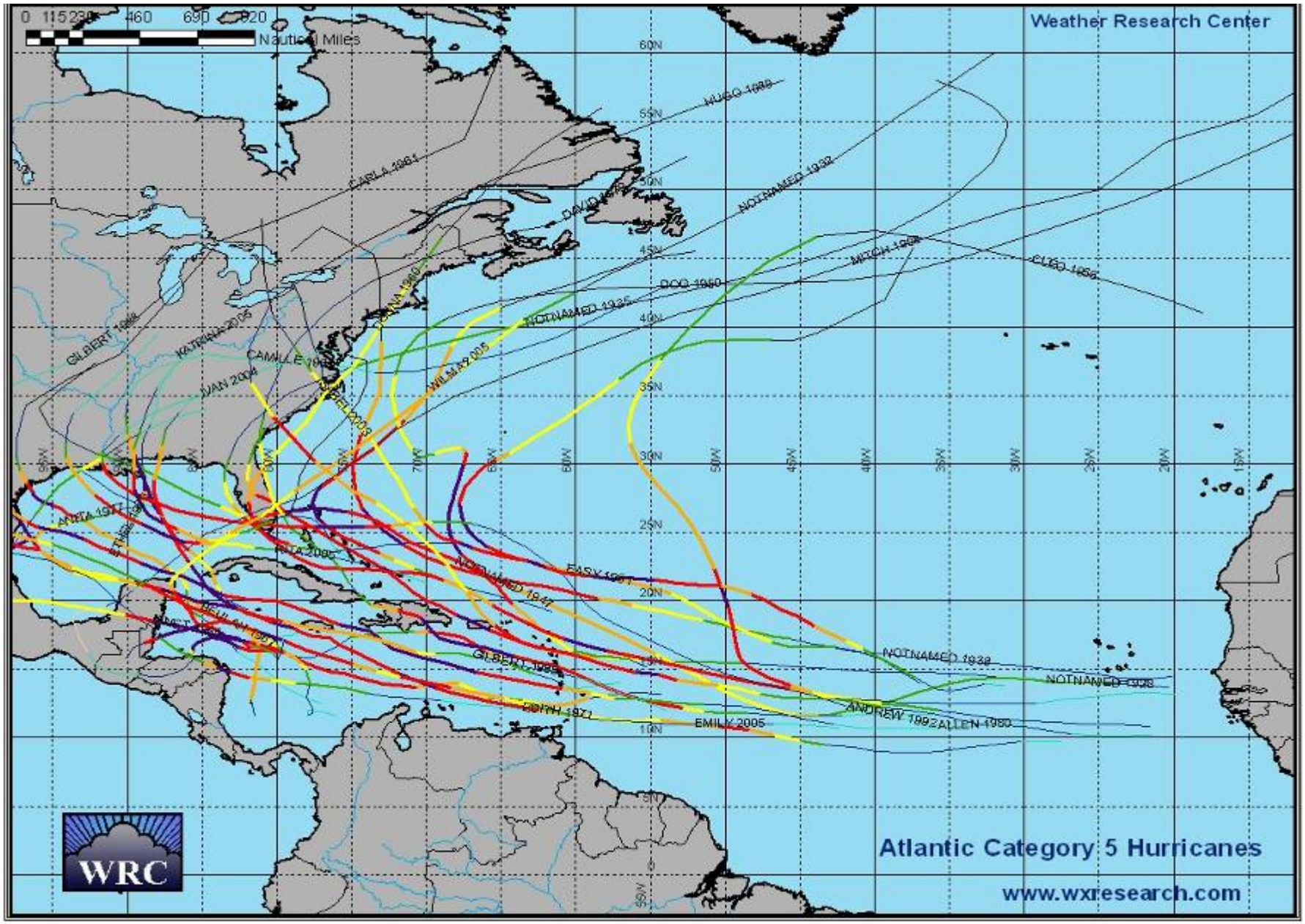
www.wxresearch.com

WRC

The John C. Freeman WEATHER MUSEUM



History of Major Hurricanes 1851–2006 in the Atlantic and Eastern Pacific 1949–2006. Prior to satellites in 1960, the belief was that hurricanes were rare in the eastern Pacific (Blake et al. 2006).



Tracks of the known Category 5 hurricanes in the Atlantic since 1900 (Weather Research Center 2008a).

Atlantic Basin Category 5 Hurricanes

31 Category 5 Hurricanes have occurred since 1900

Lowest Pressure:

Hurricane Wilma 2005 – 882 mbs

Highest maximum sustained winds:

Hurricane Allen 1980 – 165 Knots

Most Category 5 Hurricanes per season:

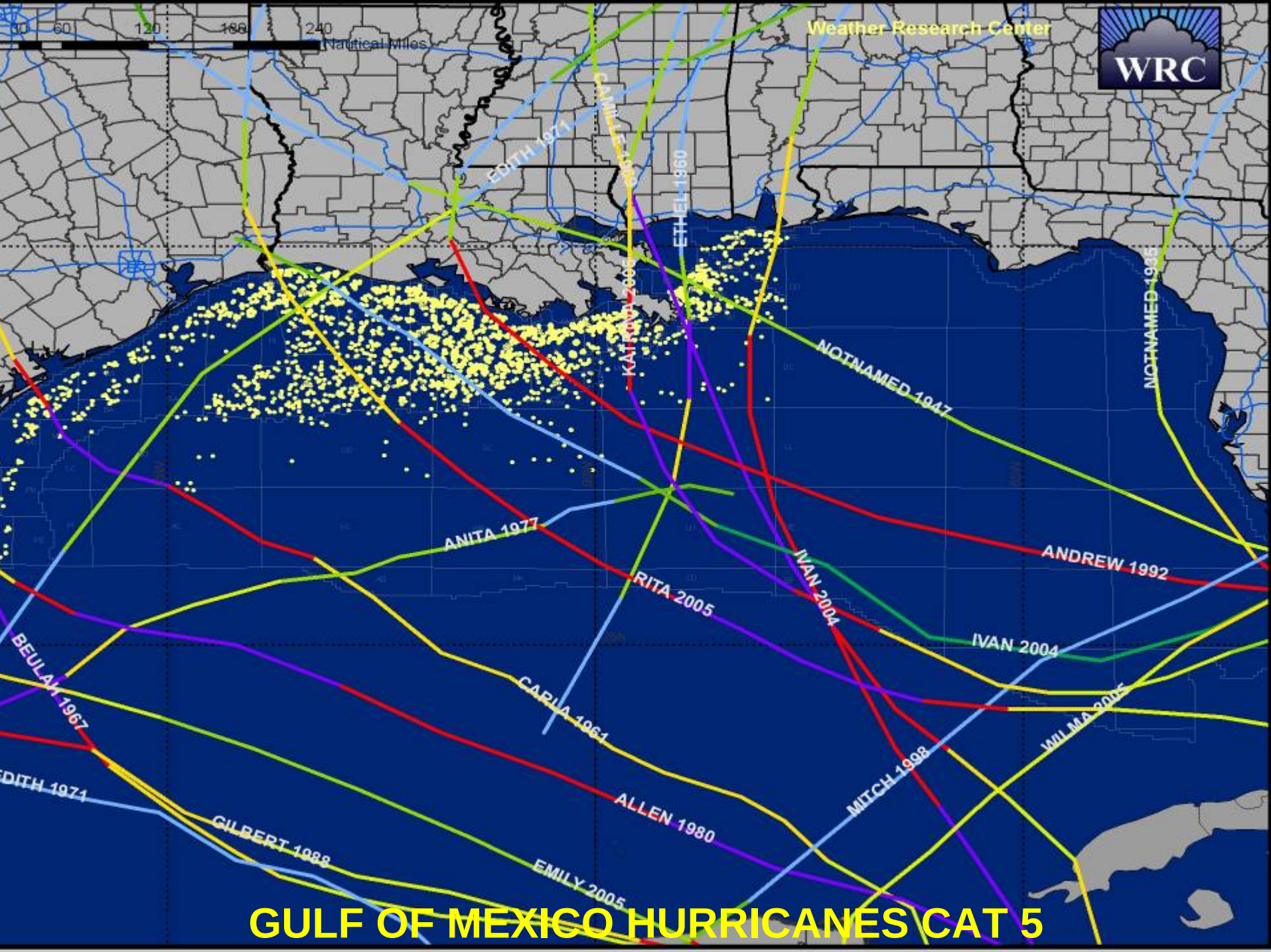
2005 – (Four) – Emily, Katrina, Rita and Wilma

2007 – (Two) – Dean and Felix

1961 – (Two) – Carla and Hattie

1960 – (Two) – Donna and Ethel

(Weather Research Center 2008a)



GULF OF MEXICO HURRICANES CAT 5

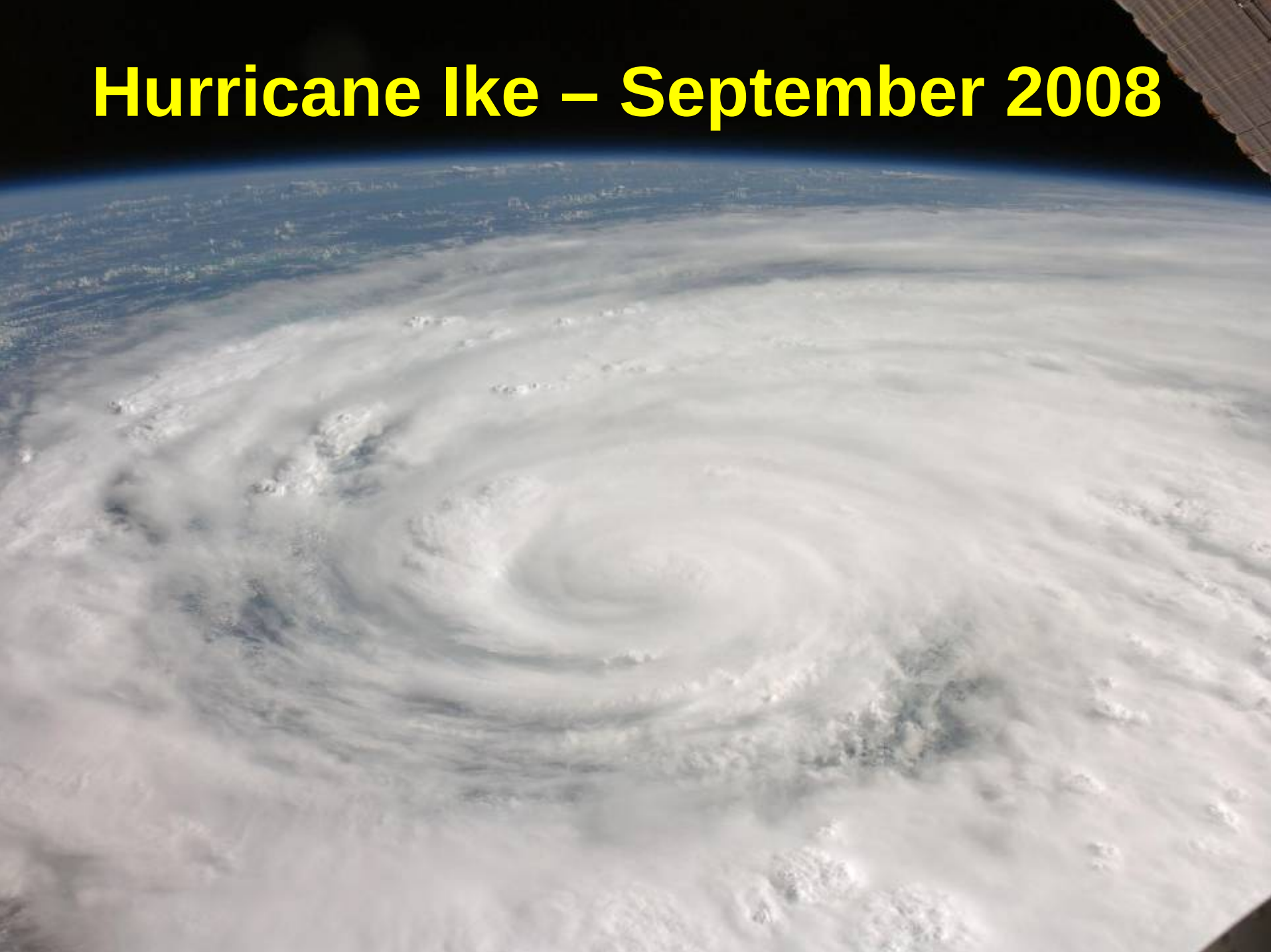
Hurricane Strikes on the United States Mainland 1851–2007

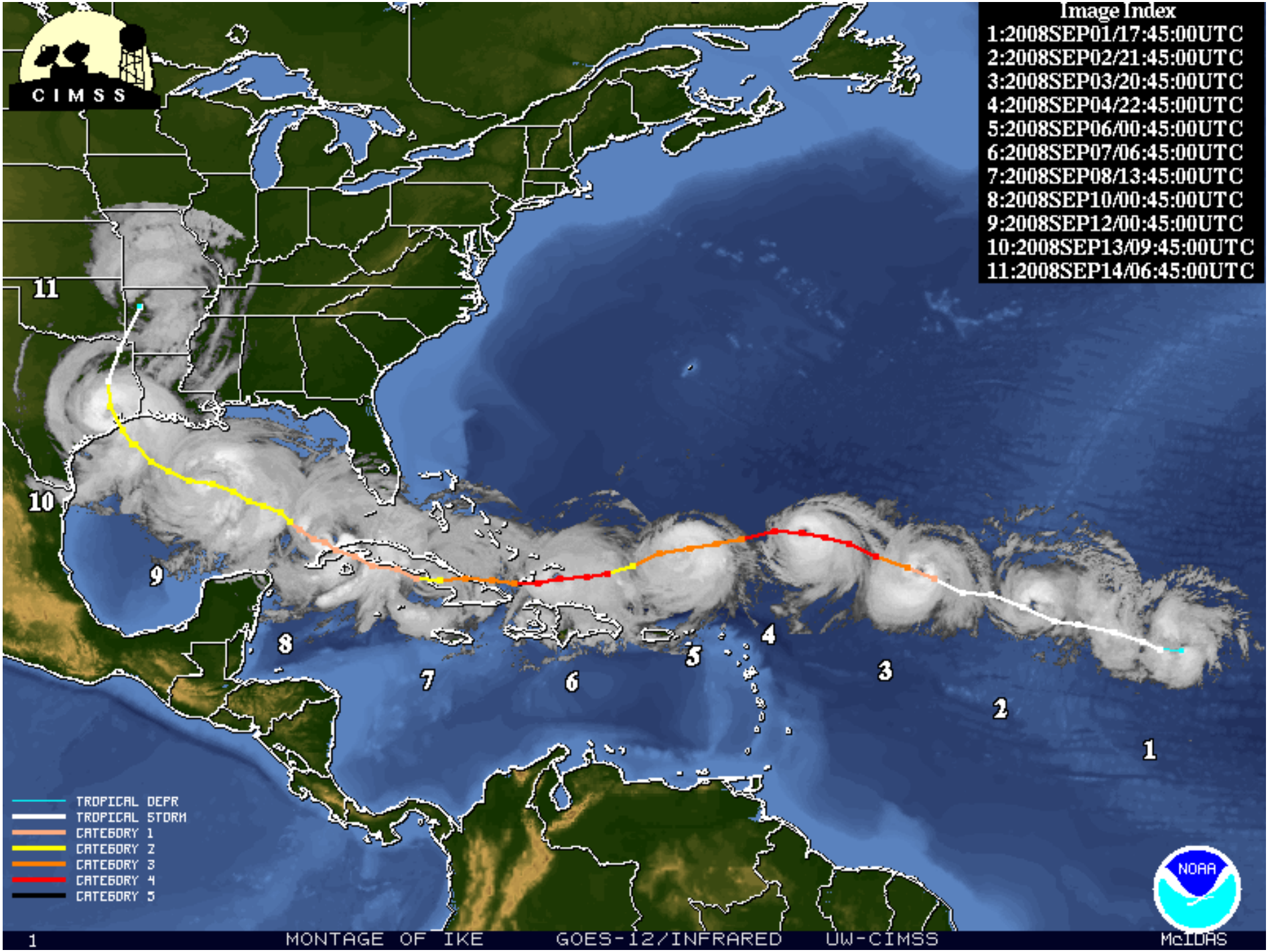
Category	Strikes
5	3
4	18
3	75
2	73
1	111
TOTAL	280
Major	96

Category 3 or higher at landfall

The number of known hurricanes making landfall on the United States coast mainland 1851–2007 by category (Blake et al. 2006).

