

2005

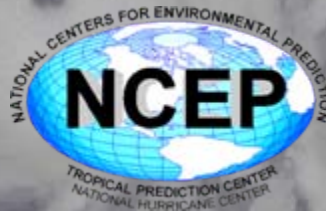
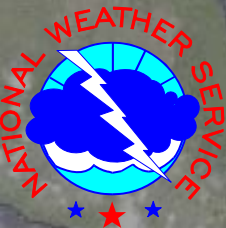
# Hurricane Analysis and Forecasting at the National Hurricane Center

12 November, 2008

Katrina  
28 August

Chris Landsea

National Hurricane Center, Miami



# OUR MISSION

***“TO SAVE LIVES, MITIGATE PROPERTY LOSS AND IMPROVE ECONOMIC EFFICIENCY BY ISSUING THE BEST WATCHES, WARNINGS, FORECASTS AND ANALYSES OF HAZARDOUS TROPICAL WEATHER, AND BY INCREASING UNDERSTANDING OF THESE HAZARDS.”***

# OUR VISION

***“TO BE AMERICA’S CALM, CLEAR AND TRUSTED VOICE IN THE EYE OF THE STORM AND, WITH OUR PARTNERS, ENABLE COMMUNITIES TO BE SAFE FROM TROPICAL WEATHER THREATS.”***



Before Katrina...

David & Kimberly King  
Waveland, MS



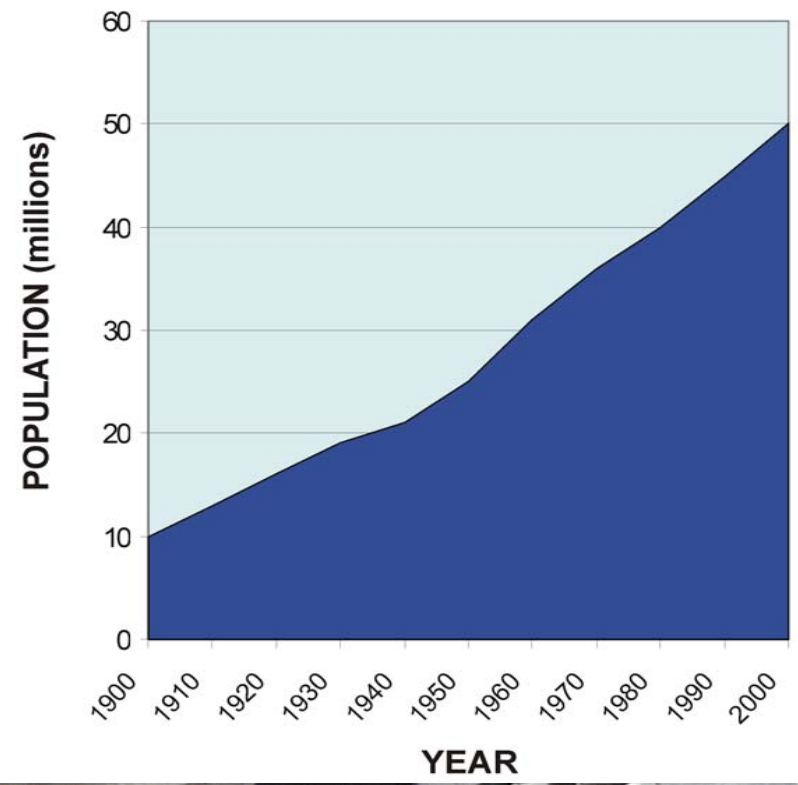
...After Katrina

David & Kimberly King  
Waveland, MS



# THE CHALLENGES:

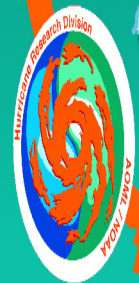
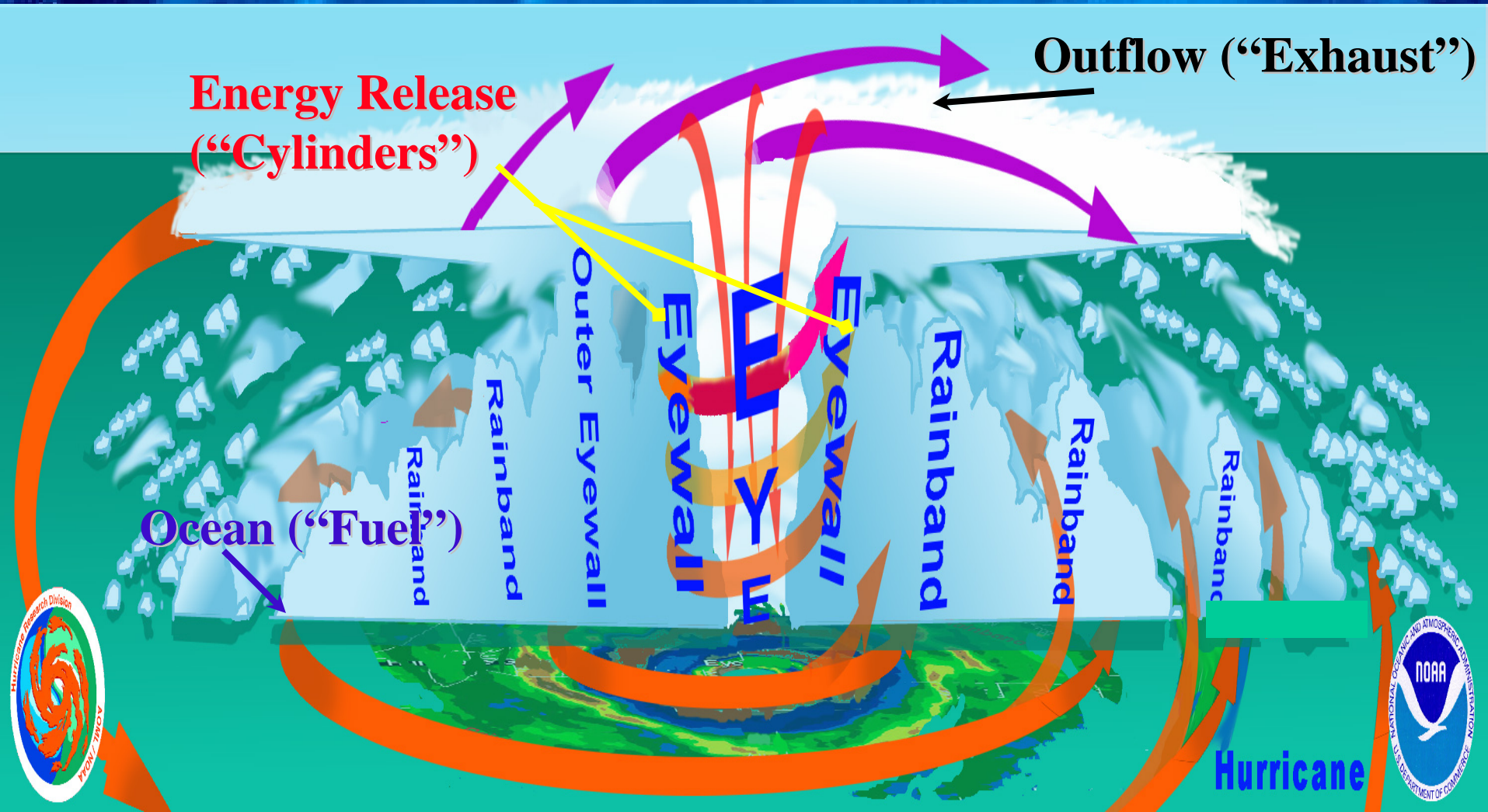
## COASTAL COUNTIES POPULATION





# Nature's great heat engine...

## The Hurricane





# Wind-caused Damage



# Storm Surge



# Inland Flooding



Buffalo Bayou, Downtown Tunnel Flooded, 6/9/01



# Tornados





# *Tropical Cyclone Definitions*

*Tropical Depression* < 39 MPH

*Tropical Storm* 40-73 MPH

*Hurricane* 74 MPH or higher



# *Saffir-Simpson Hurricane Scale*

CATEGORY	WIND SPEED (MPH)	TYPICAL DAMAGE
1	74-95	MINIMAL
2	96-110	MODERATE
3	111-130	EXTENSIVE
4	131-155	EXTREME
5	> 155	CATASTROPHIC