Hurricane Ike – September 2008

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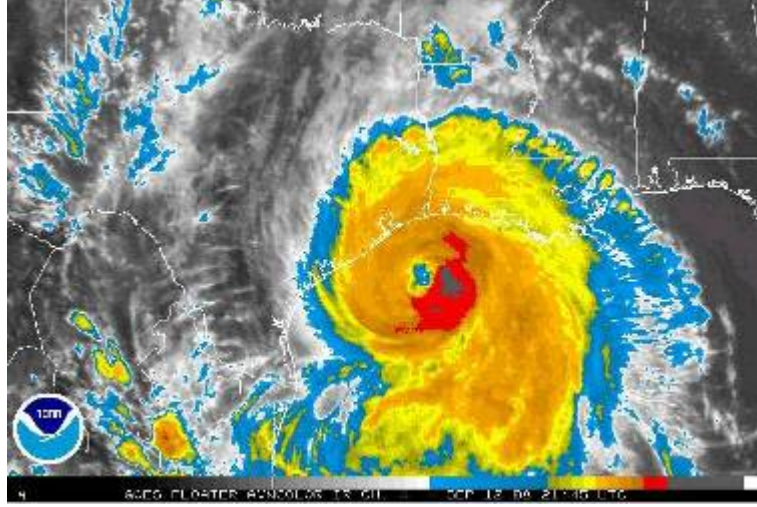


Hurricane Ike

Just prior to landfall:

Minimum central pressure was 952 mbs

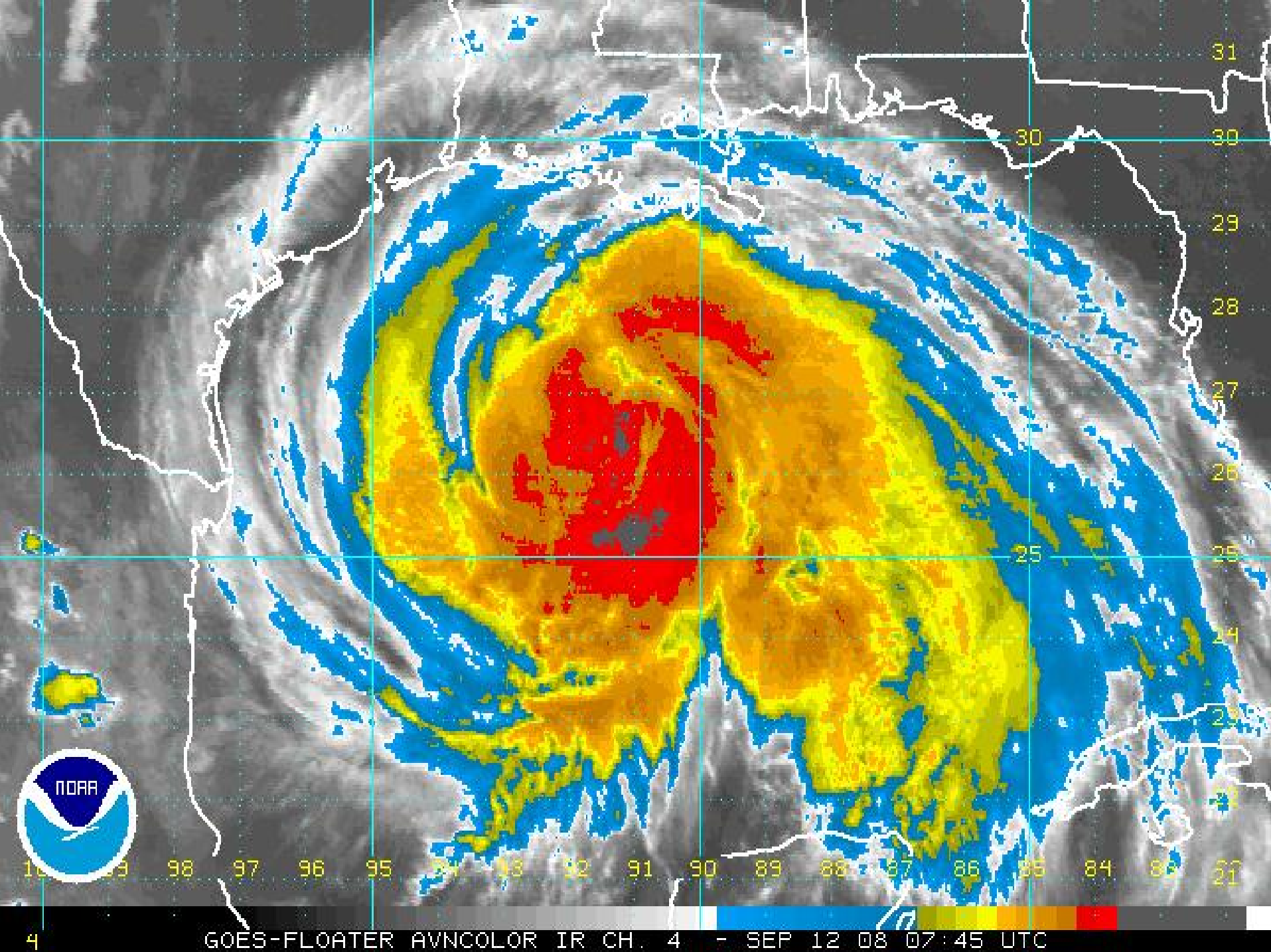
Maximum sustained winds were 95 knots gusting to 115 knots

Radius of hurricane force winds was 110 nm

Radius of tropical storm force winds was 240 nm

A pressure of 952 mbs usually indicates sustained winds of 108 knots.


Mississippi
Alabama
Texas
Louisiana
Houston
Gulf of Mexico
10 km
N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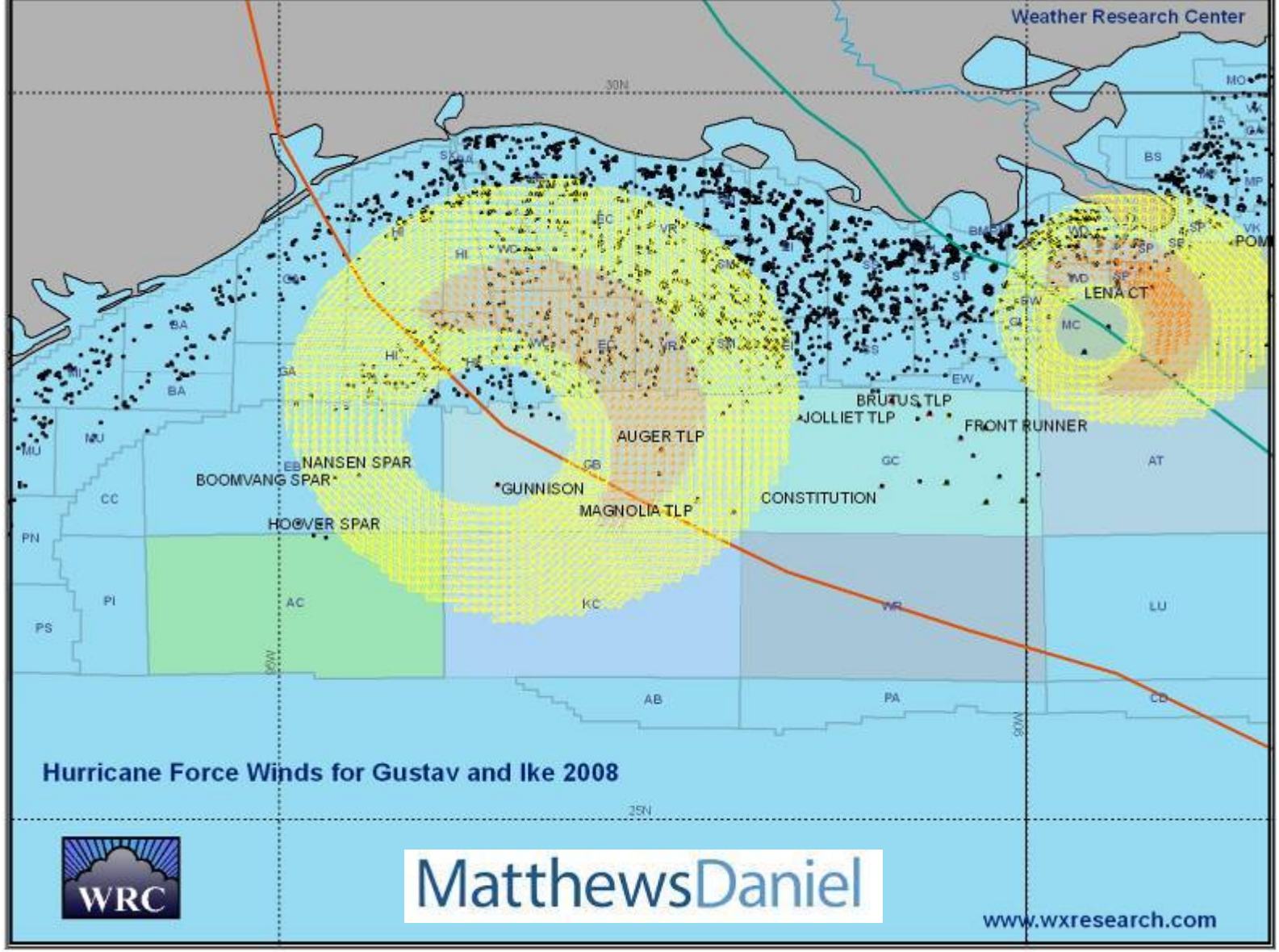
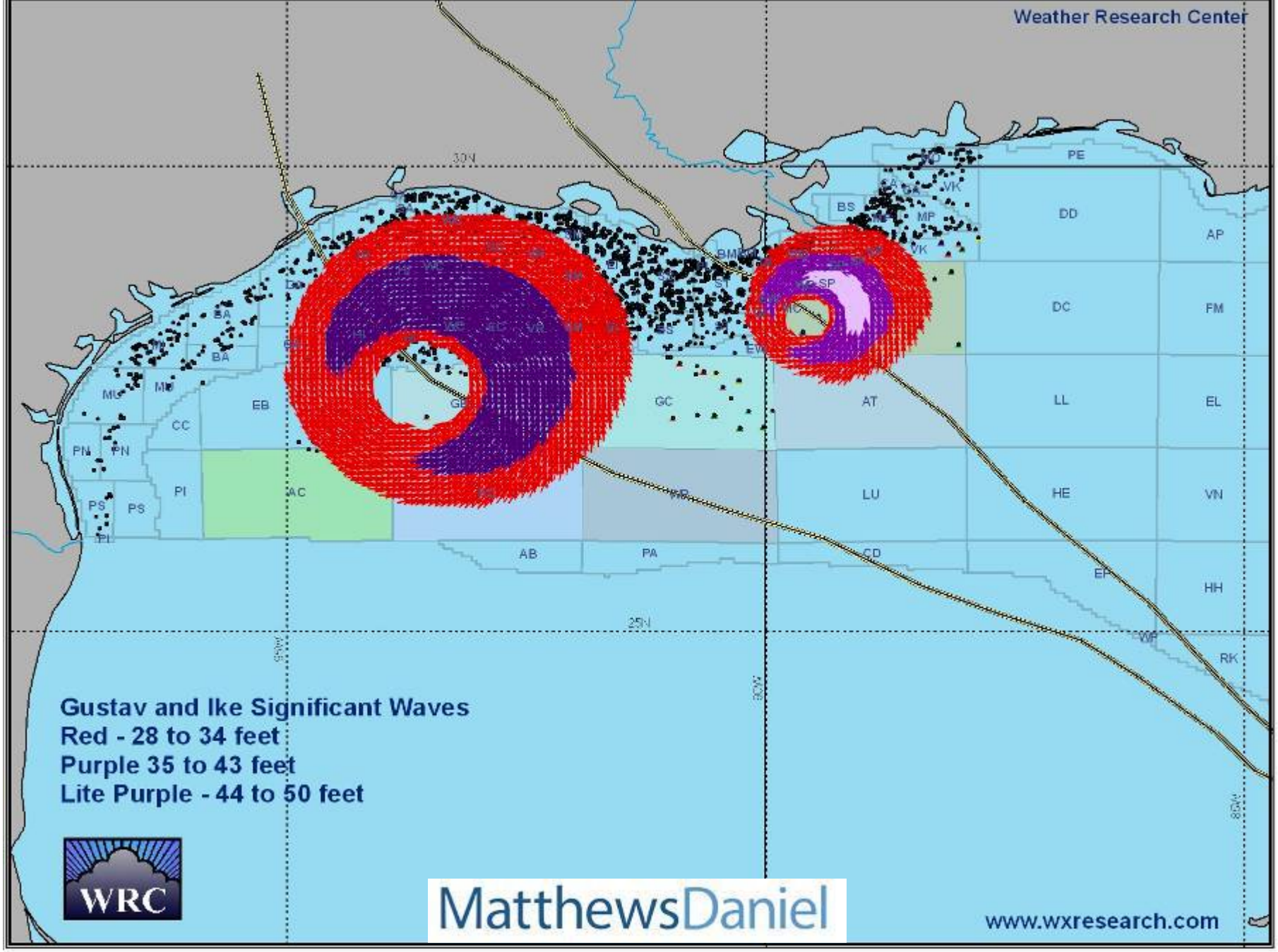


The hurricane wind fields of Hurricane Gustav [east] and Hurricane Ike [west]. The yellow wind barbs are the sustained winds greater than 64 knots [Category 1] and the light orange wind barbs are the winds greater than 83 knots[Category 2] and the dark orange are the winds barbs greater than 96 knots [Category 3]. These winds were computed using the WRC Hurricane Wind and Wave Model (Weather Research Center 2008b).



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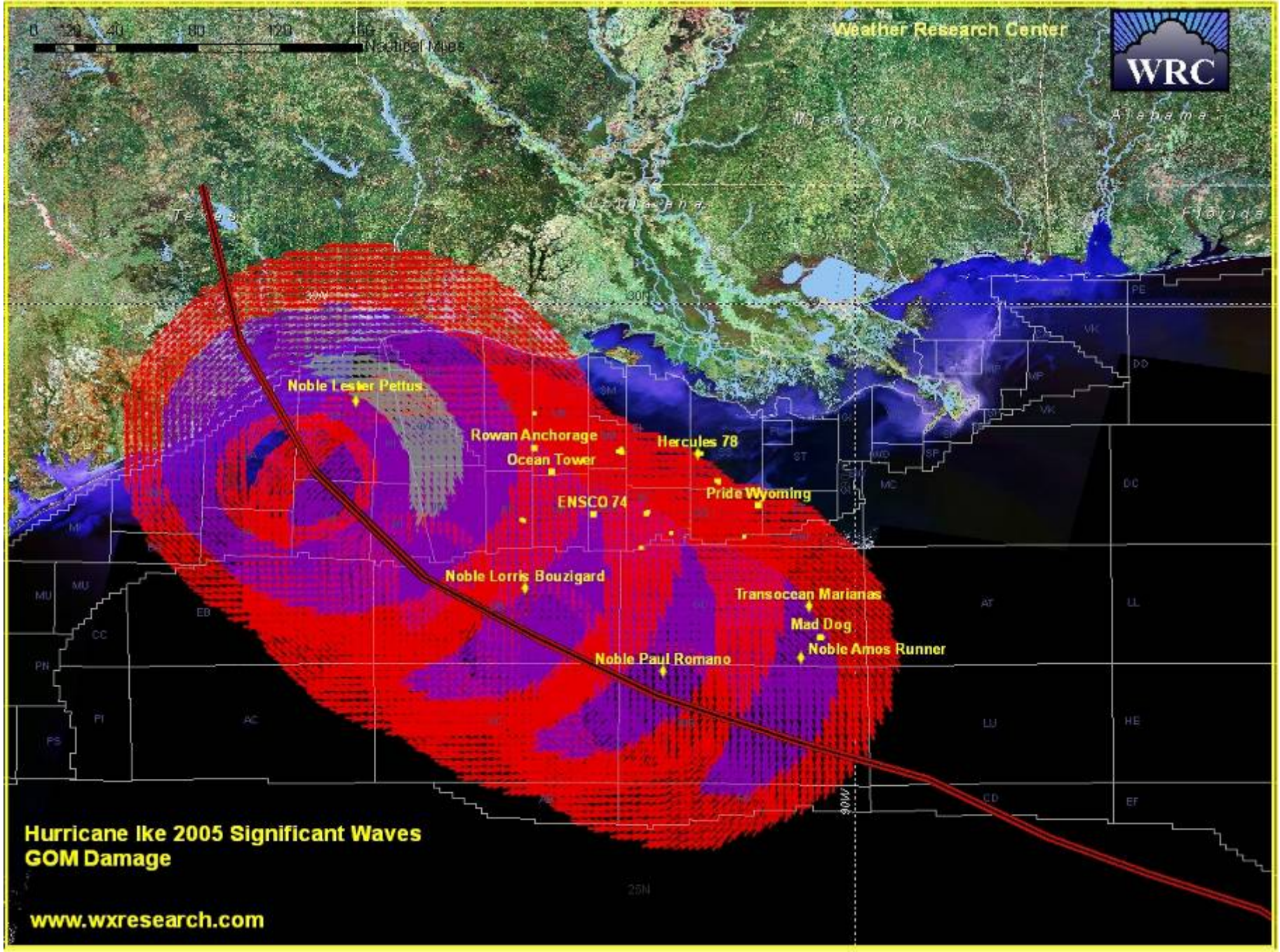
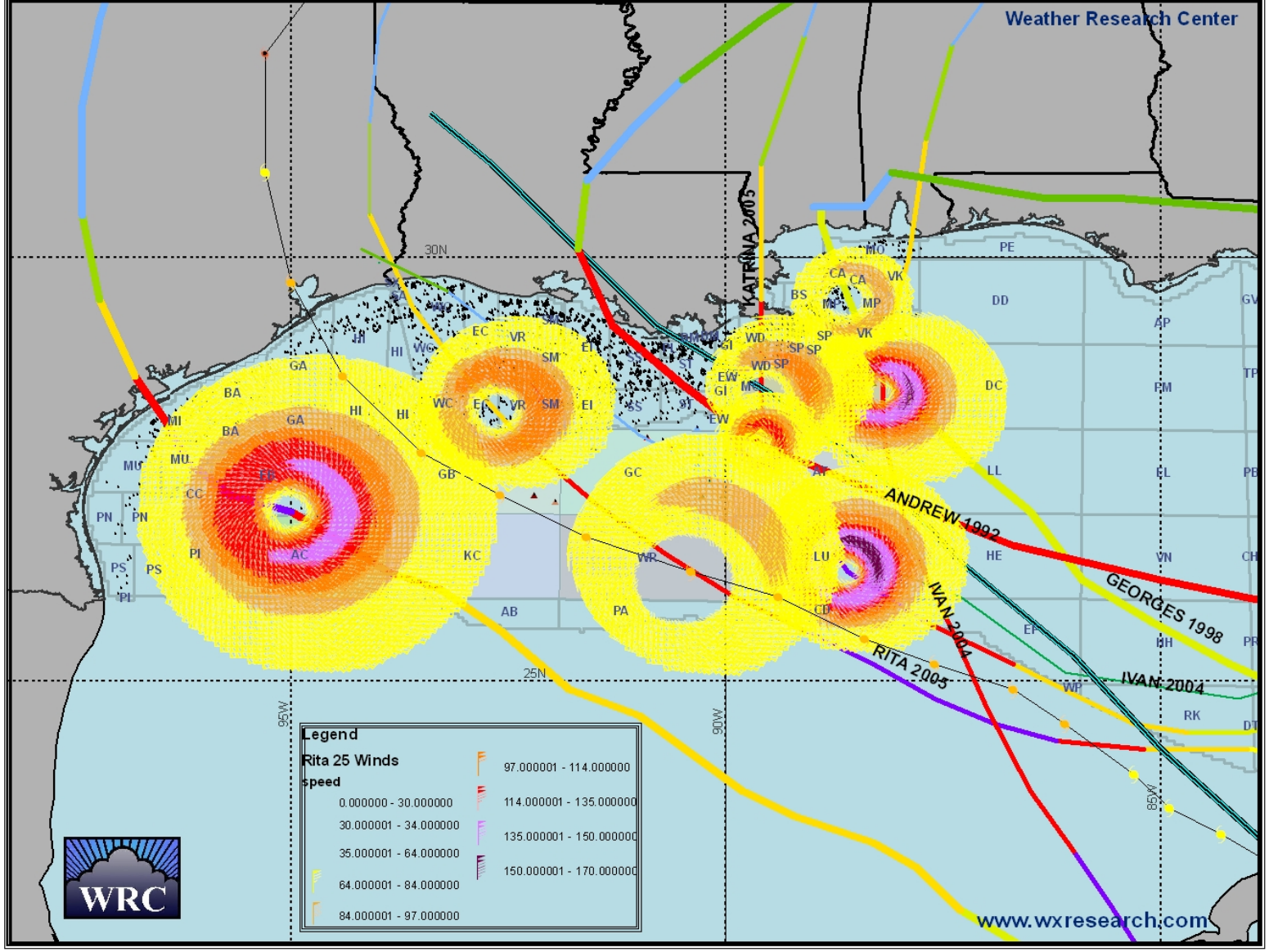
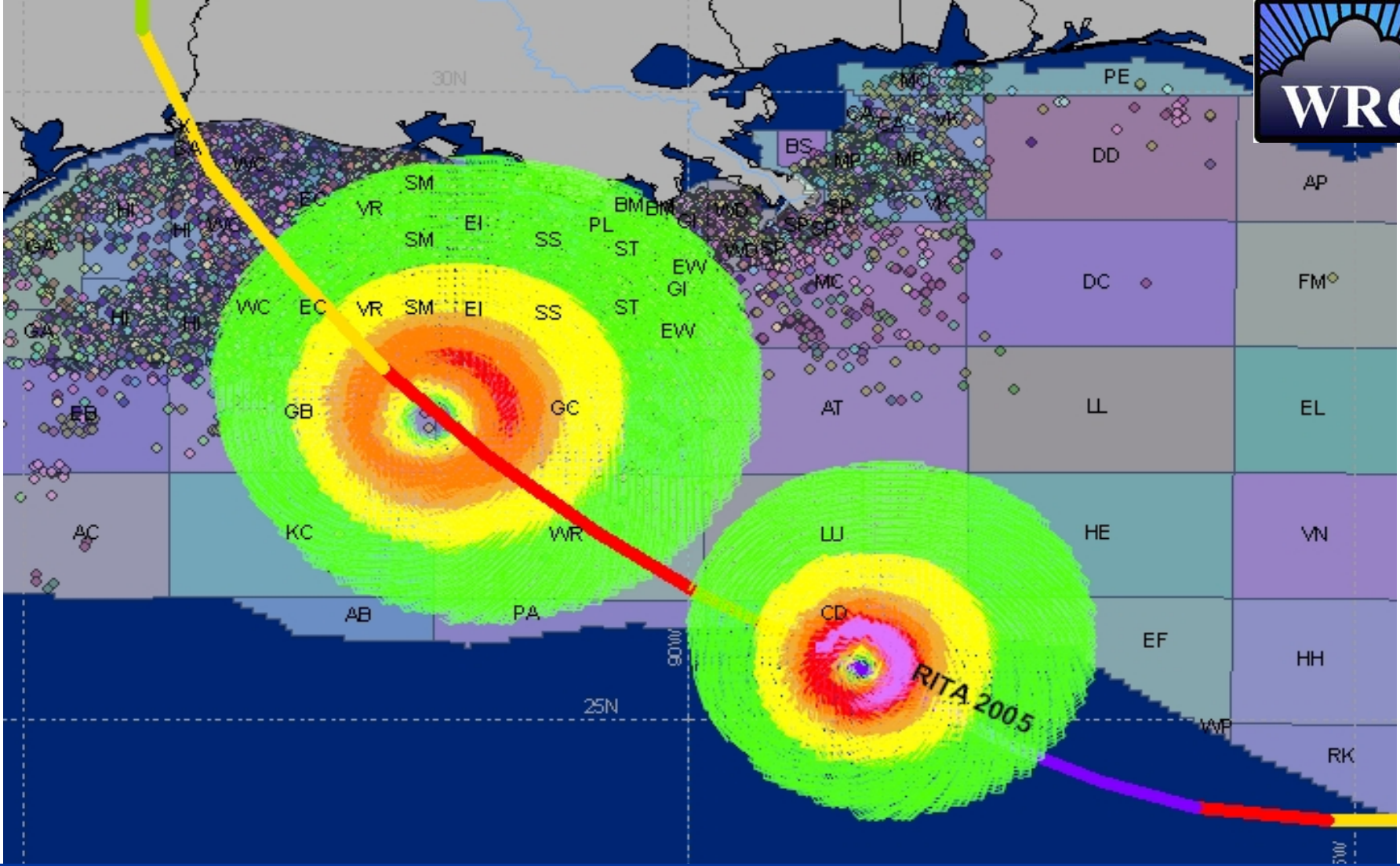


(Weather Research Center 2008b)

Size Matters!



Are the hurricane wind fields for past Gulf of Mexico Hurricanes. The largest off the central Texas Coast is for Hurricane Carla, 1961. The Colors represent the winds in each of the 4 categories on the Saffir/Simpson Scale. This slide shows that hurricanes come in all sizes from very small to very large with Hurricane Carla. These wind Were hindcasts using the WRC Hurricane Wind and Wave Model (Weather Research Center 2008b).

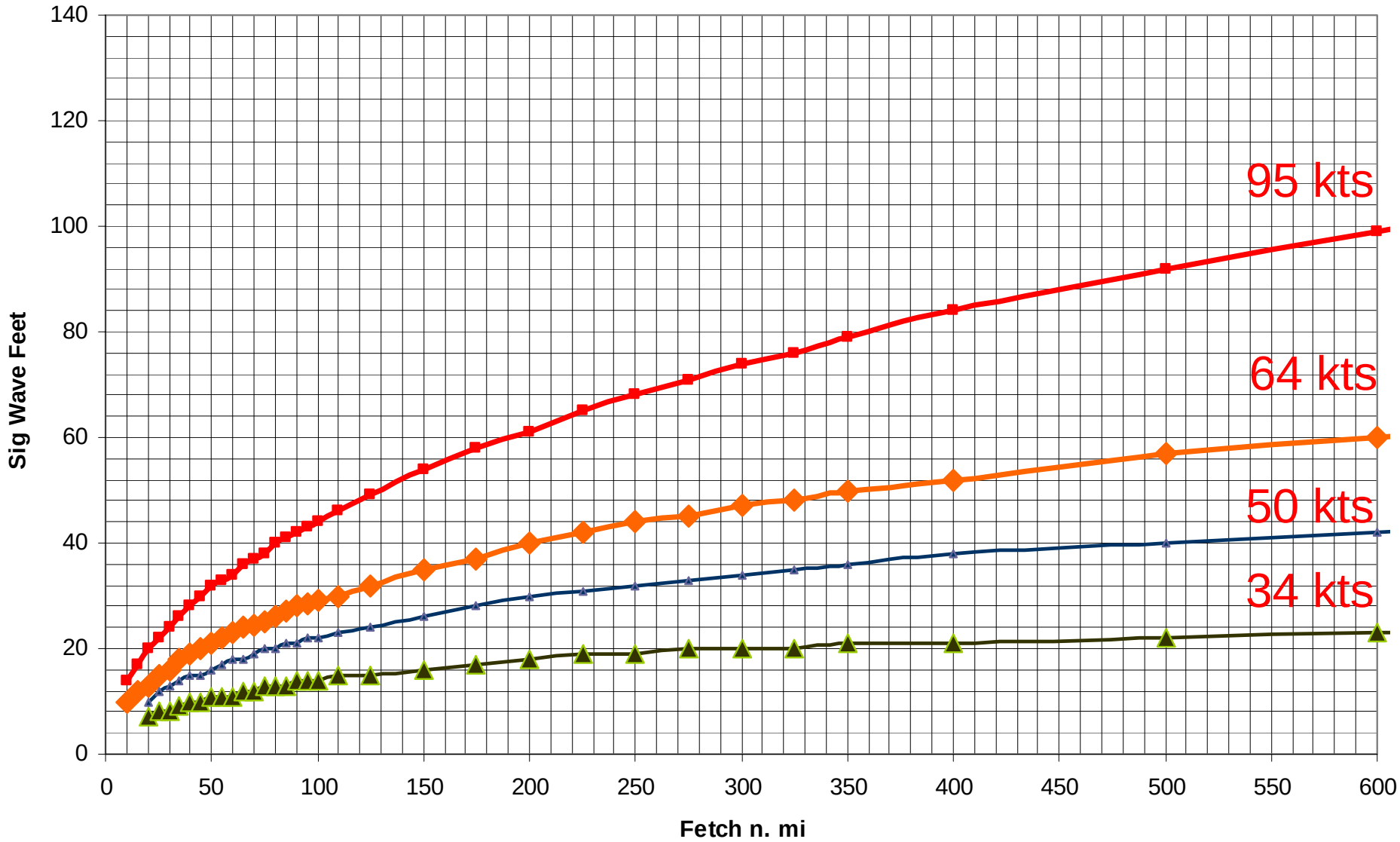


Size of the windfield can change during the life of a hurricane. The windfield of Rita expanded as the storm weakened from a Category 5 hurricane.

(Weather Research Center 2008b)

WHY SIZE MATTERS!

The greater the distance the wind blows over a body of water [fetch] and the longer the duration of the high winds, the higher the waves can become.


Sig Wave by Fetch for maximum sustained winds of 34, 50, 64 and 95 kt
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80
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120
140
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50
100
150
200
250
300
350
400
450
500
550
600
95 kts
64 kts
50 kts
34 kts

Other Parameters

Not only the size matters but also

the track through the oil leases,

forward speed,

duration [dependent on hurricane size]

Most important: the offshore properties exposed to the high waves

Hurricanes Ivan, Katrina, Rita, and Ike – intense hurricanes similar to those of the 1960s – demonstrate a need for a model to estimate hurricane damage potential to offshore properties.

A quick look at the history of Gulf of Mexico exploration and production demonstrates this need.

The Oil Industry Moved Offshore into the Gulf of Mexico after World War II in 1947

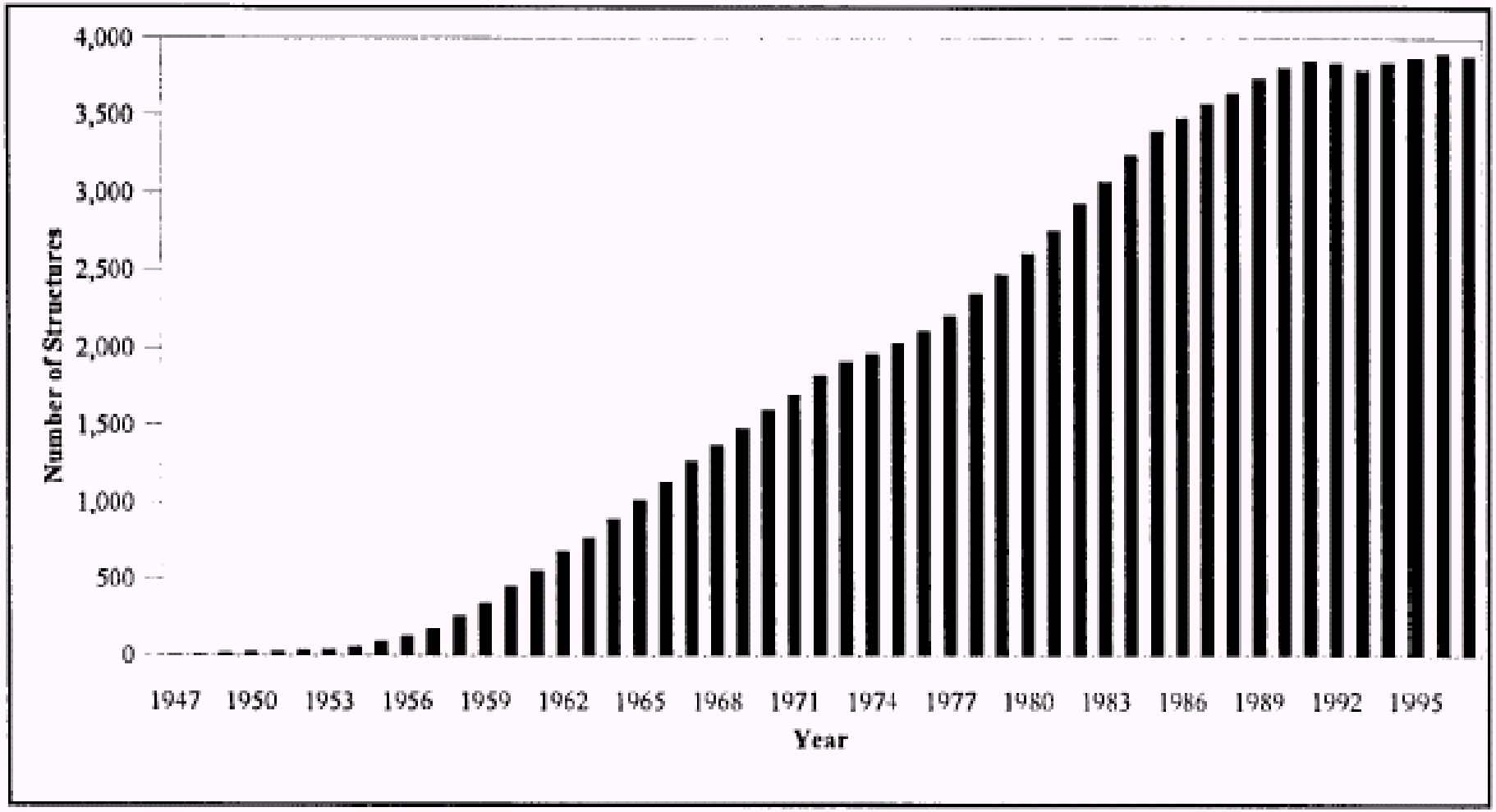

Figure 2.4. Existing offshore structures on the Gulf of Mexico OCS, 1947-1997.

(Austin et al. 2004)

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October 1949 – Freeport Hurricane severely damaged a platform with 40 foot waves.

During the 1949 Freeport Hurricane, a platform with a 26 foot deck suffered damages while a platform with a 33 foot deck showed no damage.

(Austin et al. 2004)

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More than 1,000 platforms had been built in the Gulf by the mid 60's.