# **THE TROPICAL PREDICTION CENTER/ NATIONAL HURRICANE CENTER:**

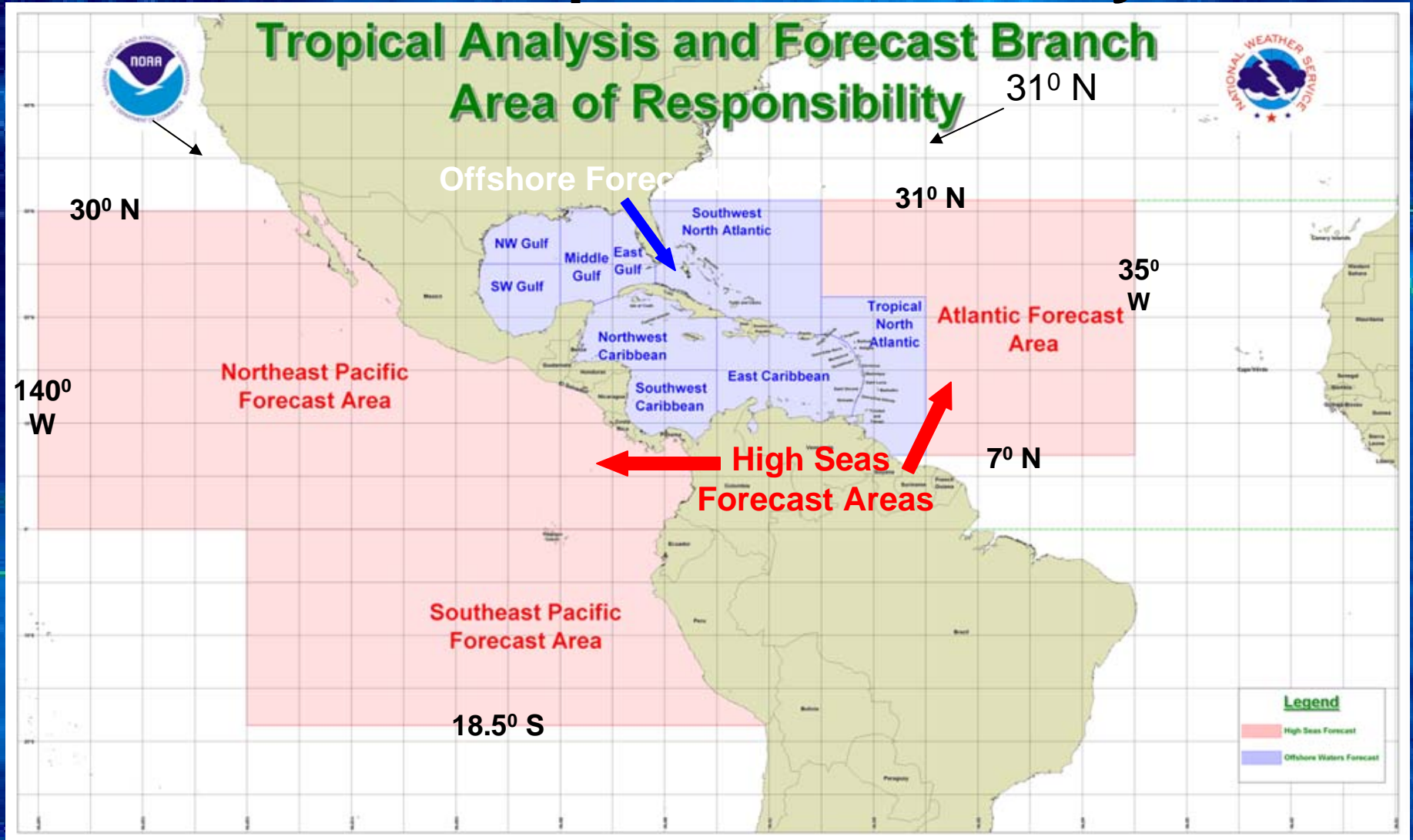
- IS THE REGIONAL SPECIALIZED METEOROLOGICAL CENTER (RSMC) FOR THE WMO RA-IV HURRICANE COMMITTEE**
- HAS OVERALL U.S. NATIONAL WEATHER SERVICE RESPONSIBILITY FOR TROPICAL CYCLONE FORECASTS AND WARNINGS FOR THE ATLANTIC AND EASTERN PACIFIC OCEANS EAST OF 140° WEST LONGITUDE (HURRICANE SPECIALIST UNIT)**
- ISSUES MARINE FORECASTS AND GRAPHICAL PRODUCTS FOR PORTIONS OF THE ATLANTIC AND EASTERN PACIFIC (TAFB)**



# Tropical Analysis and Forecast Branch - Marine Predictions



# TAFB produces 57 graphic products & 48 text products each day.

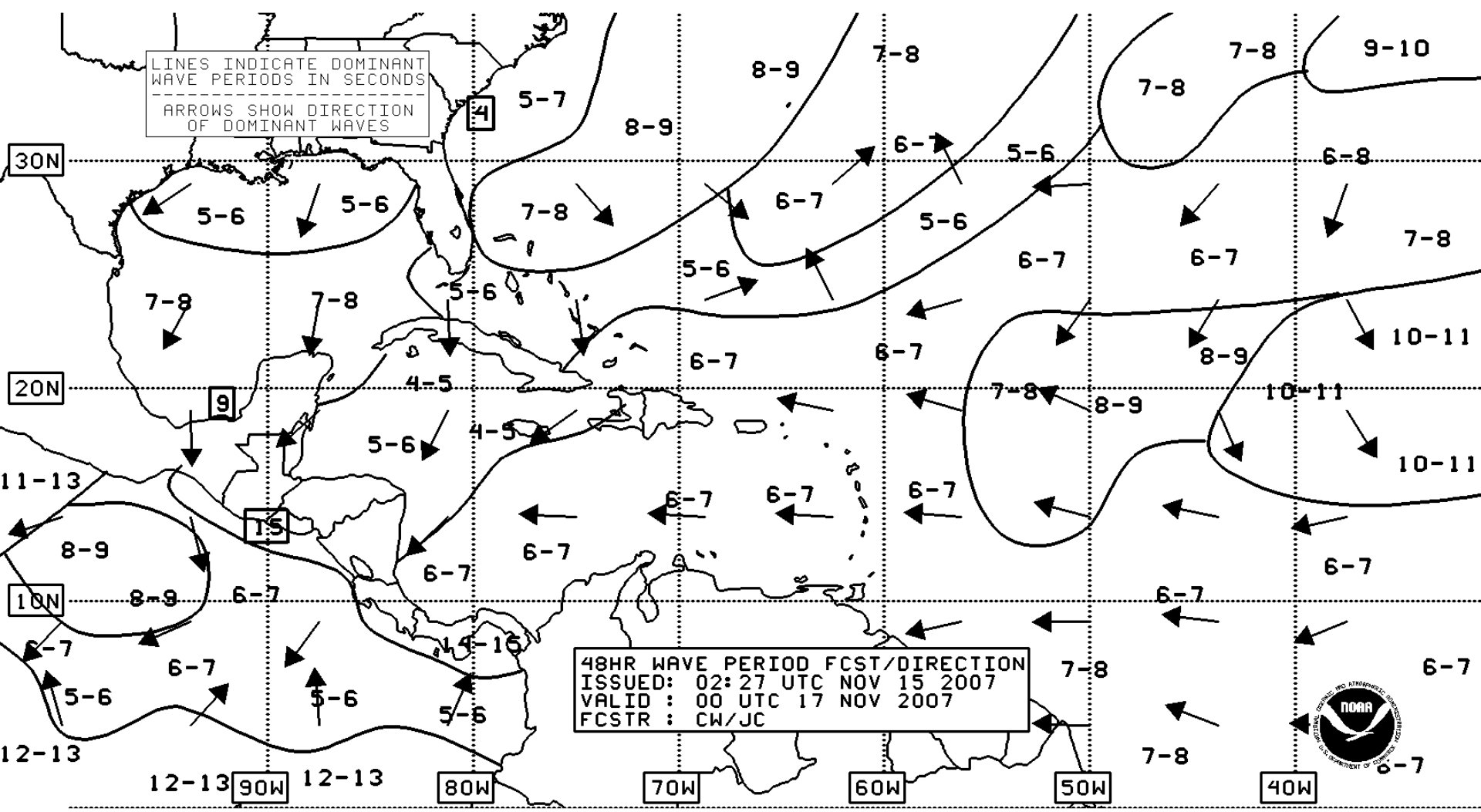


~ 14 million sq. nautical miles





# Wave Period & Direction Forecast

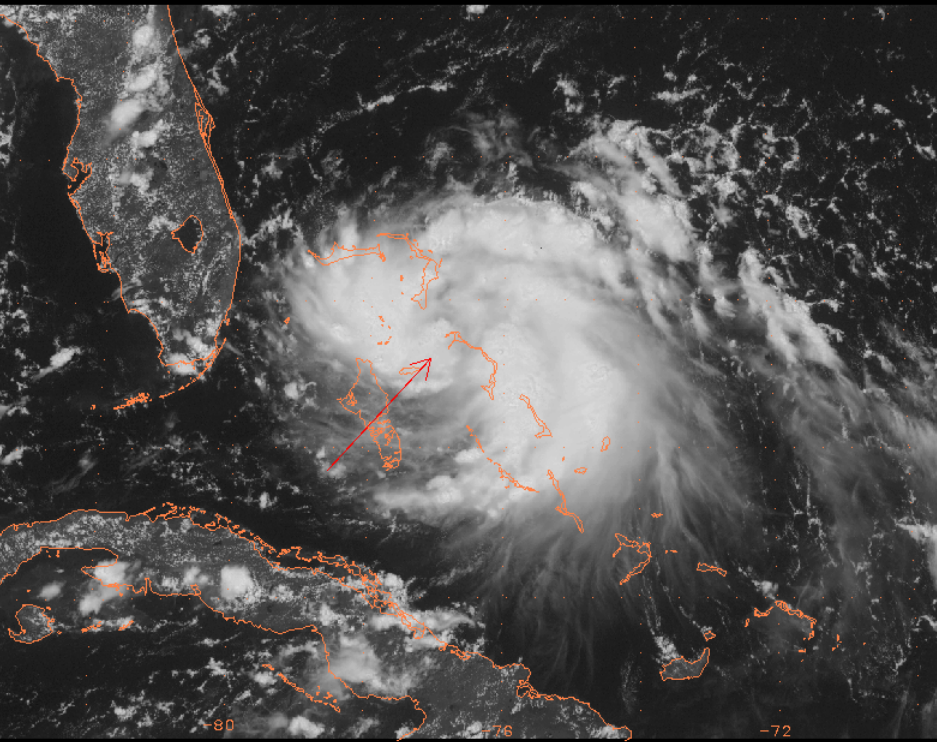




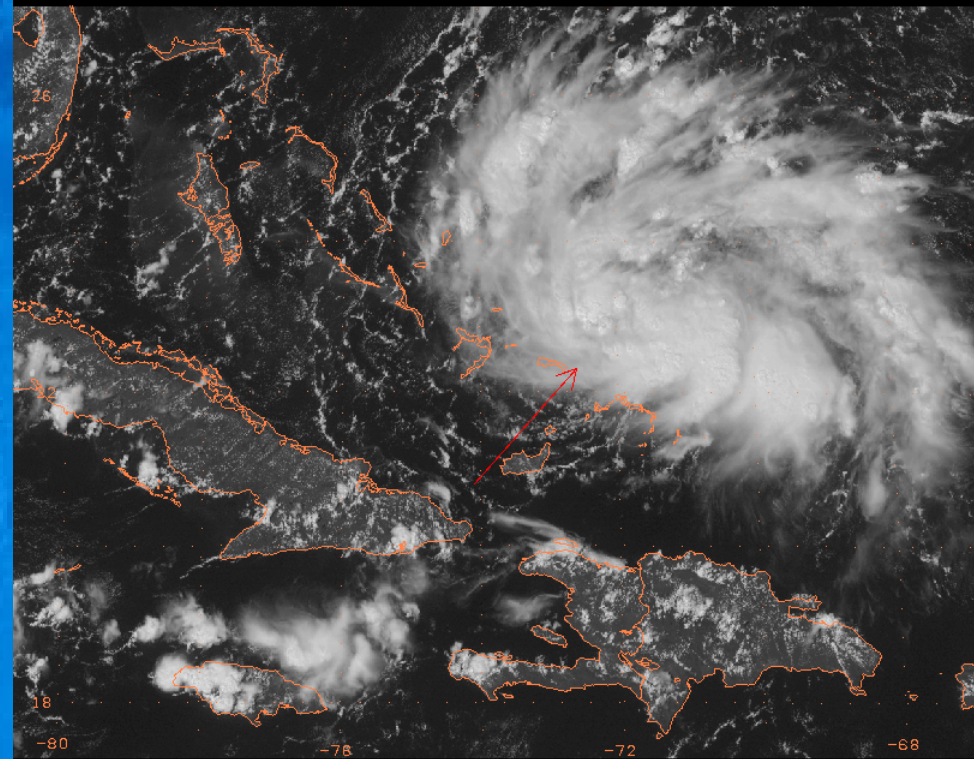
# TAFB Dvorak Classifications

Katrina August 24

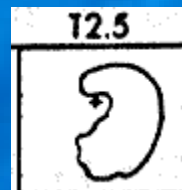
Rita September 18



GOES12 VIS 25.2 -77.1 20050824\_1745



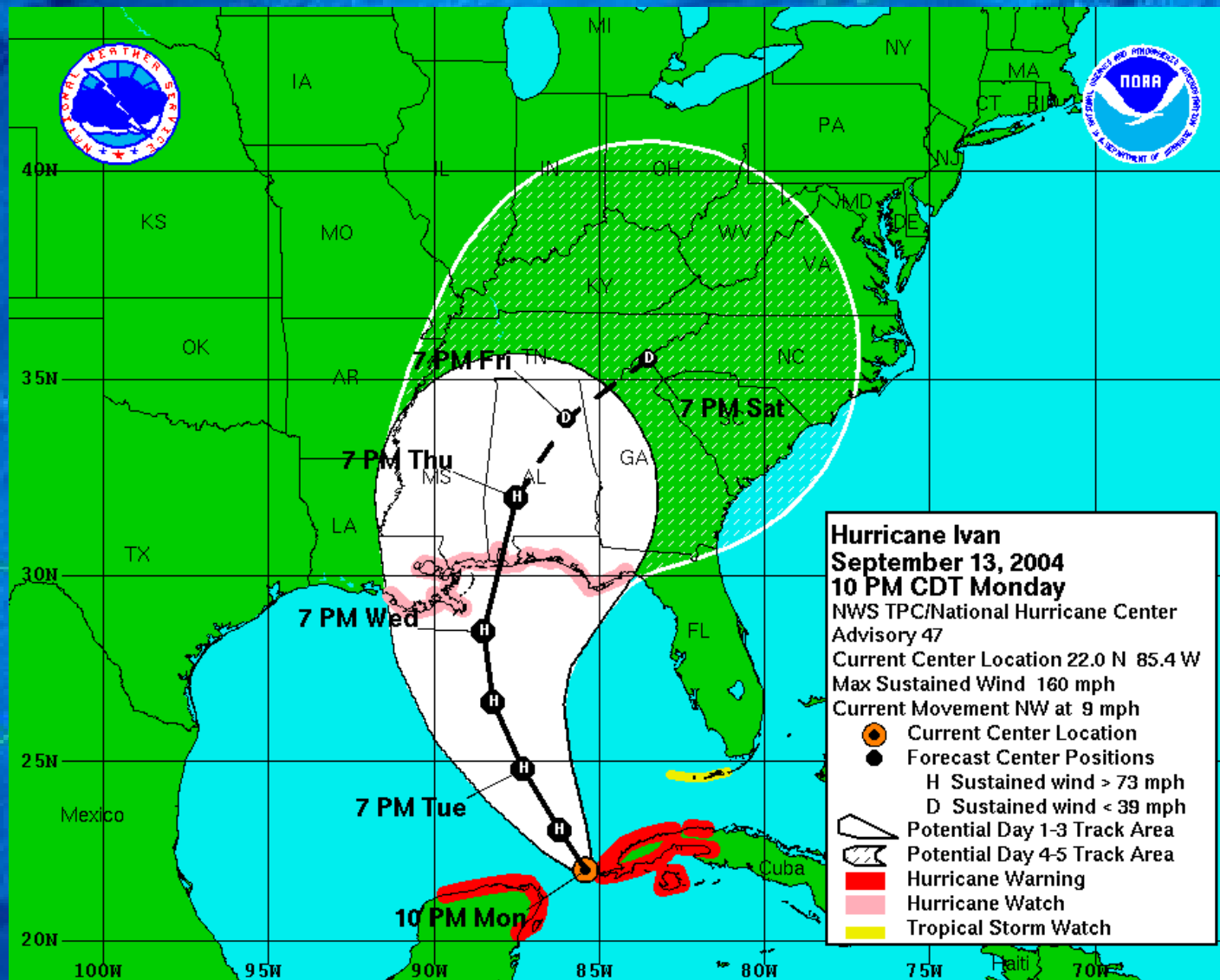
GOES12 VIS 22.3 -72.6 20050918\_1745



# Existing NHC Products Used to Convey Uncertainty

Watch/  