(Austin et al. 2004)

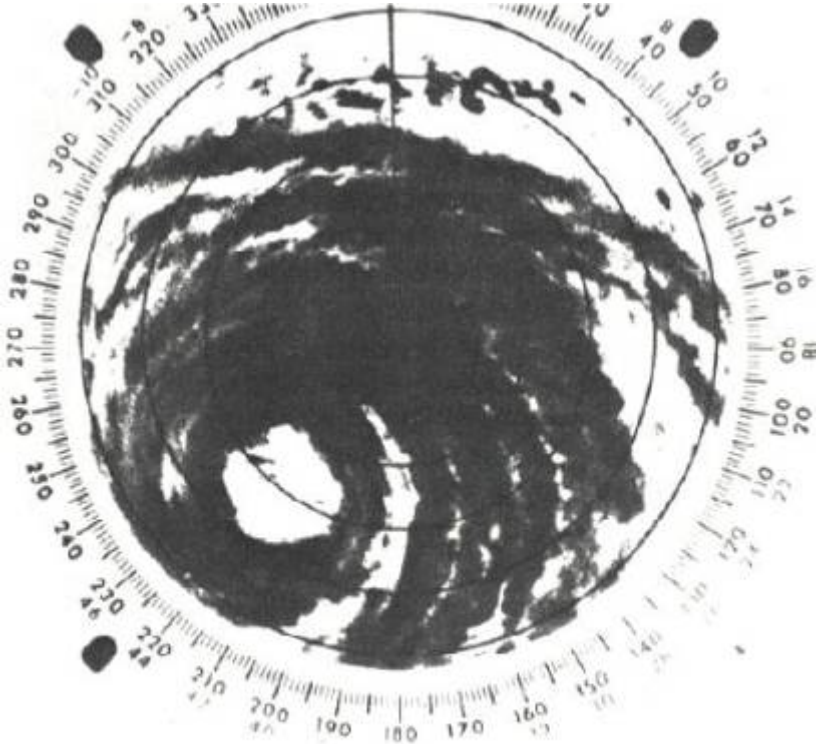


FIGURE 4.—Betsy at 0730 EST September 8, 1965, photographed from WSR-57 radar, Miami. Range marks 20 n.mi.

Until 1964, no major hurricanes moved over the areas of high concentrations of offshore operations.

Three hurricanes Hilda (1964), Betsy (1965) and Camille (1969) demonstrated that the risks presented by major hurricanes were gravely underestimated.

(Austin et al. 2004)

Hurricane Hilda 1964 – 100 year Storm

13 platforms destroyed and 5 more damaged beyond repair

Hurricane Betsy 1965 – 100 Year Storm

8 platforms destroyed and damaged others

Hurricane Camille 1969 – 400 year Storm

Shell measured waves of 70 to 75 feet

(Austin et al. 2004)

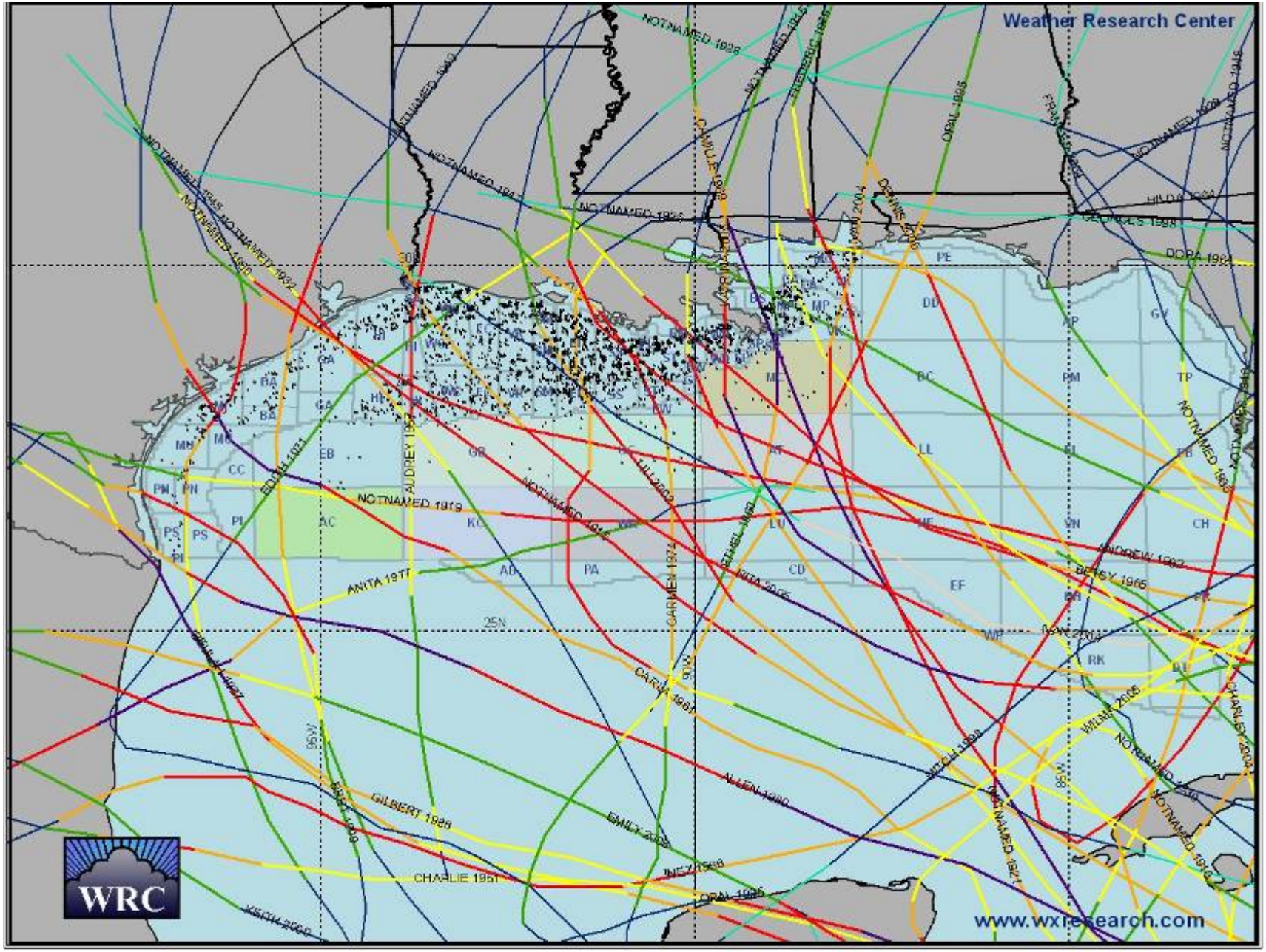
Table 1. Saffir/Simpson Hurricane Scale, modifed from Simpson (1974).

Scale Number (Category)	Winds (Mph)	Typical characteristics of hurricanes by category			
		(Millibars)	(Inches)	Surge (Feet)	Damage
1	74-95	> 979	> 28.91	4 to 5	Minimal
2	96-110	965-979	28.50-28.91	6 to 8	Moderate
3	111-130	945-964	27.91-28.47	9 to 12	Extensive
4	131-155	920-944	27.17-27.88	13 to 18	Extreme
5	> 155	< 920	< 27.17	> 18	Catastrophic

Central Pressure/Wind Relationship

960 mbs – Sustained winds of 100 knots – 115 mph – Cat 3
945 mbs – Sustained winds of 115 knots – 132 mph – Cat 4
931 mbs – Sustained winds of 128 knots – 147 mph – Cat 4
922 mbs – Sustained winds of 135 knots – 155 mph – Cat 4
914 mbs – Sustained winds of 142 knots – 163 mph – Cat 5

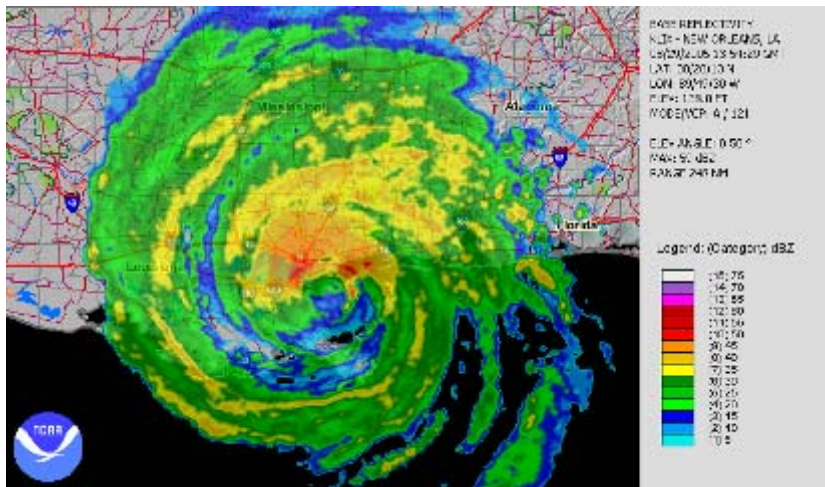
(Simpson and Riehl 1981)



The tracks of Category 4 or greater hurricanes over the Gulf of Mexico oil leases (Weather Research Center 2008a).

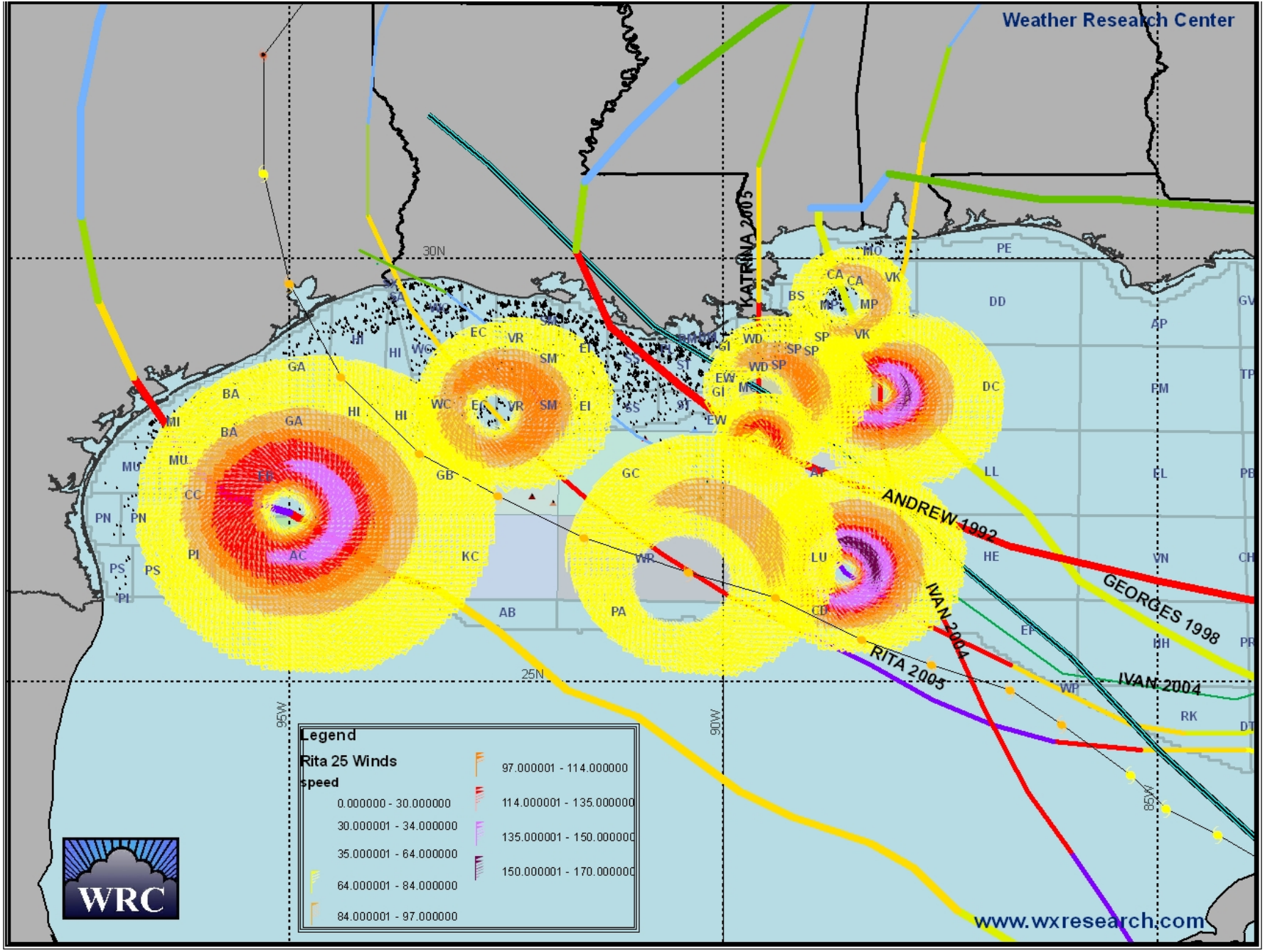
NOTABLE CATEGORY 5 GOM LEASE HURRICANES

165 kts	Hurricane Camille	1969
155 kts	Hurricane Allen	1980
155 kts	Hurricane Rita	2005
150 kts	Hurricane Carla	1961
150 kts	Hurricane Katrina	2005
140 kts	Hurricane Beulah	1967
140 kts	Hurricane Ethel	1960
135 kts	Hurricane Betsy	1965

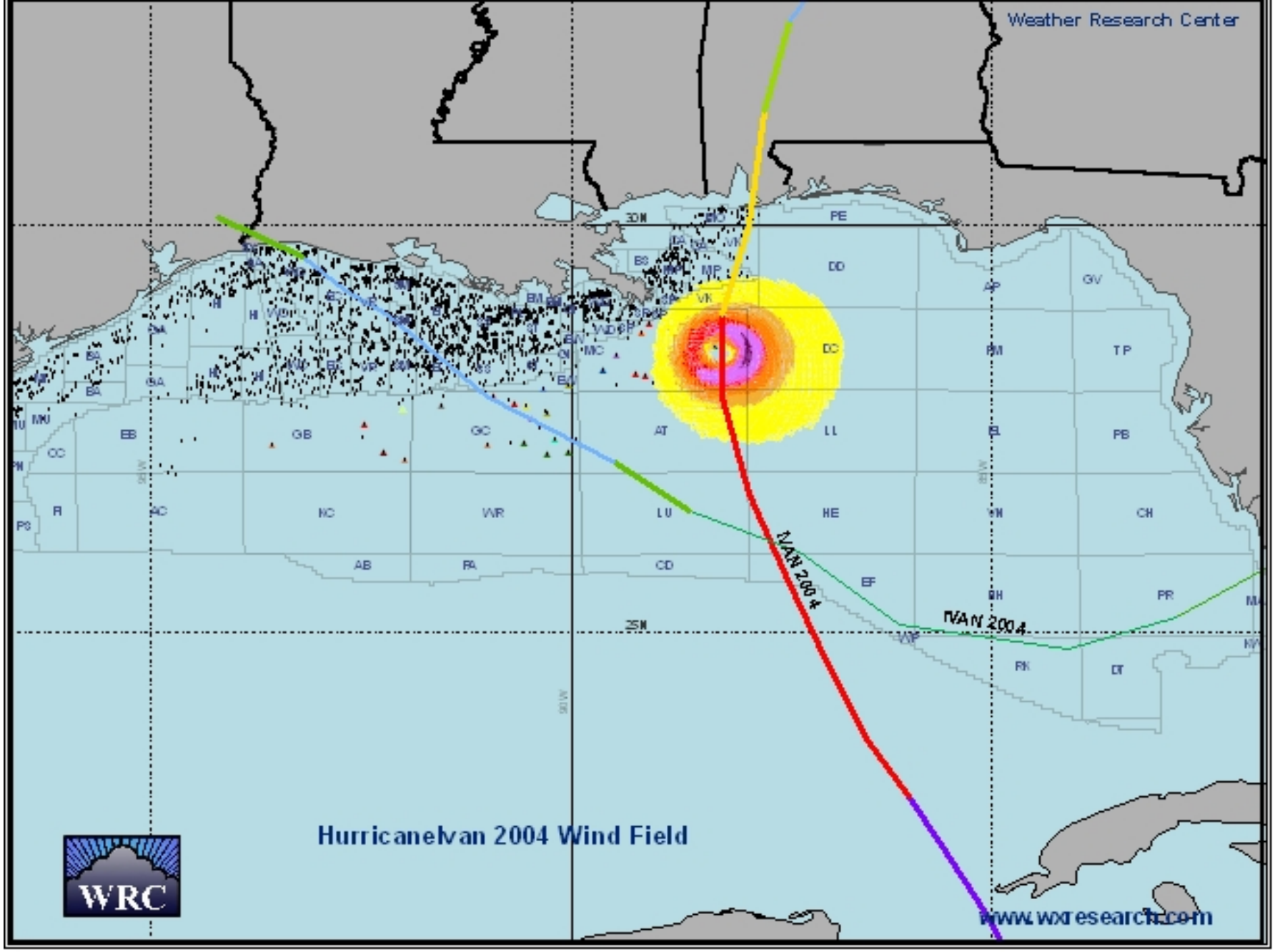


WRC Meteorologists

- **Computed the maximum sustained windfields for the some of hurricanes over the GOM Leases**
- **The windfields were then plotted using GIS Software**



(Weather Research Center 2008b)