Warning  
Graphic

Indicates  
forecast track  
and long-term  
mean error





# Additional Content of NHC Products

- Coastal watches and warnings
- Current forward motion, central pressure, eye diameter (if applicable)
- Generalized storm surge forecast
- Generalized rainfall forecast
- Tornado potential
- General information on other hazards
- Forecaster reasoning
- Forecast uncertainties

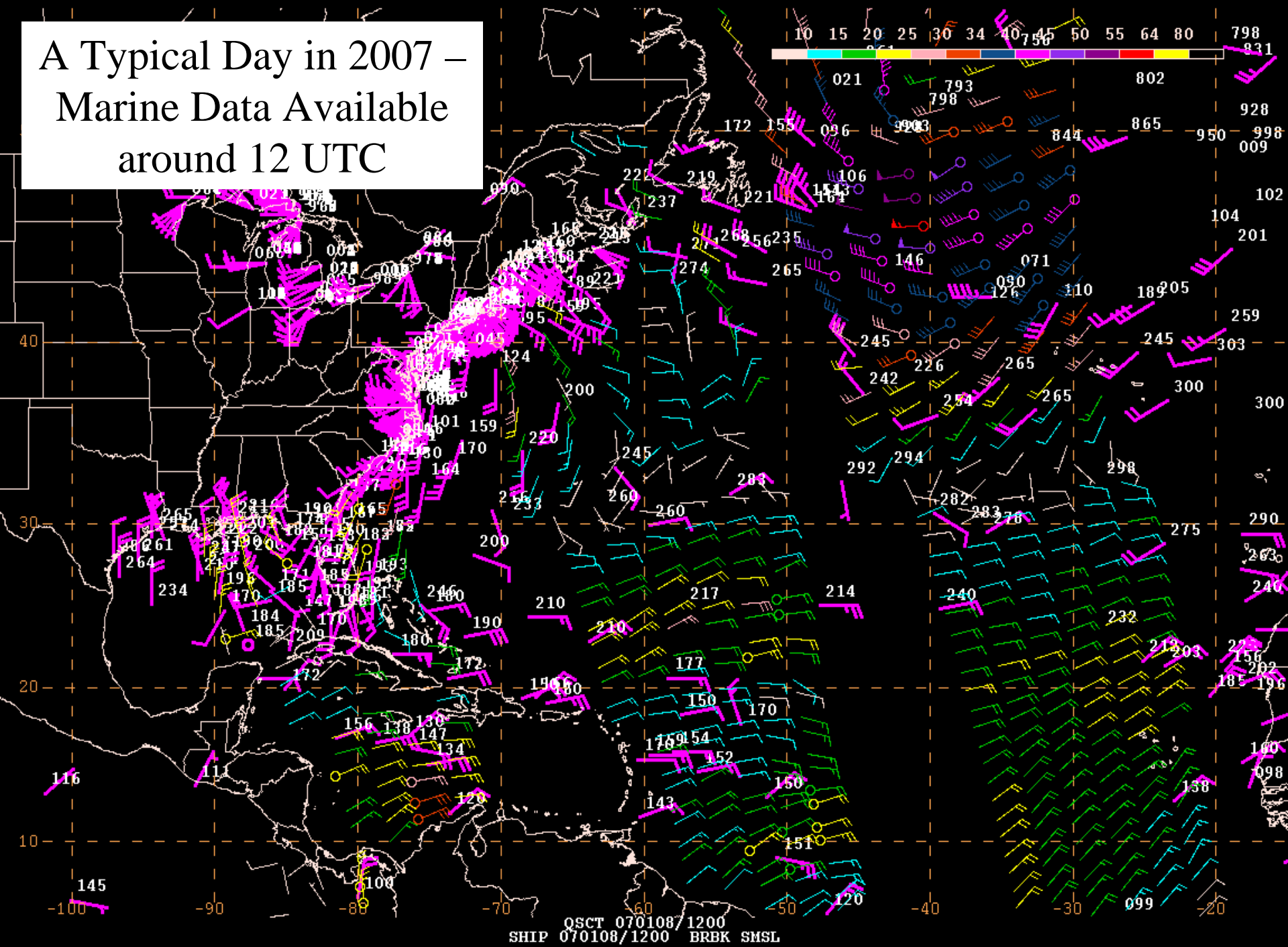
NHC provides the “big picture” that complements and guides local NWS forecast office products, and provides guidance for international partners

# NHC Does Not:

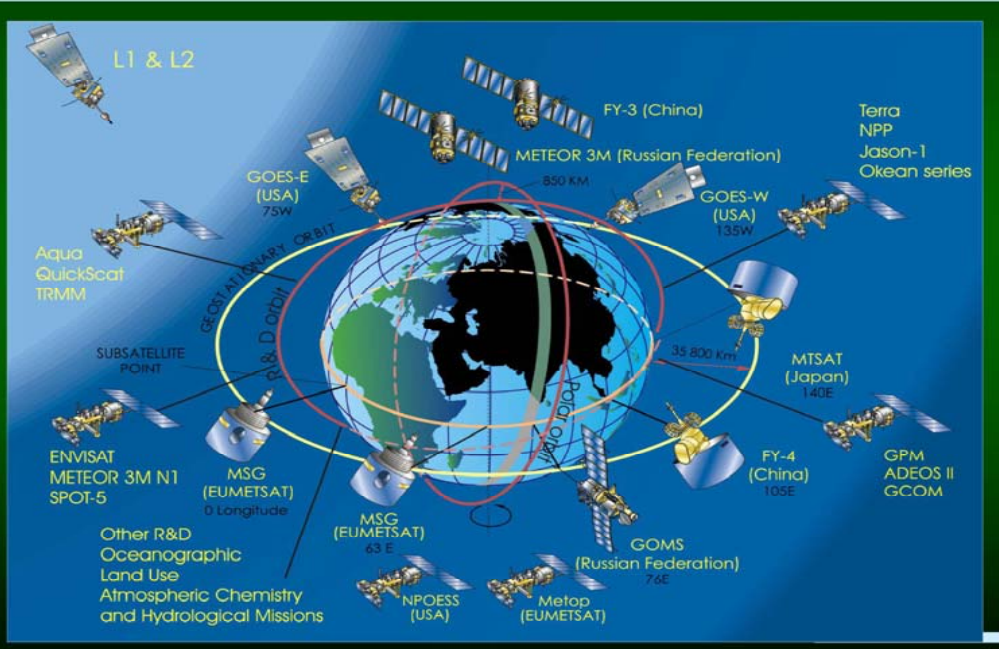
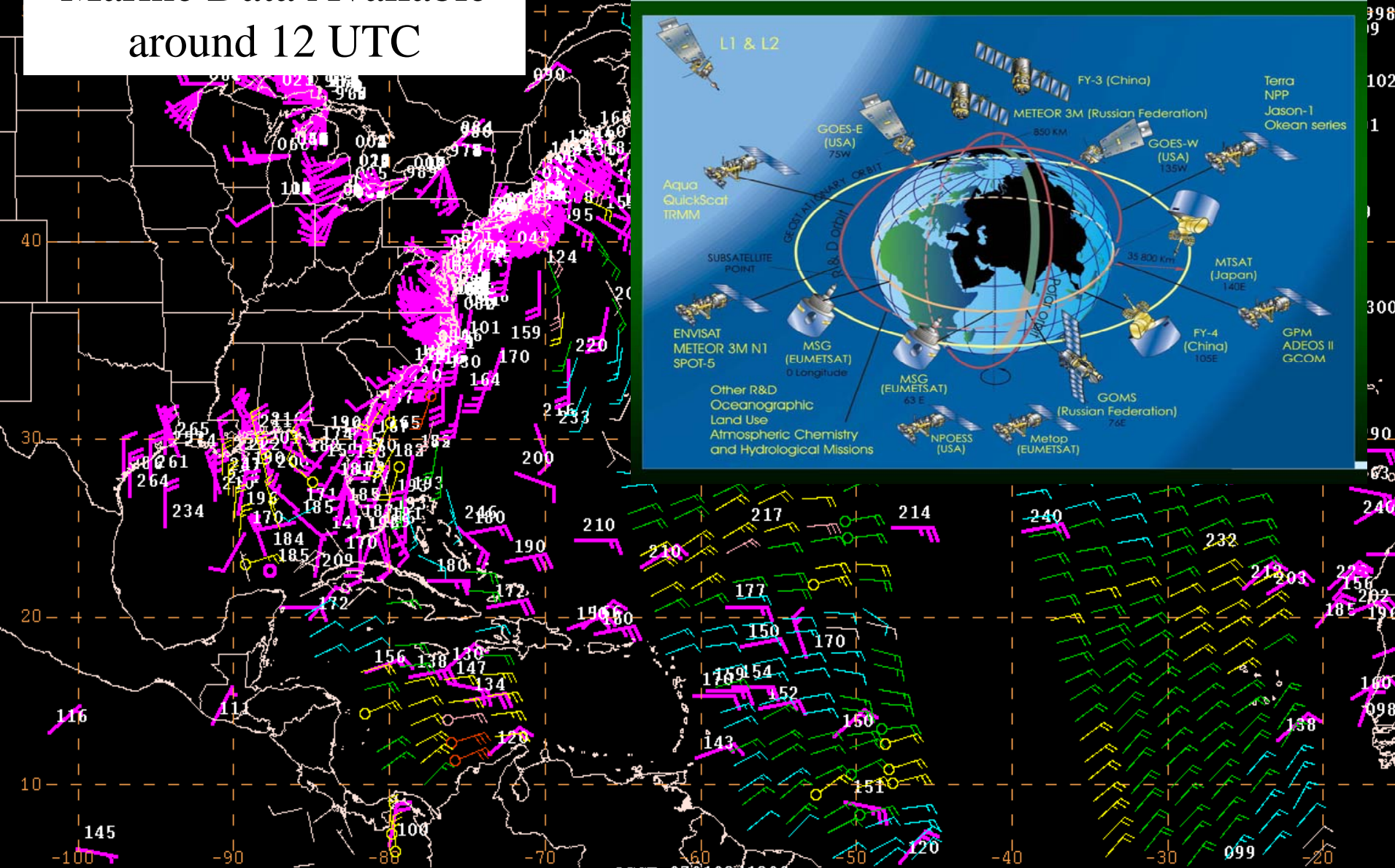
- Issue evacuation orders or make other emergency management decisions
- Have its own TV station for public broadcast
- Issue watches and warnings for other countries
- Make perfect forecasts



# A Typical Day in 2007 – Marine Data Available around 12 UTC



# A Typical Day in 2007 – Marine Data Available around 12 UTC



QSCY 070108/1200  
SHIP 070108/1200 BRBK SMSL





“Miss Piggy” Built  
in 1976 at  
Lockheed-Martin,  
Marietta, Georgia



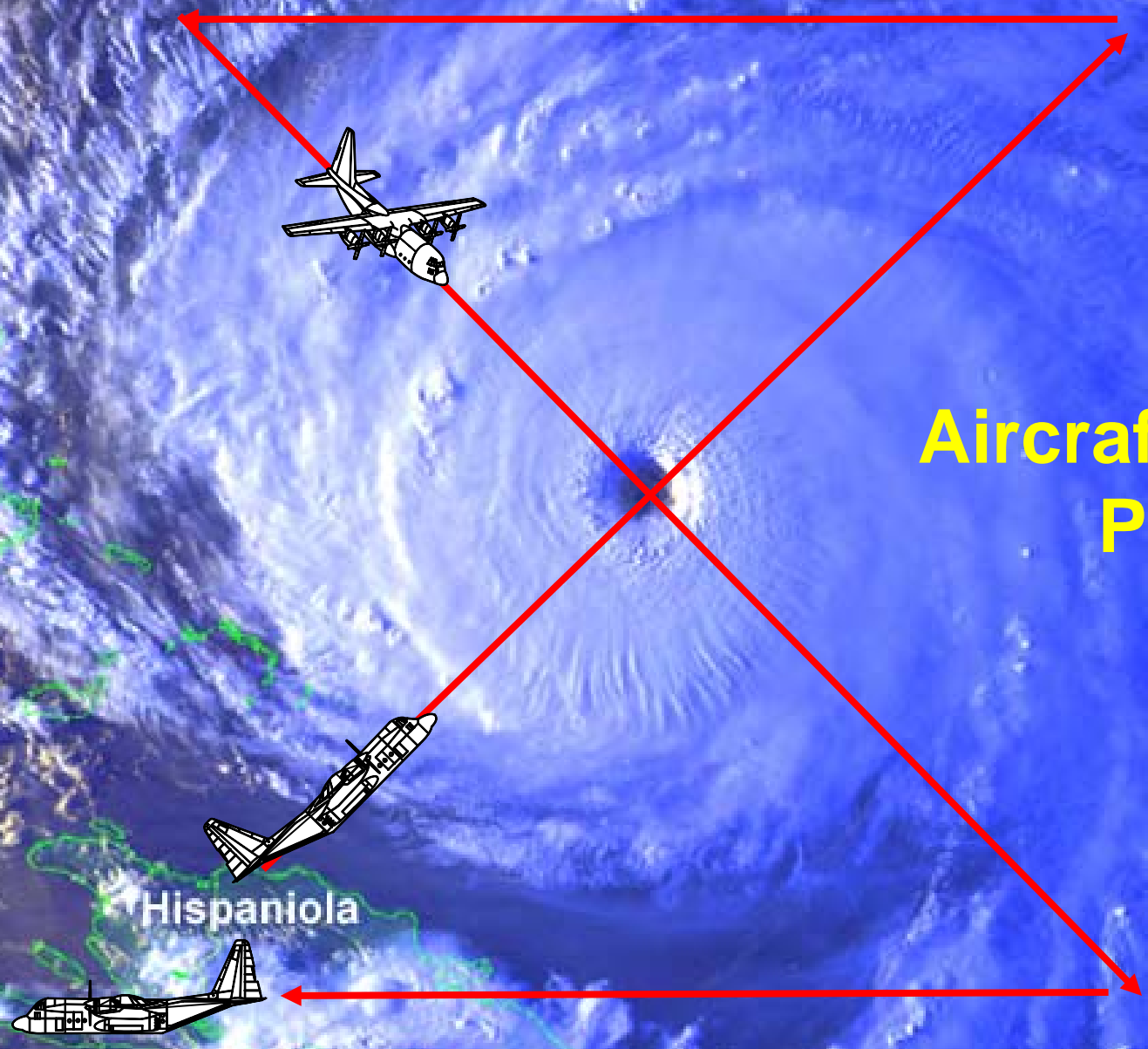
“Kermit” Built in 1975  
at Lockheed-Martin,  
Marietta, Georgia



“Gonzo”  
Built in 1994  
at  
Gulfstream  
Aerospace  
Corporation  
in Savannah  
Georgia