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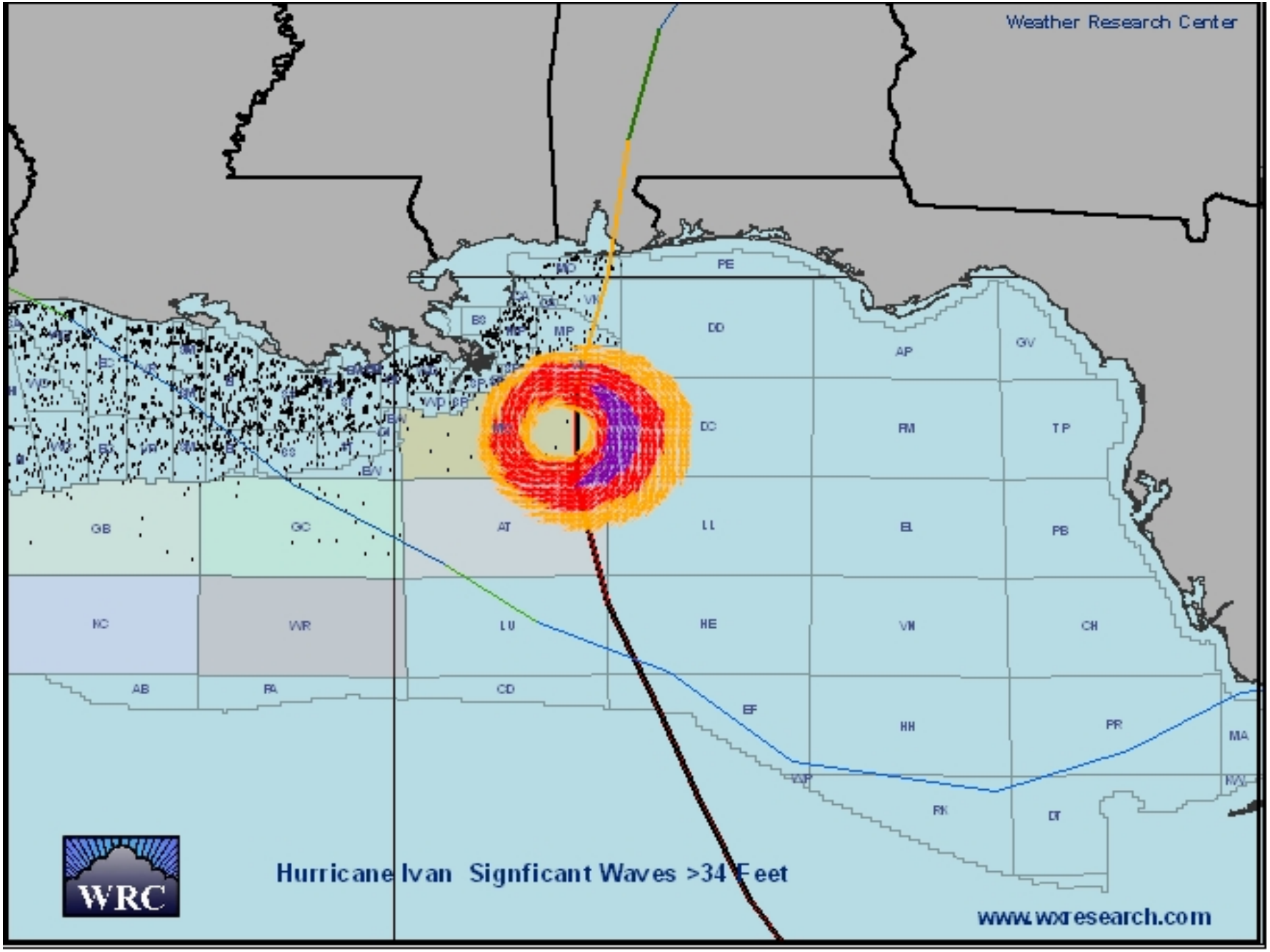

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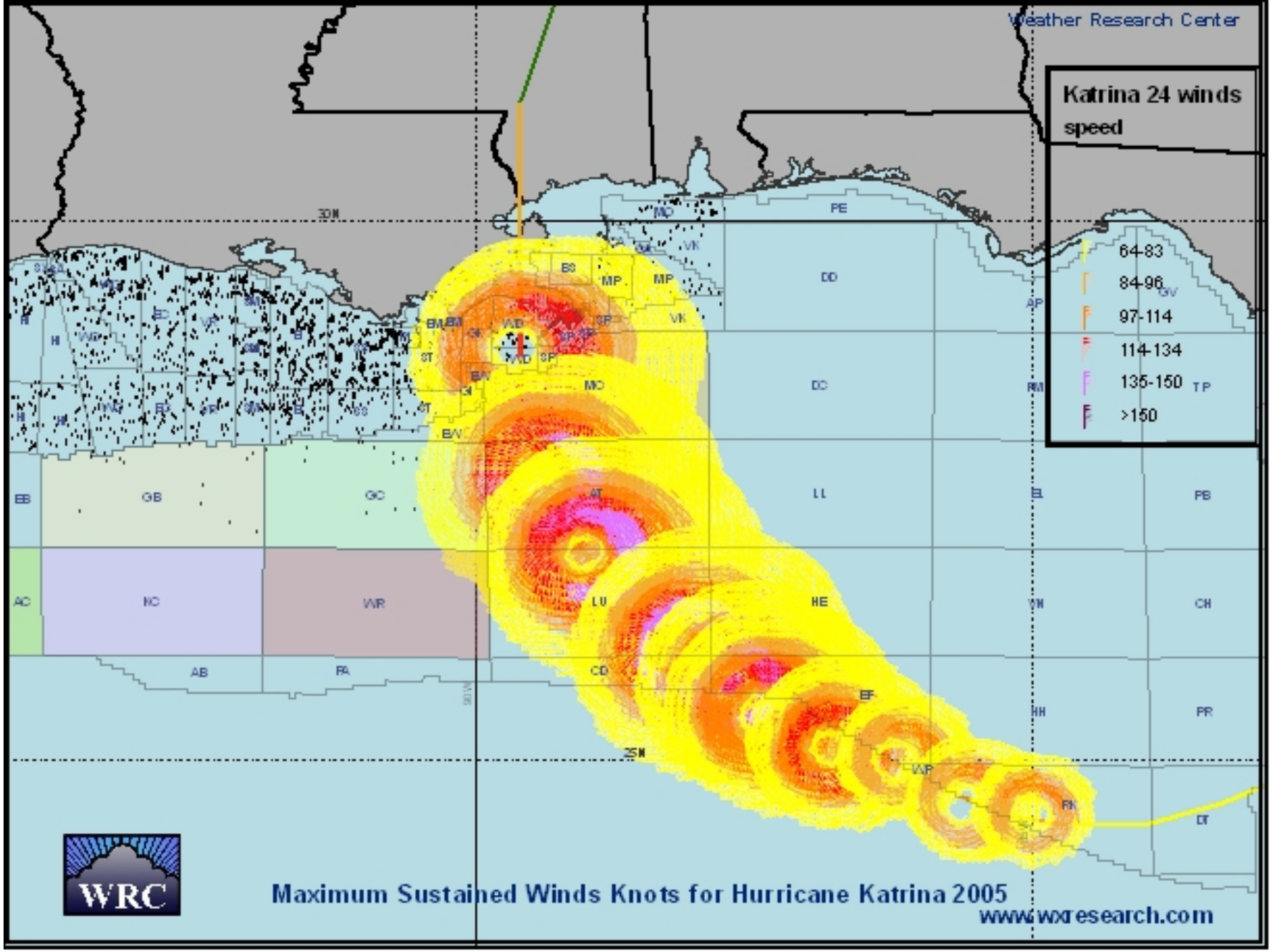

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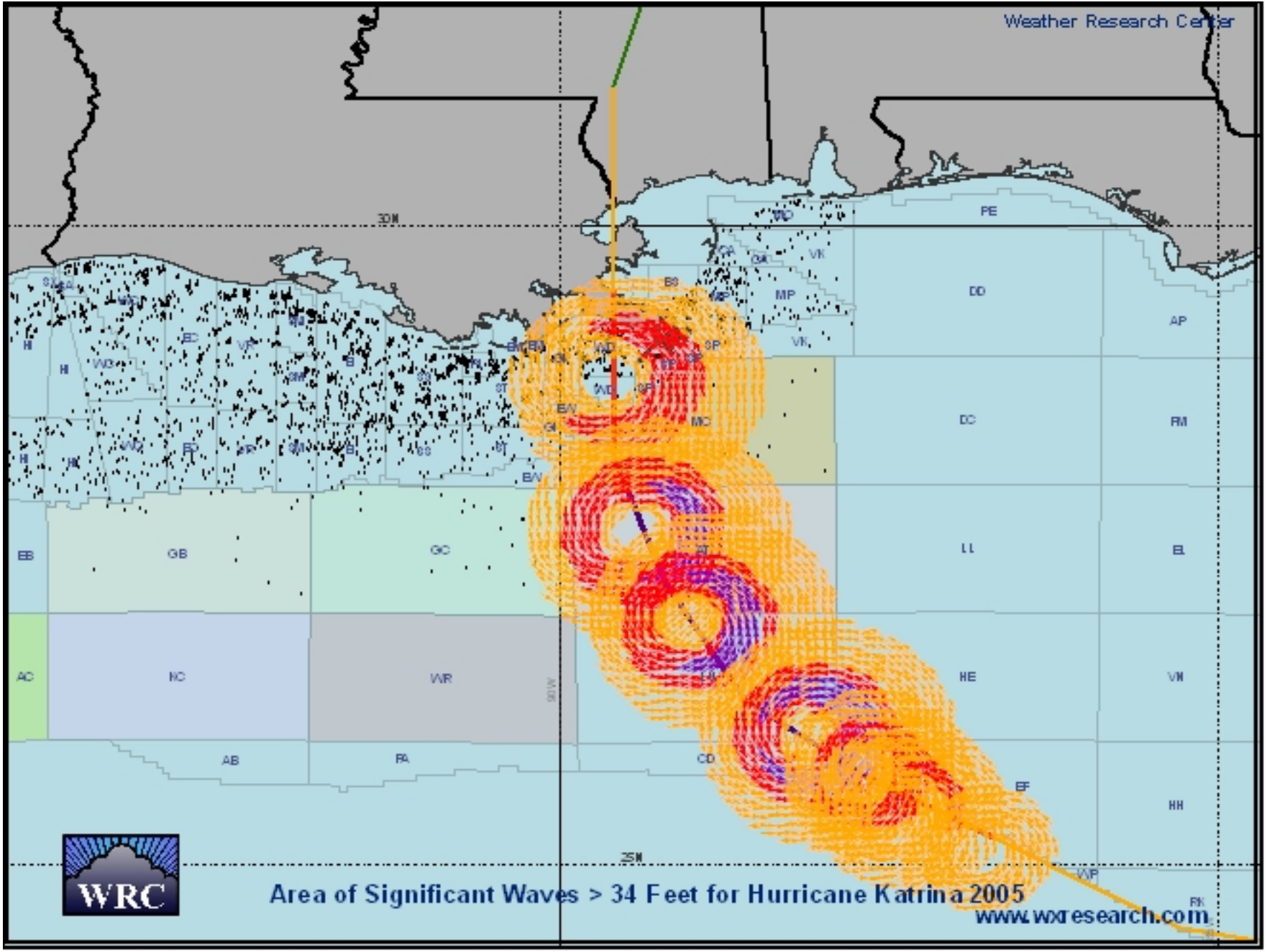

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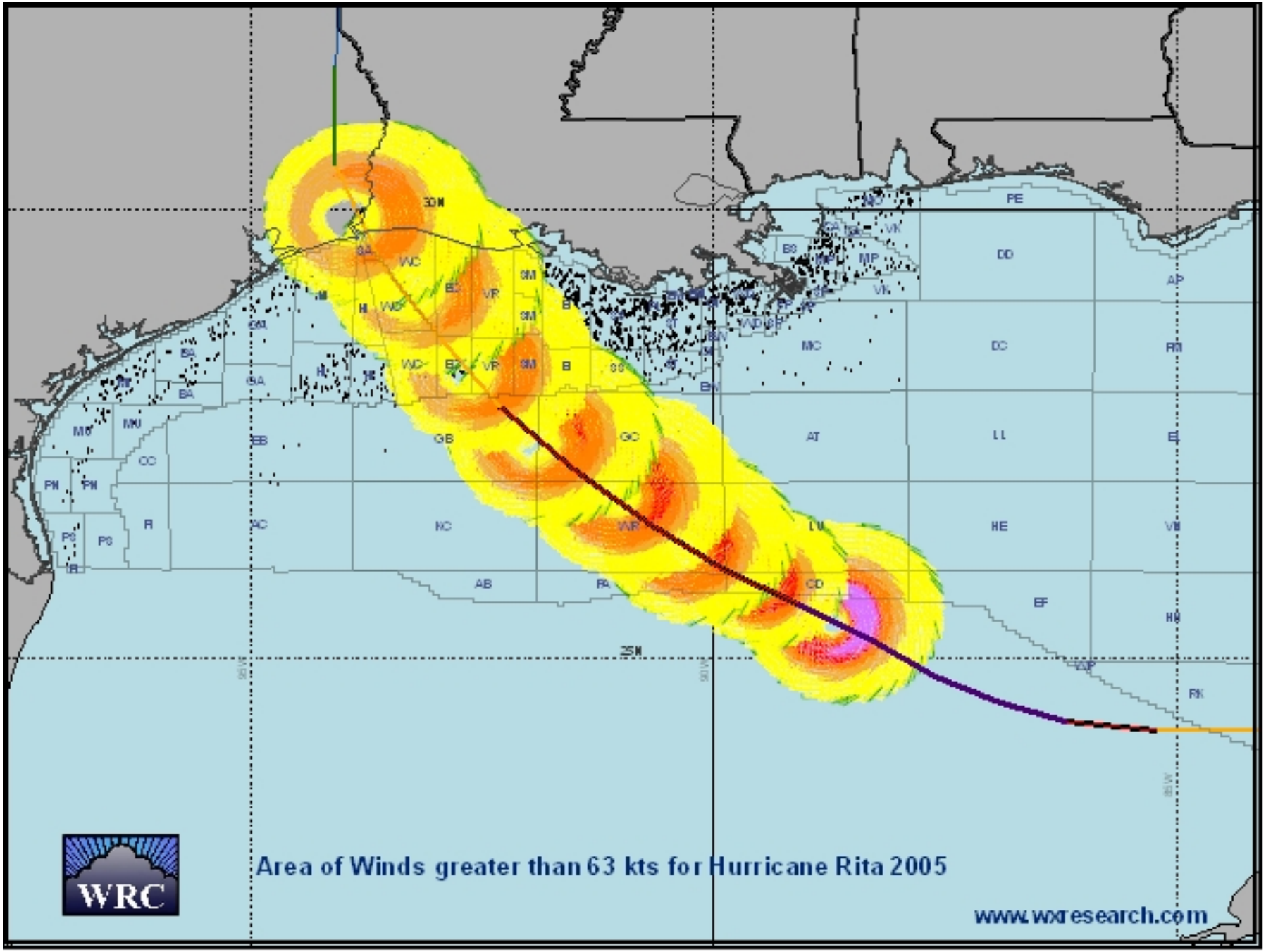

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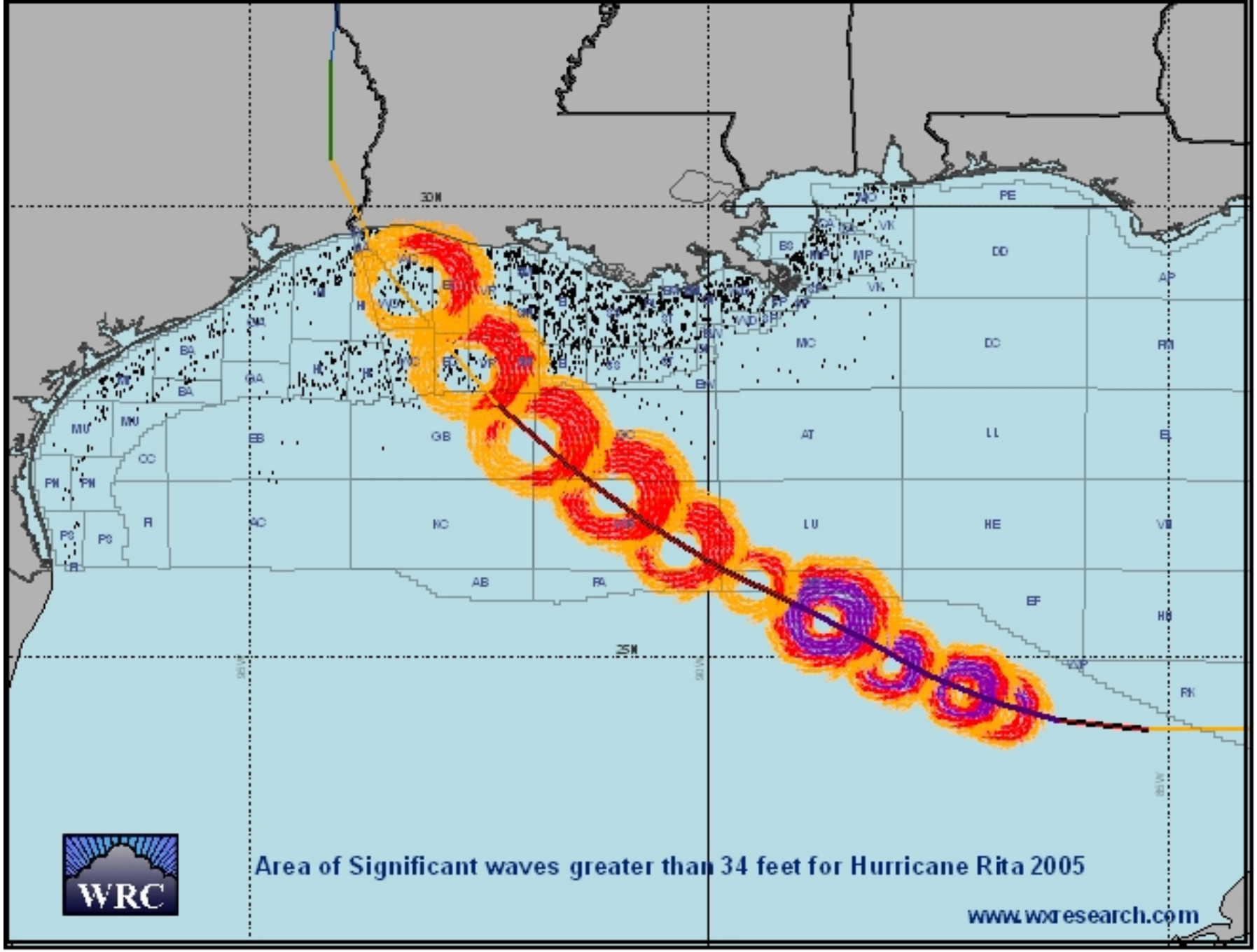

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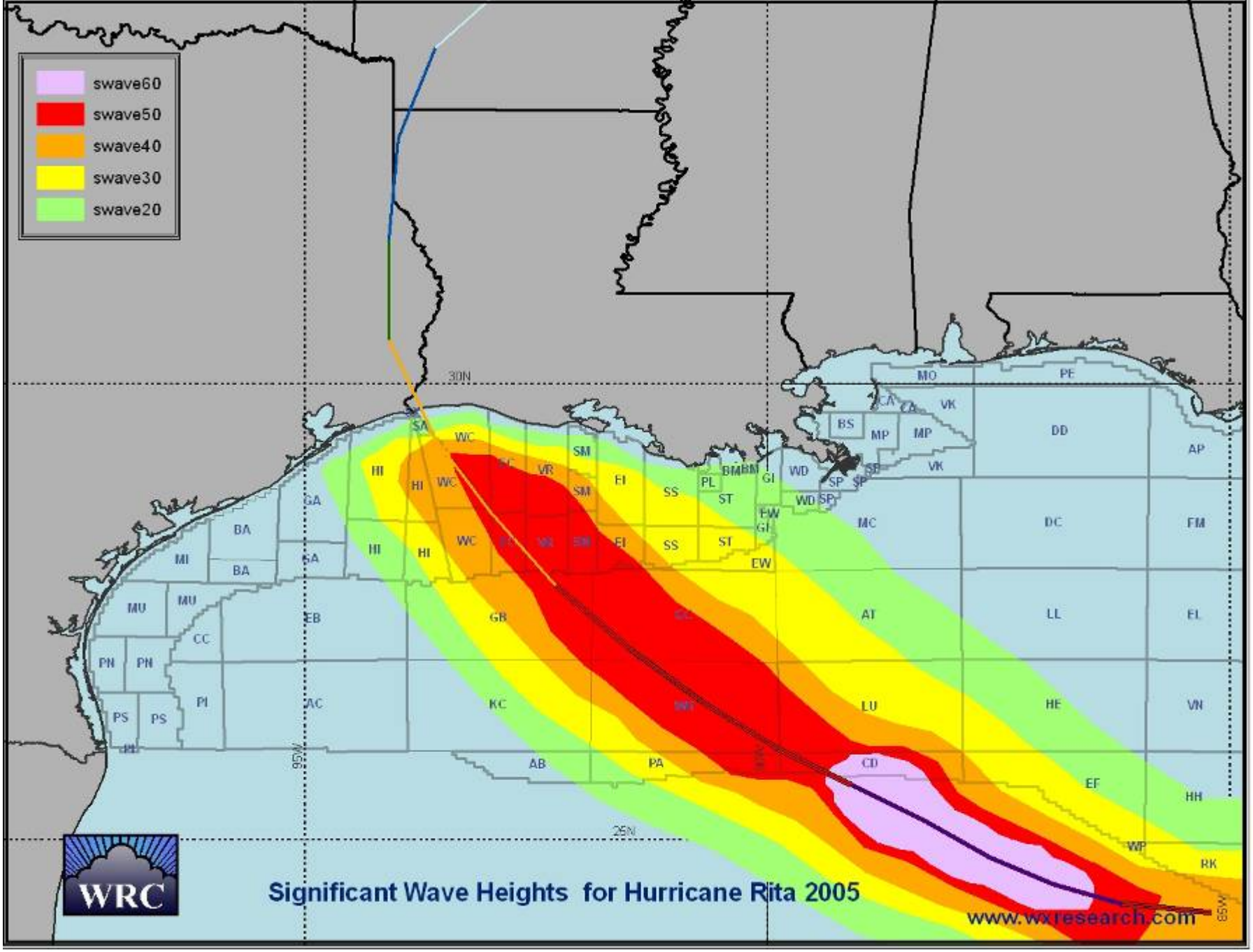

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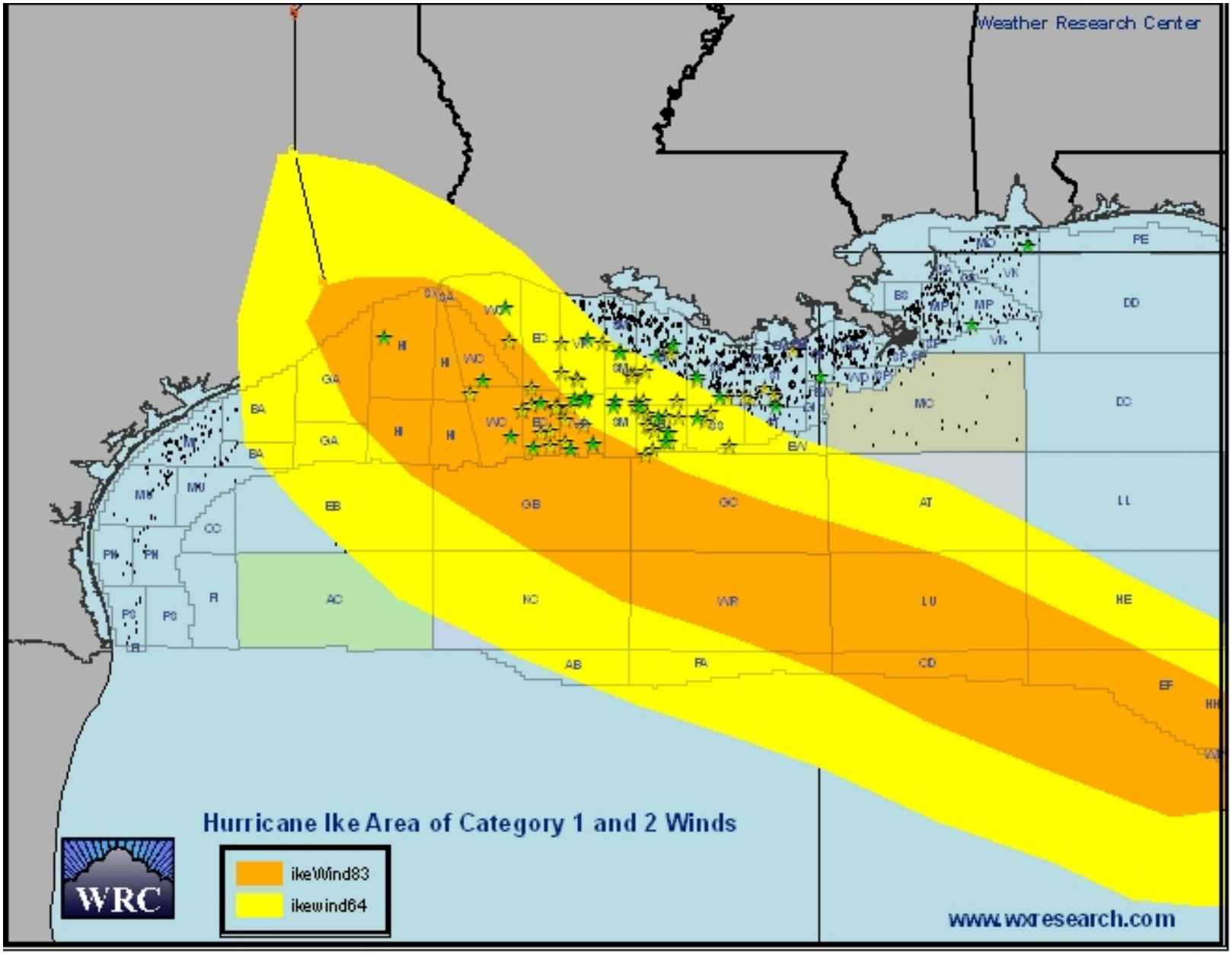


(Weather Research Center 2008b)

WRC Meteorologists then plotted a cross section to show the wind profiles and wave profiles for past hurricanes.

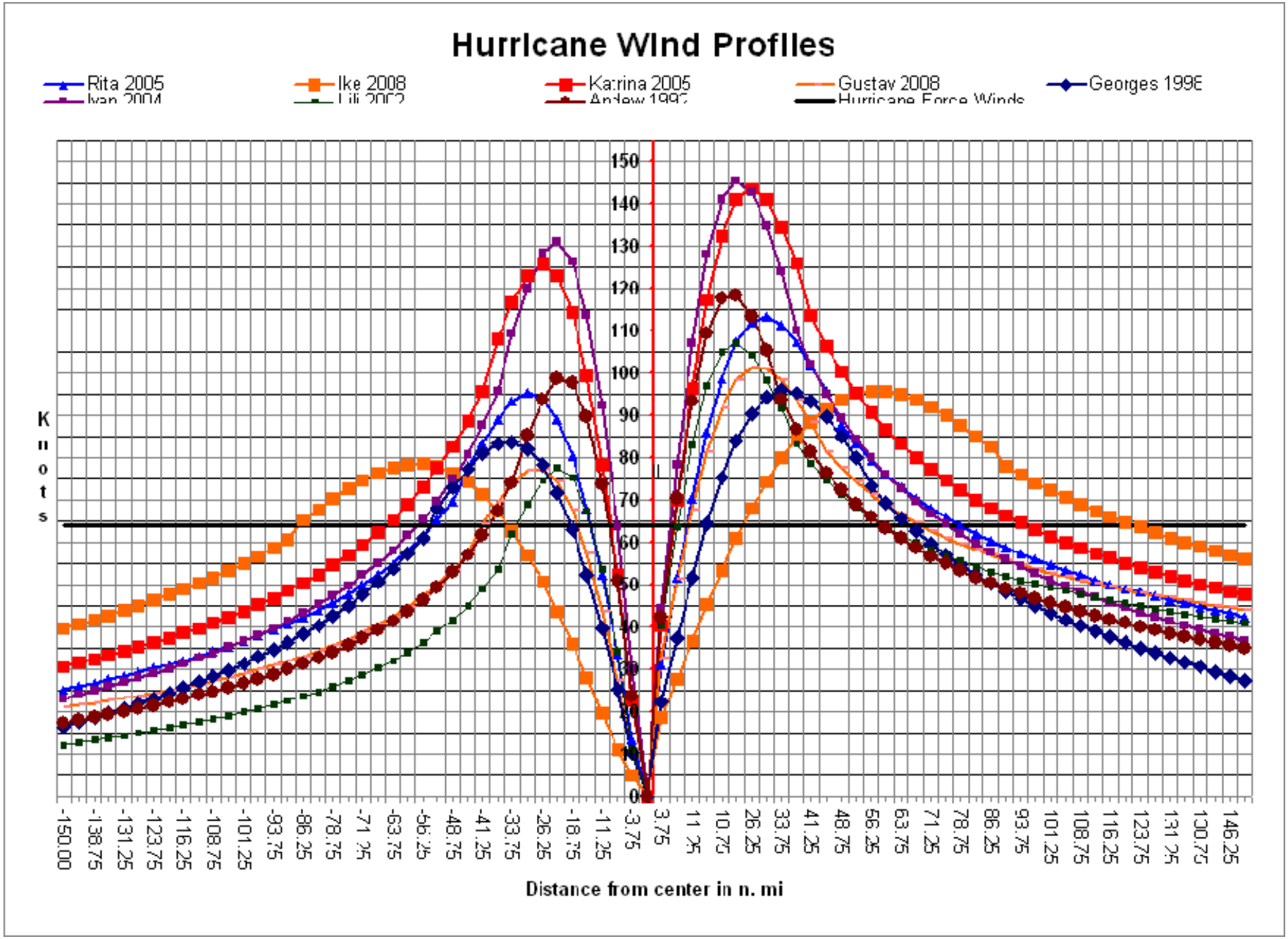
As you can see from the profiles, each hurricane is a different size: Hurricane Andrew 1992

Hurricane Ivan 2004

Hurricane Katrina 2005

Hurricane Rita 2005

Hurricane Ike 2008



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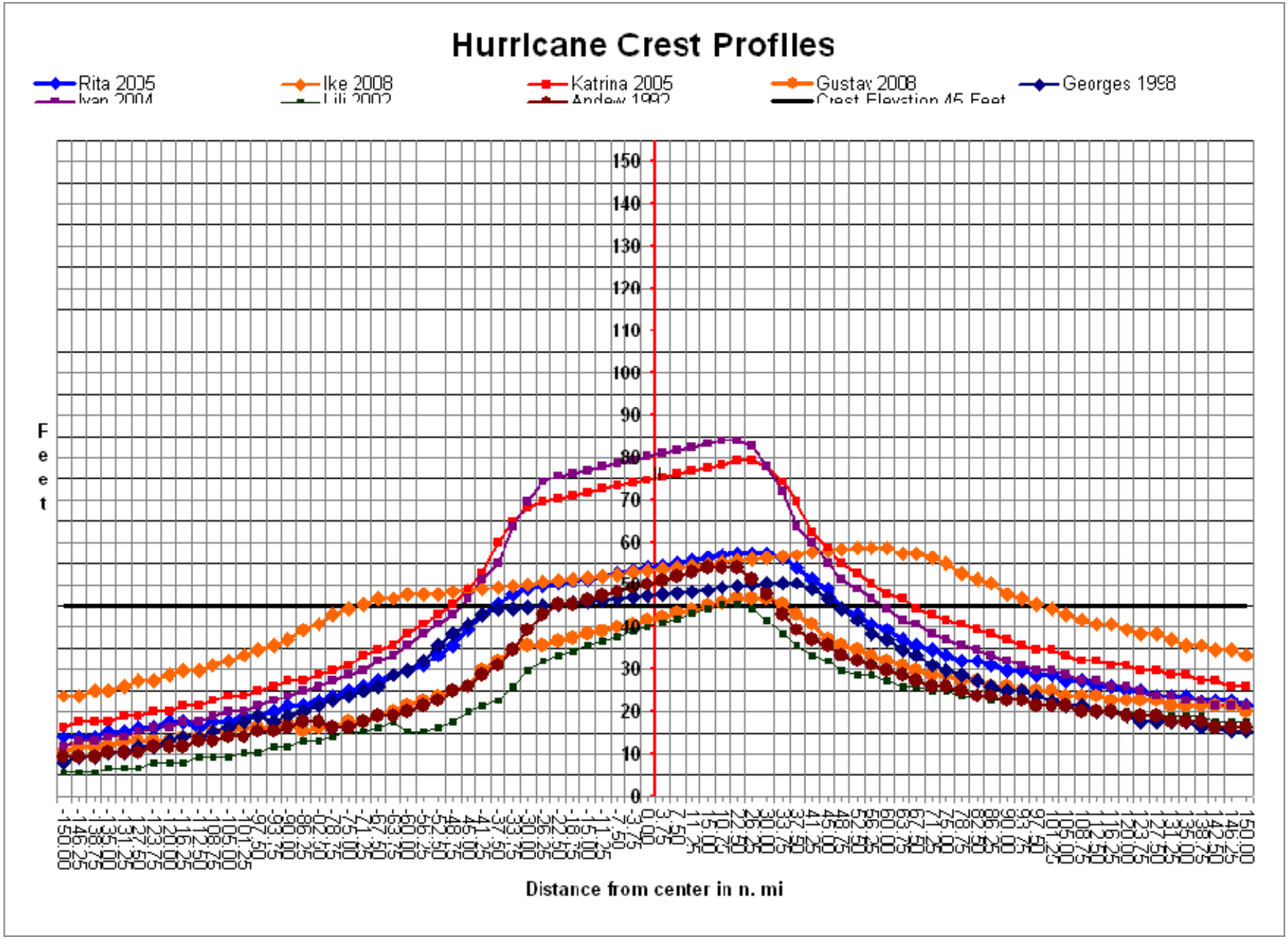