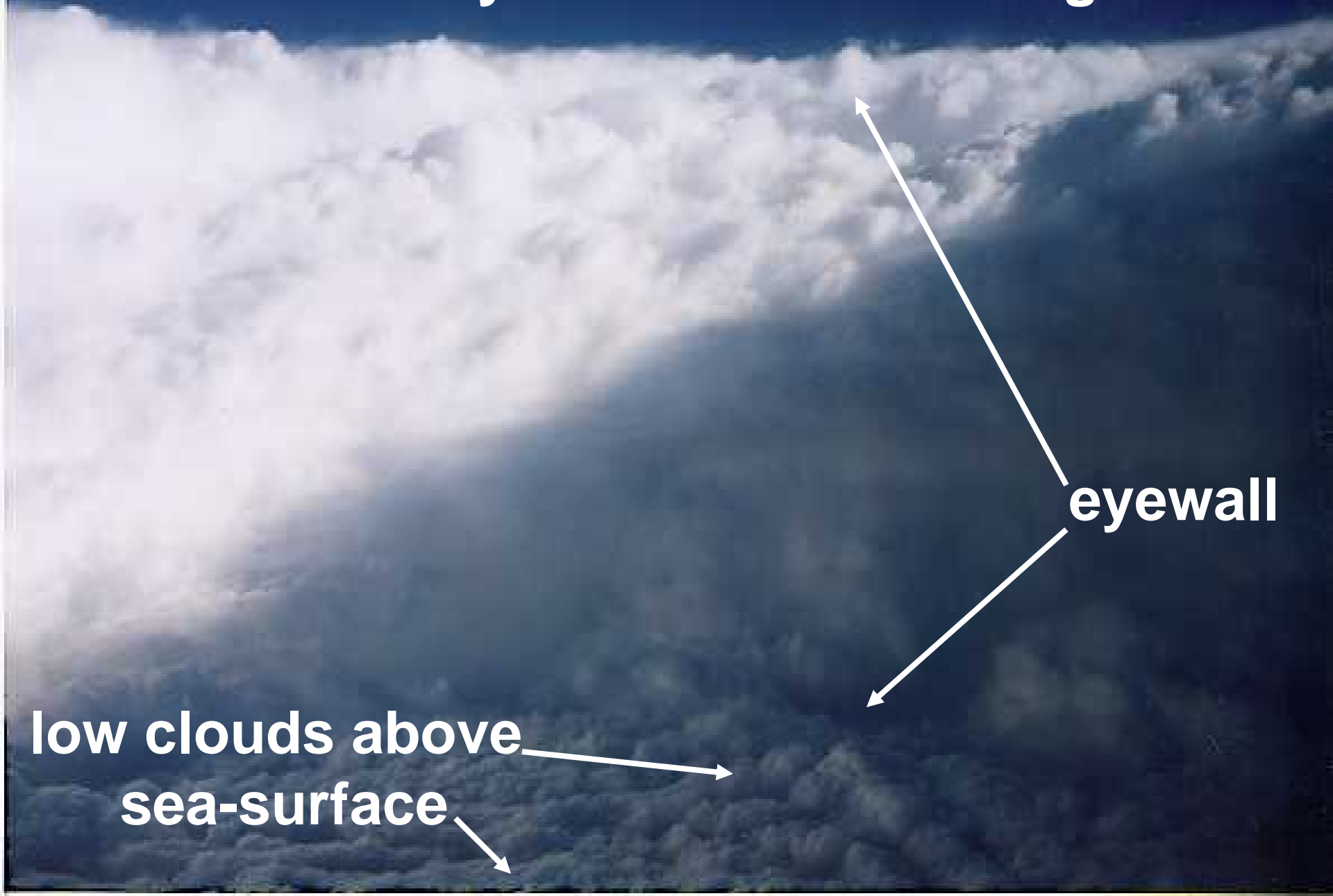
# RECONNAISSANCE FLIGHT PATH

Aircraft "ALPHA"  
Pattern





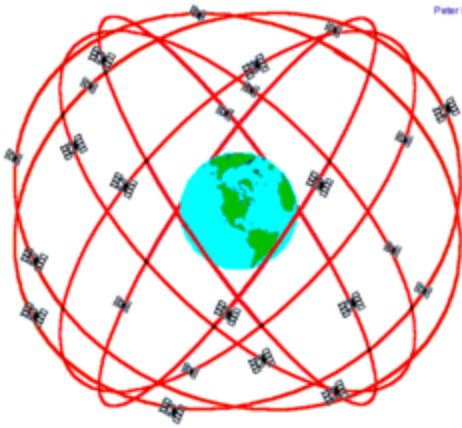
# Within the Eye of Hurricane Georges



**eyewall**

**low clouds above  
sea-surface**

# GPS DROPWINDSONDE

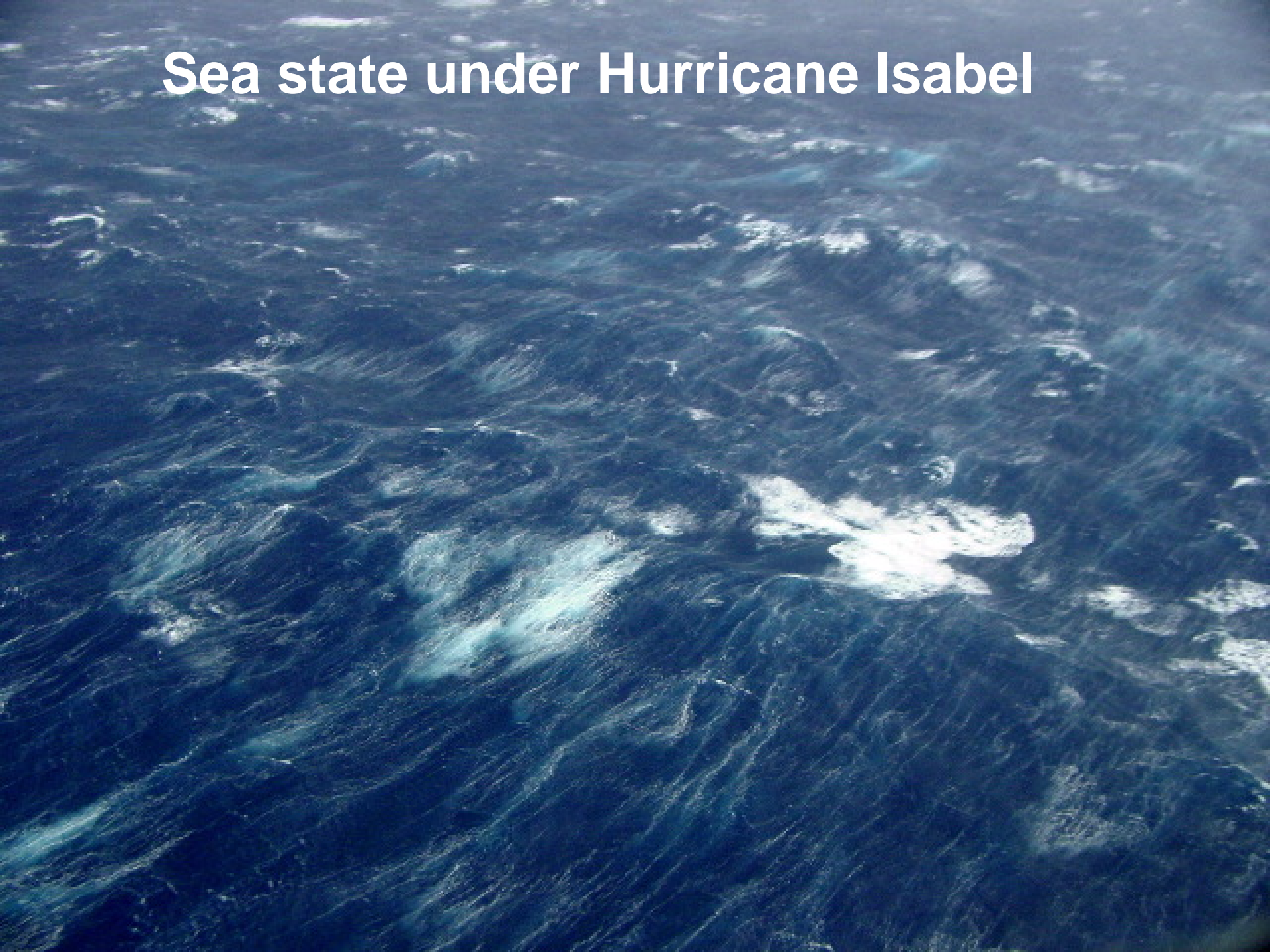


GPS Nominal Constellation  
24 Satellites in 6 Orbital Planes  
4 Satellites in each Plane  
20,200 km Altitudes, 55 Degree Inclination

- Developed in conjunction with the NOAA Gulfstream-IV jet aircraft. First use for hurricane was late in 1996 season.
- GPS dropsondes provide, for the first time, direct measurements of the winds at low levels in the hurricane eyewall.
- Dropsonde data reveal that the structure of the eyewall is very complex, and can vary tremendously from storm to storm.