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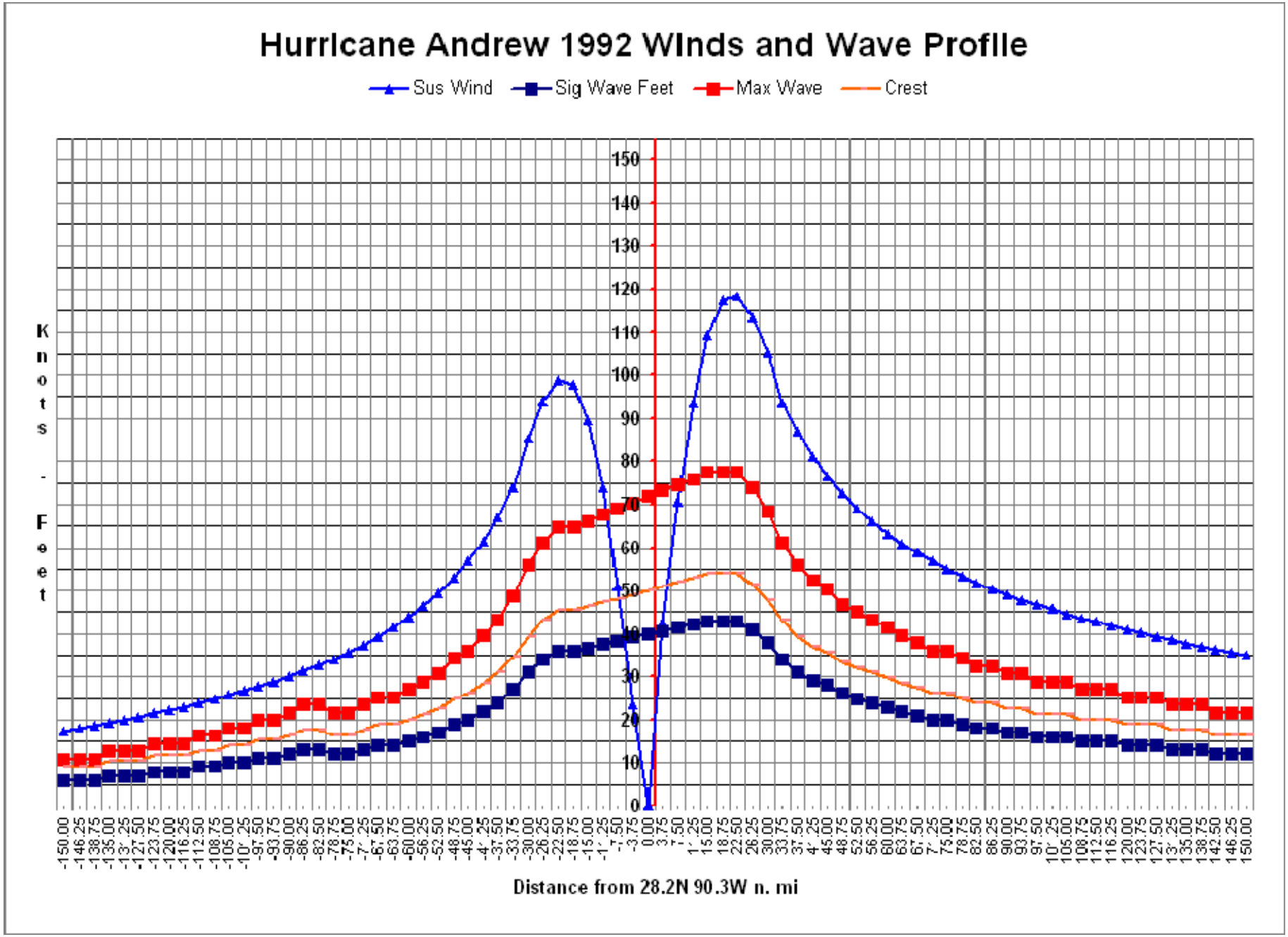

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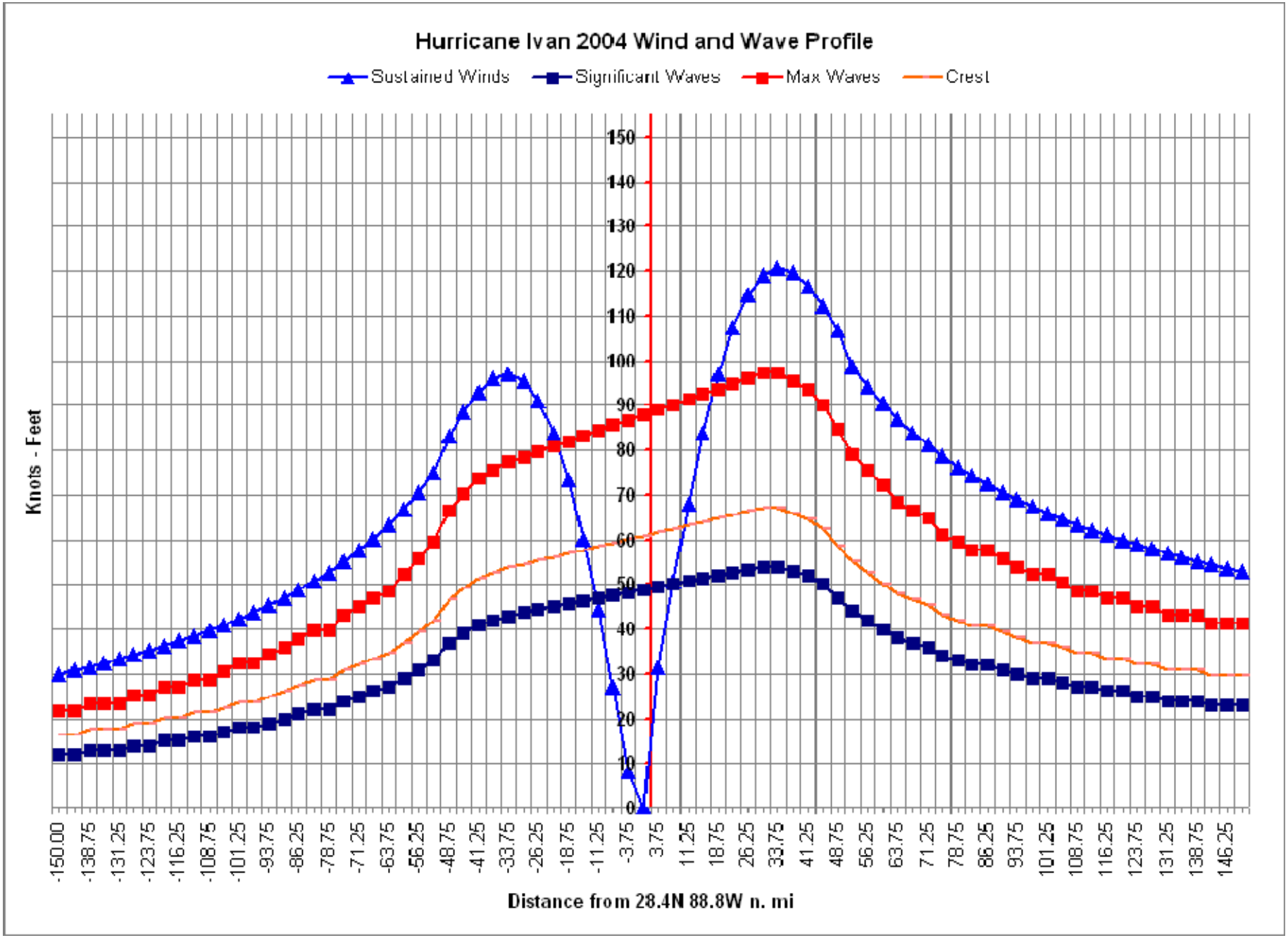

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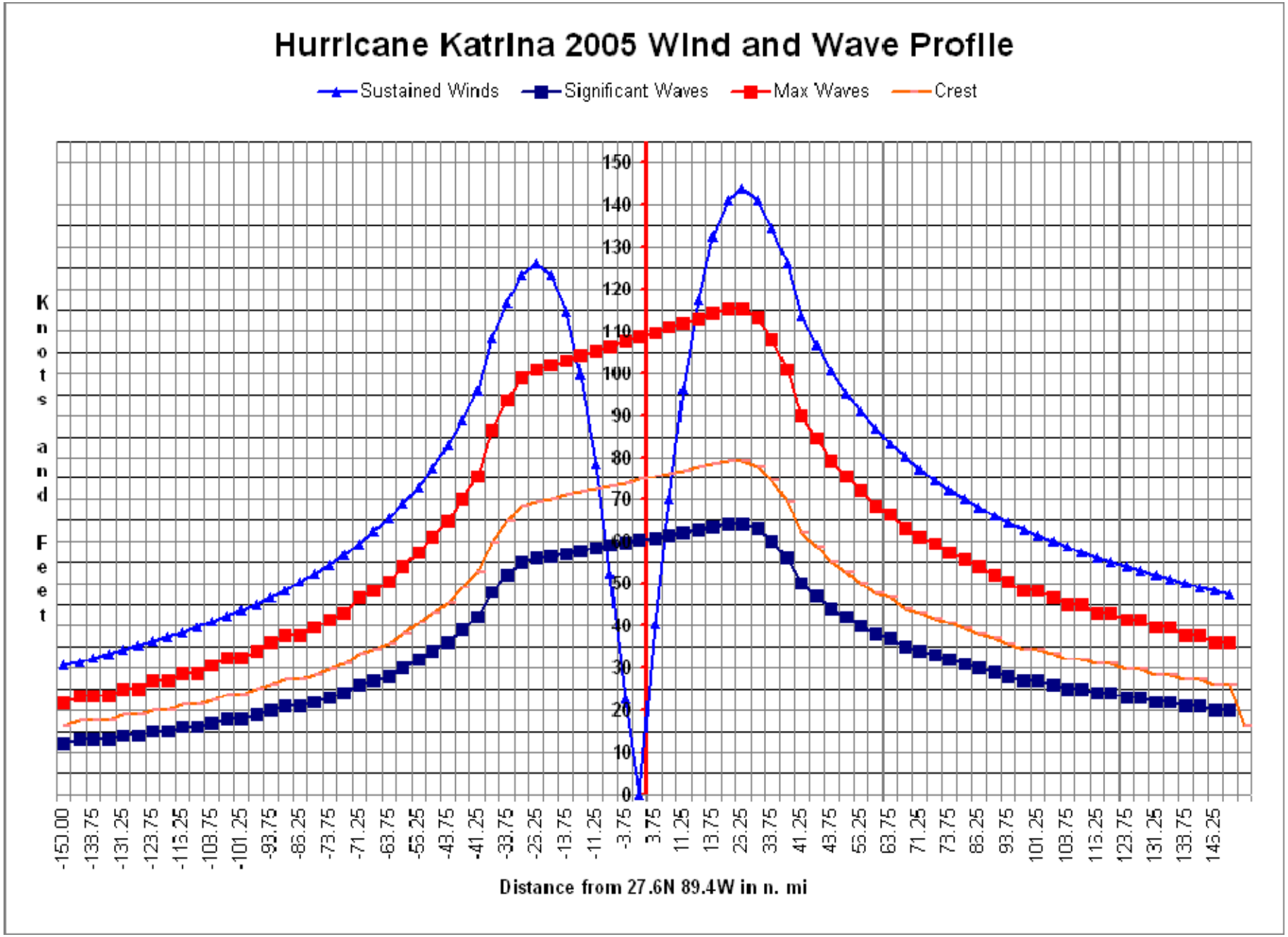

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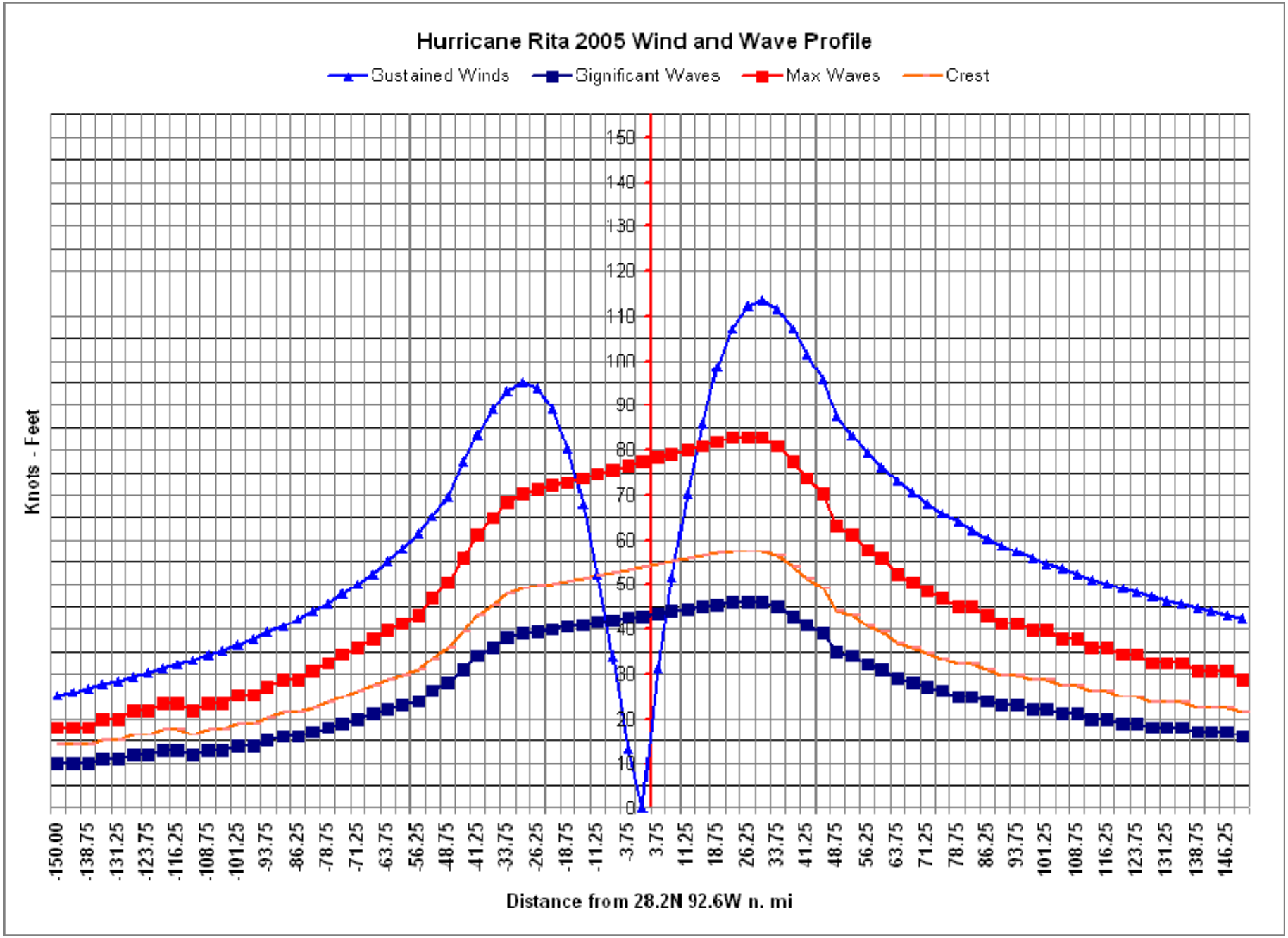

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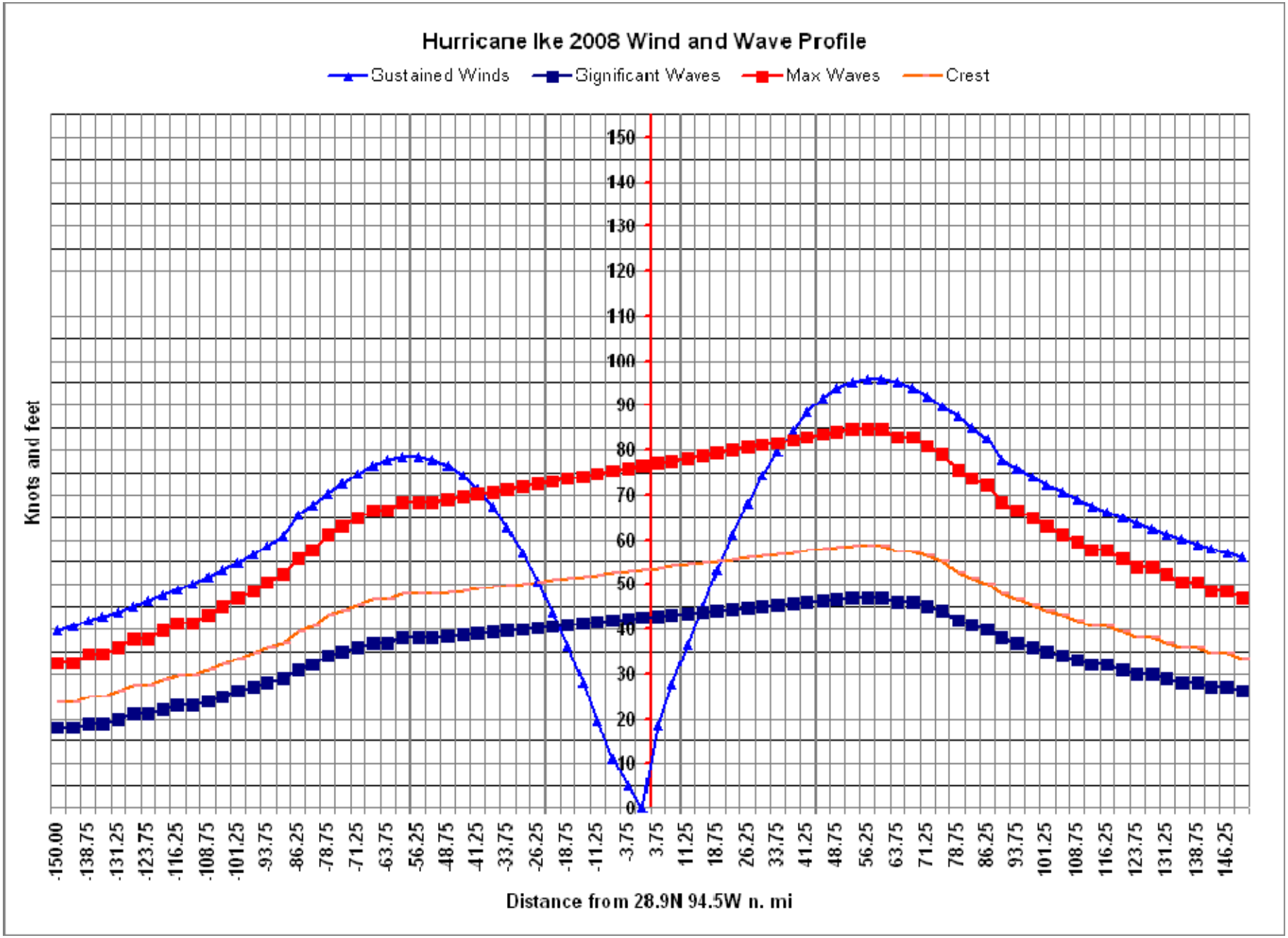

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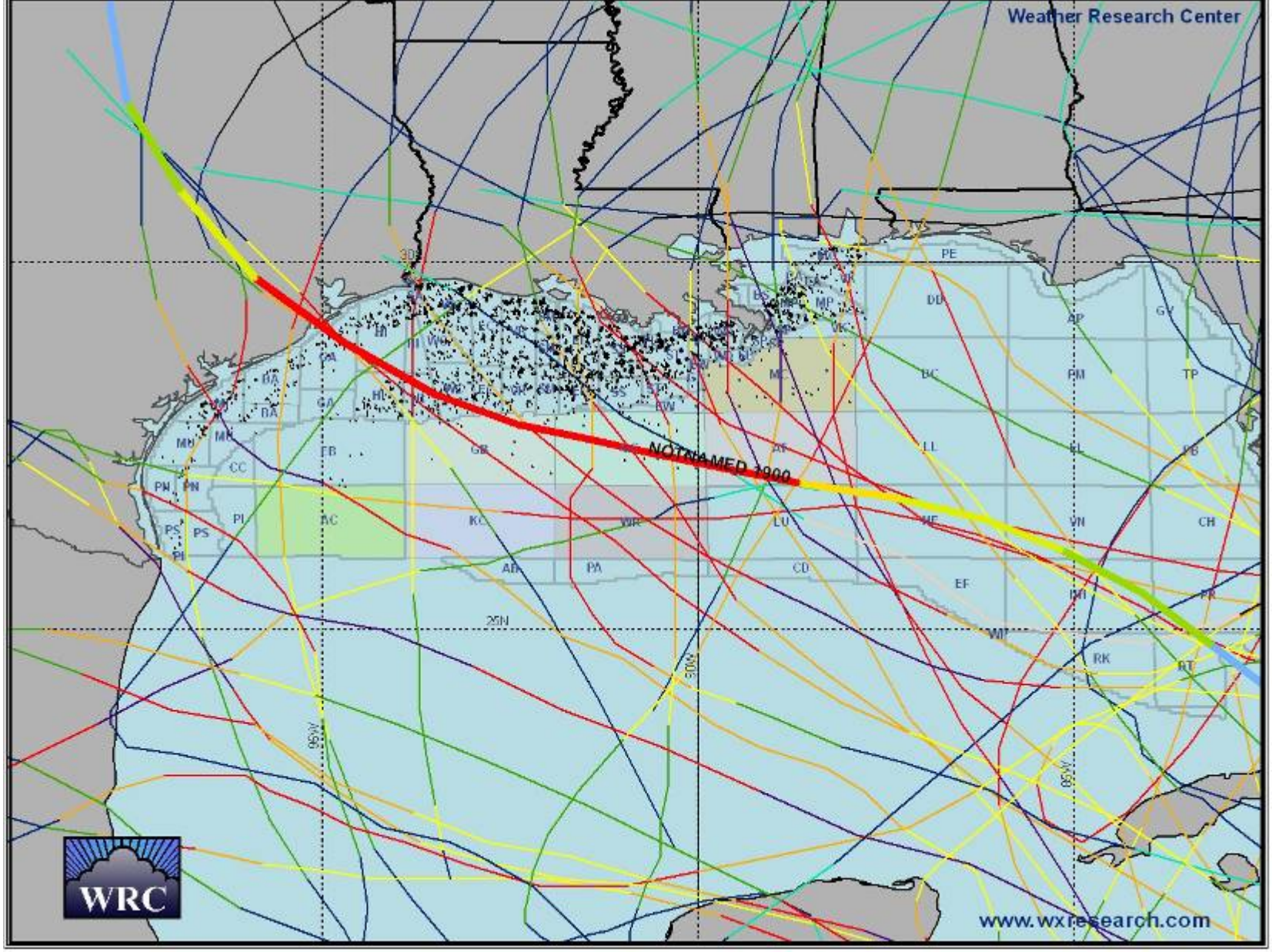
(Weather Research Center 2008b)

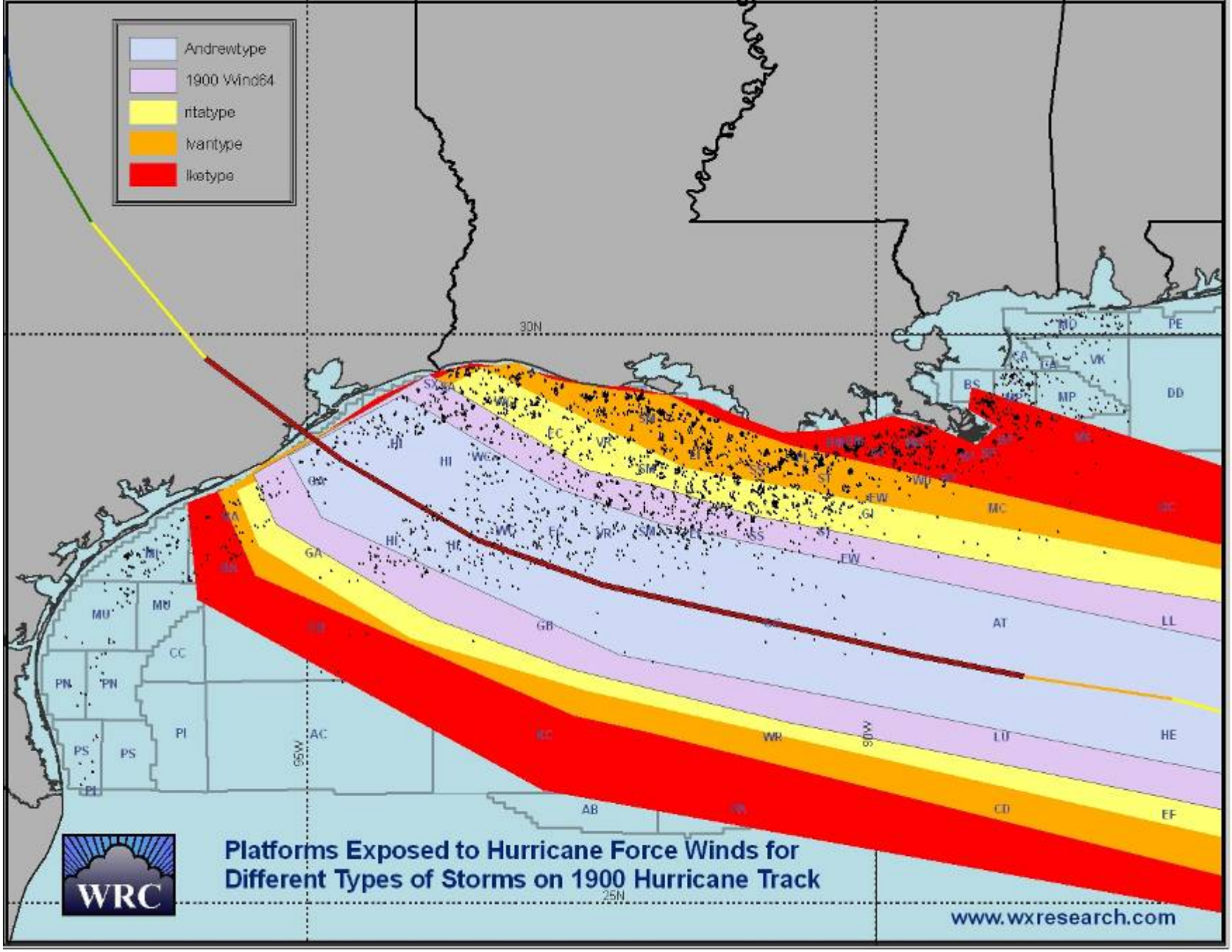
In order to develop a Hurricane Damage Potential Scale, the past hurricane tracks were plotted with the offshore properties.

The track of the 1900 hurricane that devastated Galveston seems to be the one that would expose the most offshore properties for various hurricanes.



1900 Hurricane with Platforms

(Weather Research Center 2008a)



(Weather Research Center 2008b)

The result of this research is the development of

The Freeman Hurricane Damage Potential Scale

[Freeman - HDP Scale]

(Weather Research Center 2008b)

The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**

The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**
- **Radius of Hurricane Force Winds**

The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**
- **Radius of Hurricane Force Winds**
- **Central Pressure**

The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**
- **Radius of Hurricane Force Winds**
- **Central Pressure**
- **Area of Significant Wave >34 Feet**

The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**
- **Radius of Hurricane Force Winds**
- **Central Pressure**
- **Area of Significant Wave >34 Feet**
- **Hurricane Track**

The Freeman Hurricane Damage Potential Scale is based on:

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The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**
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- **Area of Significant Wave >34 Feet**
- **Hurricane Track**
- **Hurricane Speed**
- **Duration of Hurricane Force Winds**

The Freeman Hurricane Damage Potential Scale is based on:

- **Maximum Sustained Wind**
- **Radius of Hurricane Force Winds**
- **Central Pressure**
- **Area of Significant Wave >34 Feet**
- **Hurricane Track**
- **Hurricane Speed**
- **Duration of Hurricane Force Winds**
- **Exposed Offshore Properties**

Freeman Hurricane Damage Potential Scale

R64	<=30	>30	>=45	>=60	>=80
Saffir/Simpson					
1	0	0	0	4	5
2	0	0	0	5	5
3	0	0	1	5	5
4	0	1	2	5	5
5	1	2	3	5	5

Freeman Hurricane Damage Potential Scale	1	2	3	4	5
HPD Percent	2%	4%	6%	8%	10%

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Freeman HPD	# Platforms Exposed to winds> 63 kts	# Platforms Exposed to waves> 34 ft	WRC	Damage Factor	Destroyed or Damaged Properties
1	0-399	0-199	Hurricane must be Category 5 Hurricane to cause sig. waves >34 feet	0.02	4
2	400-989	200-495	Hurricane must be Category 4 or greater hurricane to cause sig waves > 34 feet	0.04	20
3	990-1749	496-874	Hurricane must be a Category 3 or greater hurricane to cause sig waves > 34 feet	0.06	52
4	1750-2499	875-1000	Hurricane must be a Category 2 or greater hurricane to cause sig waves > 34 feet	0.08	80
5	>=2500	>1000	Hurricane must be a Category 1/2 or greater hurricane to cause sig waves > 34 feet	0.1	>100

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DRAFT FOR PAST STORMS	CAT	Size	Exposed waves >34 feet	Estimated Destroyed or Damaged	Actual Exposed waves >34 feet	Estimated Destroyed or Damaged
Ike 2008	2	5	>1000	>100	1135	114
Gustav 2008	3	1	0-199	0-4	967	19
Dolly 2008	2	0	0	0		0
Rita 2005	4	5	>1000	>100	1055	106
Katrina 2005	5	5	>1000	>100	697	70
Ivan 2004	4	5	>1000	>100	267	26.7
Lili 2002	3	1	0-199	0-4	400	8
Georges 1998	2	0	0	0	0	0
Andrew 1992	4	2	200-495	20		
Frederic 1979	4	5	>1000	>100		
Carmen 1974	4	2	200-495	8-20		
Camille 1969	5	1	0-199	0-4		
Betsy 1965	3	5	>1000	>100		
Hilda 1964	5	3	496-874	20-52		
Carla 1961	5	5	>1000	>100		
Audrey 1957	4	2	200-495	8-20		

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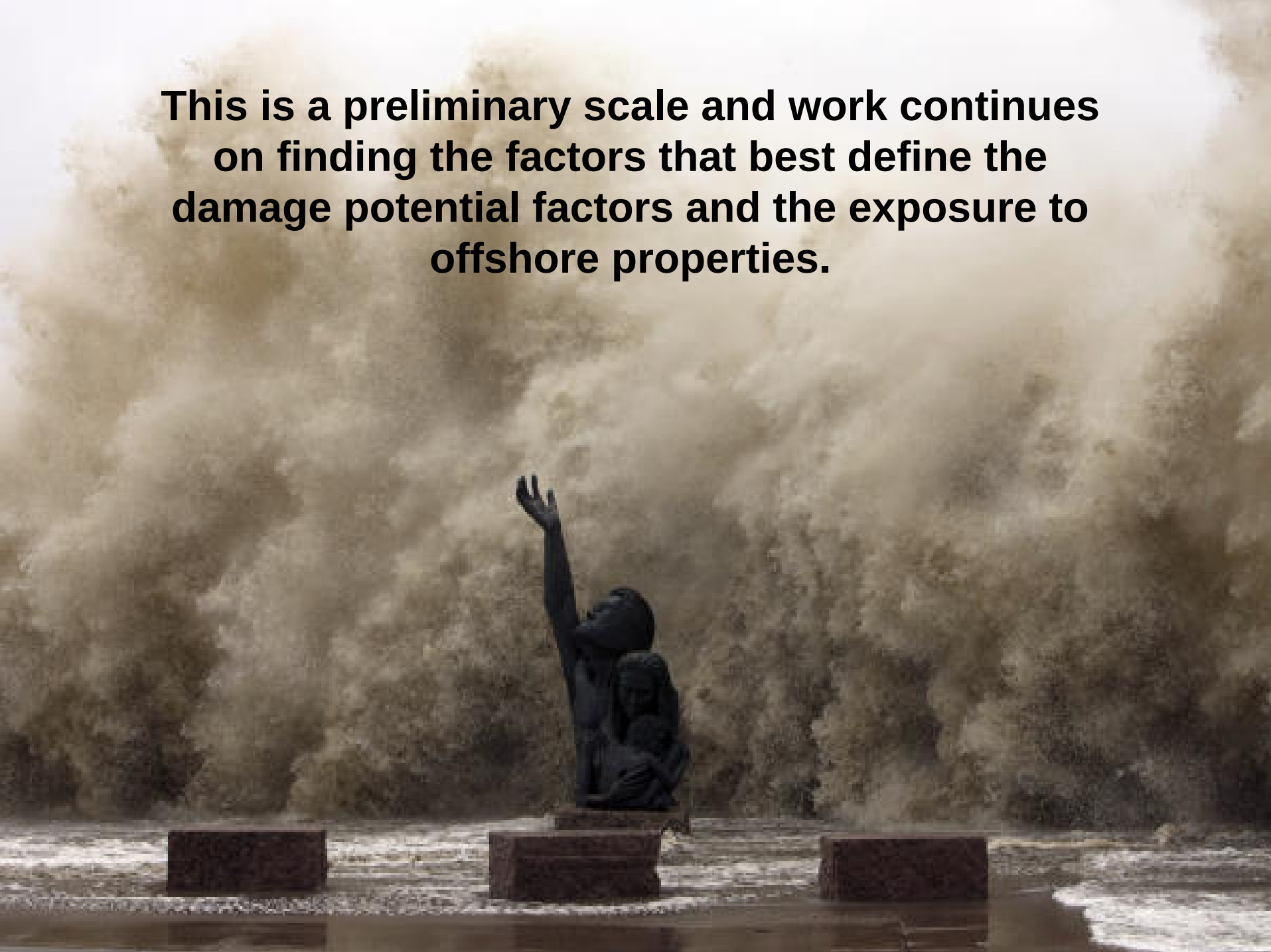
This is a preliminary scale and work continues on finding the factors that best define the damage potential factors and the exposure to offshore properties.

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