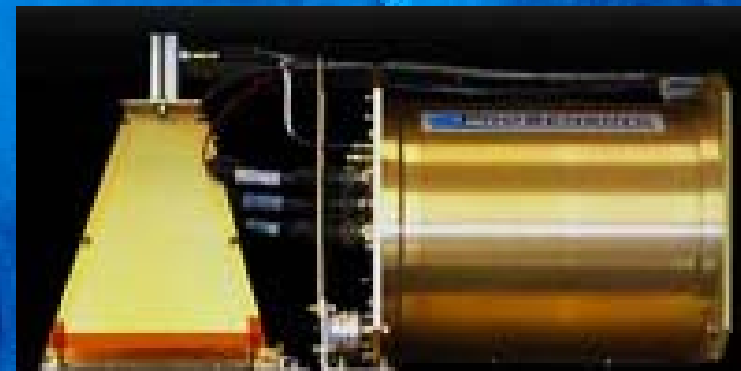
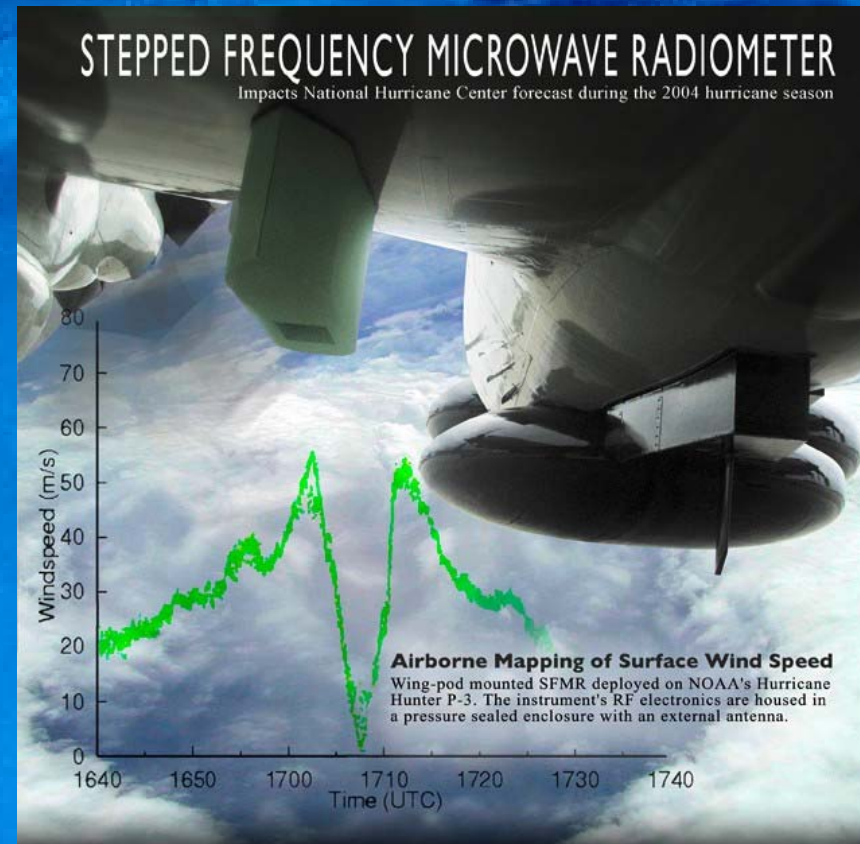
# Sea state under Hurricane Isabel



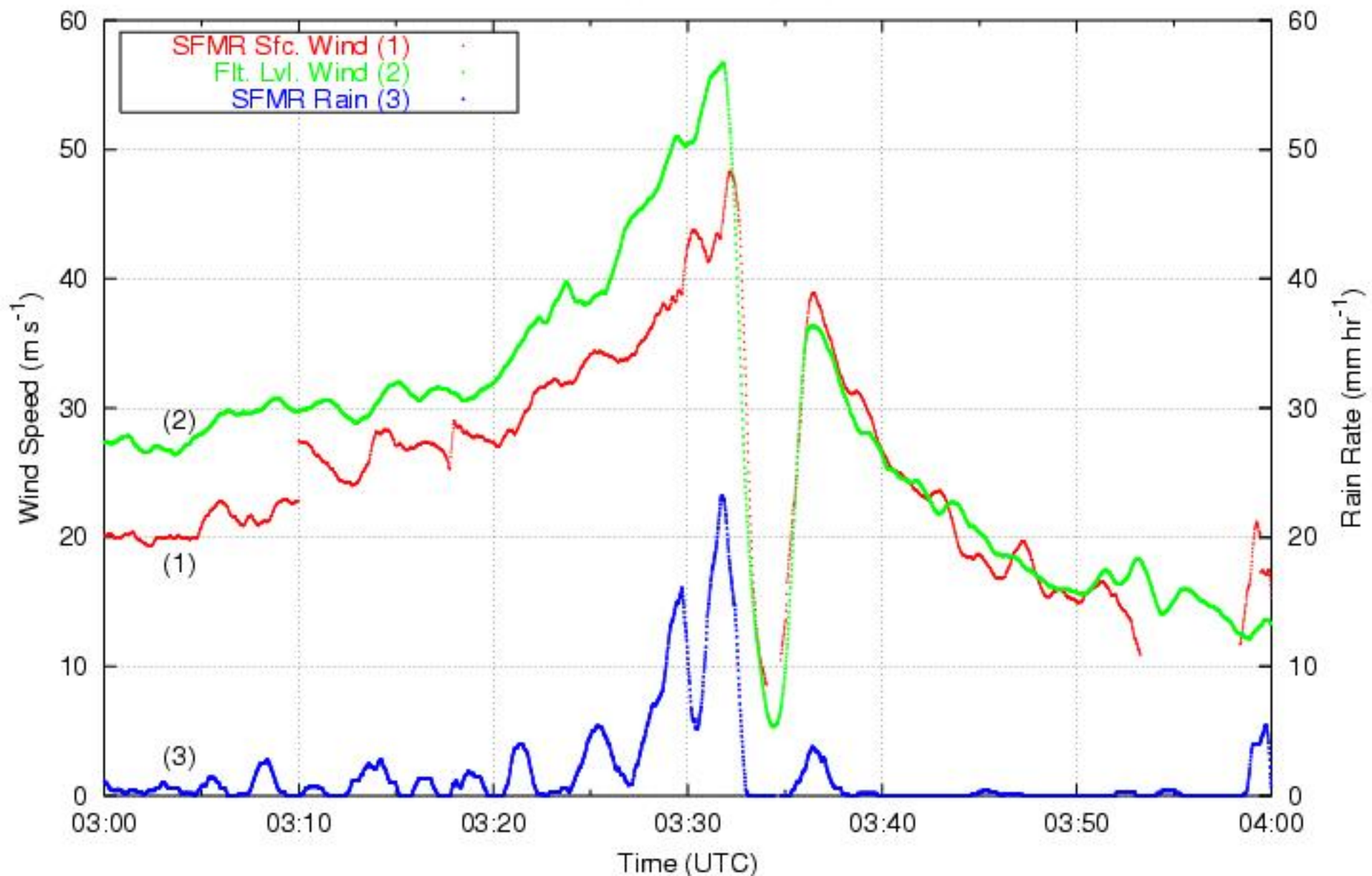


# Stepped-Frequency Microwave Radiometer

- Measures nadir brightness temperature at 6 C-band frequencies.
- Geophysical model function relates emissivity to wind speed. Emissivity depends on surface foam coverage and rain rate.
- Calibrated with GPS dropsonde data.
- First data from C-130s in 2007.

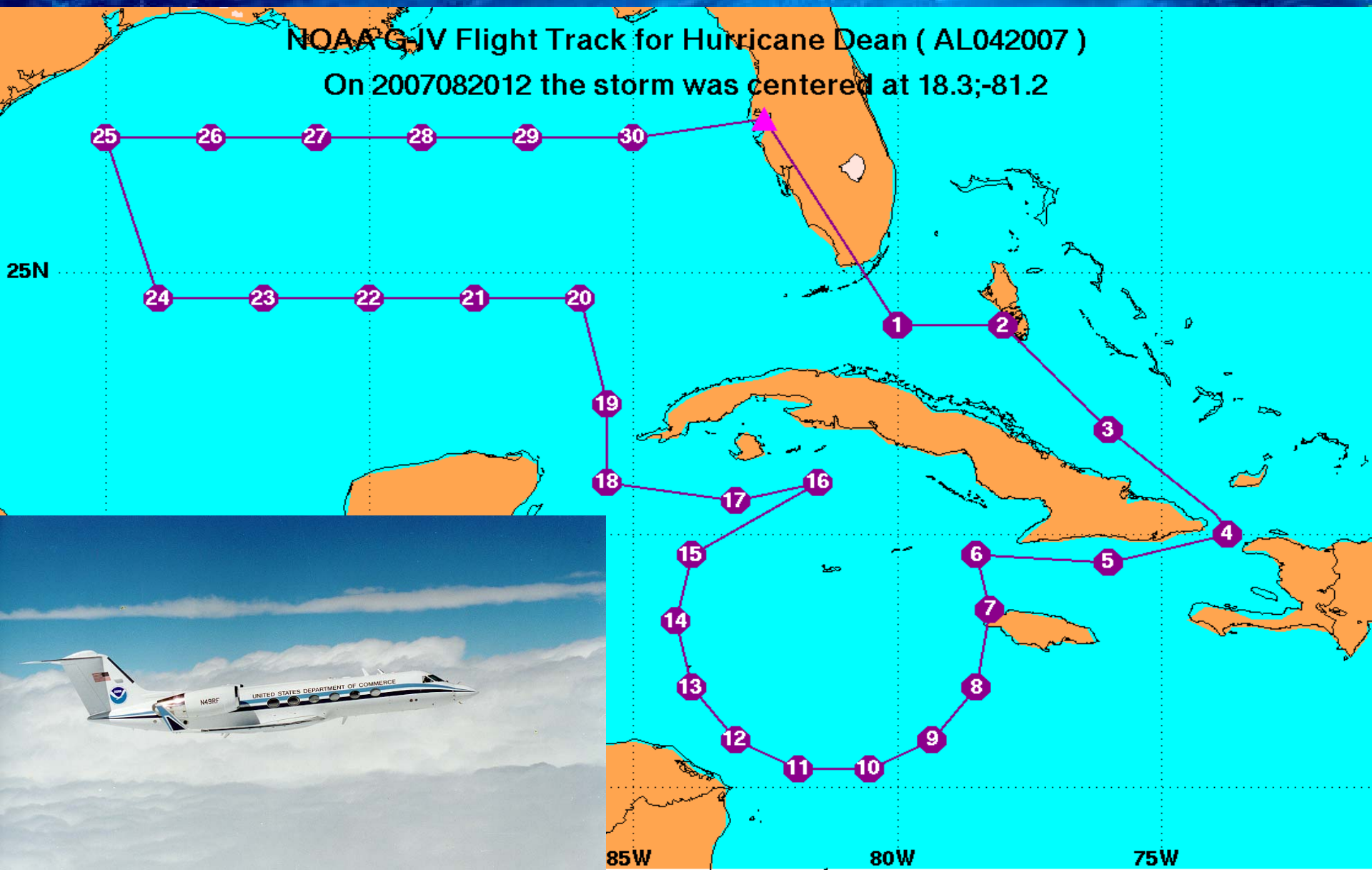


Hurricane Lili (2002/10/02)  
Cross-Track Winds and Rain



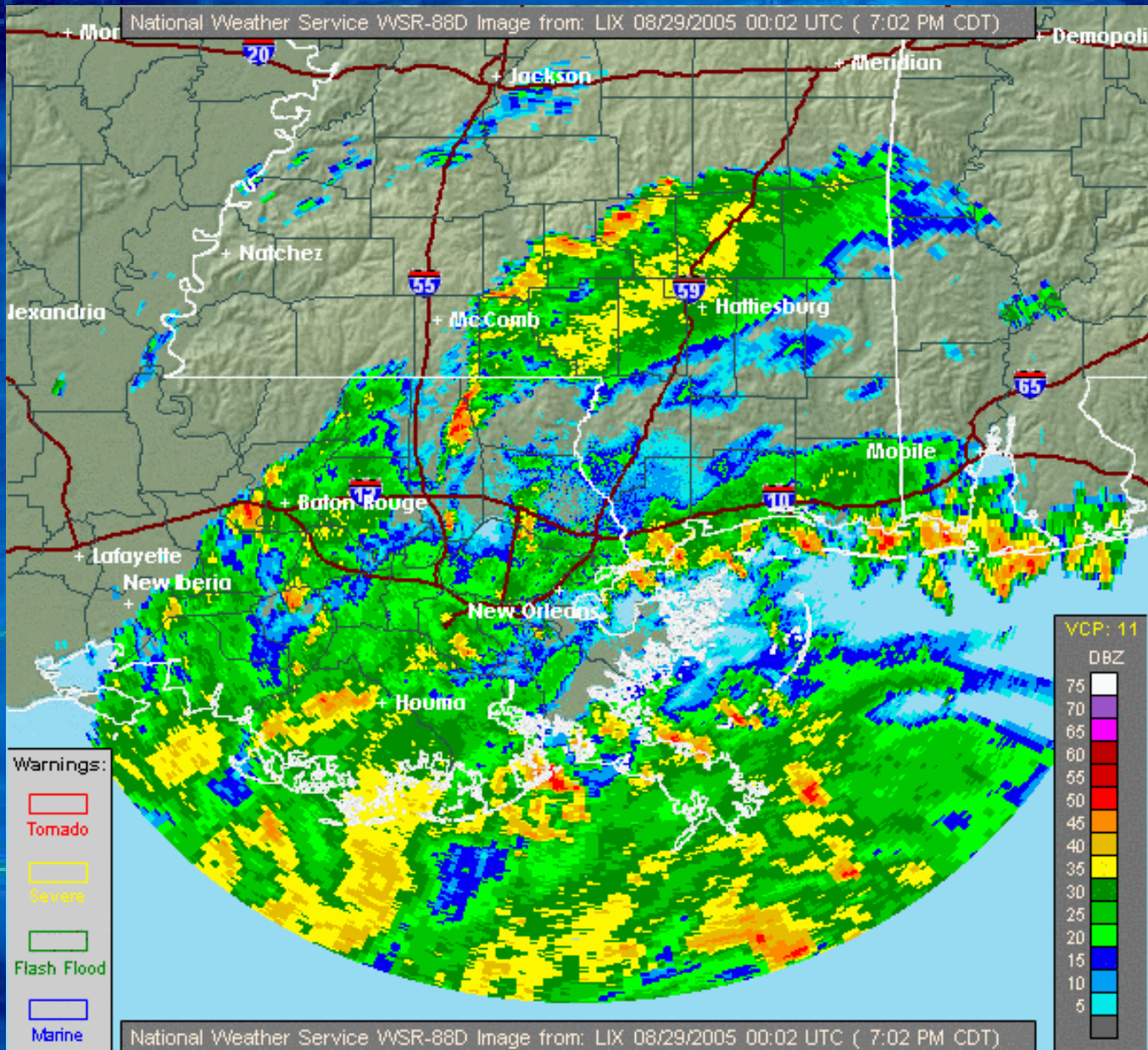
# NOAA Gulfstream IV Synoptic Surveillance

NOAA G-IV Flight Track for Hurricane Dean ( AL042007 )  
On 2007082012 the storm was centered at 18.3;-81.2

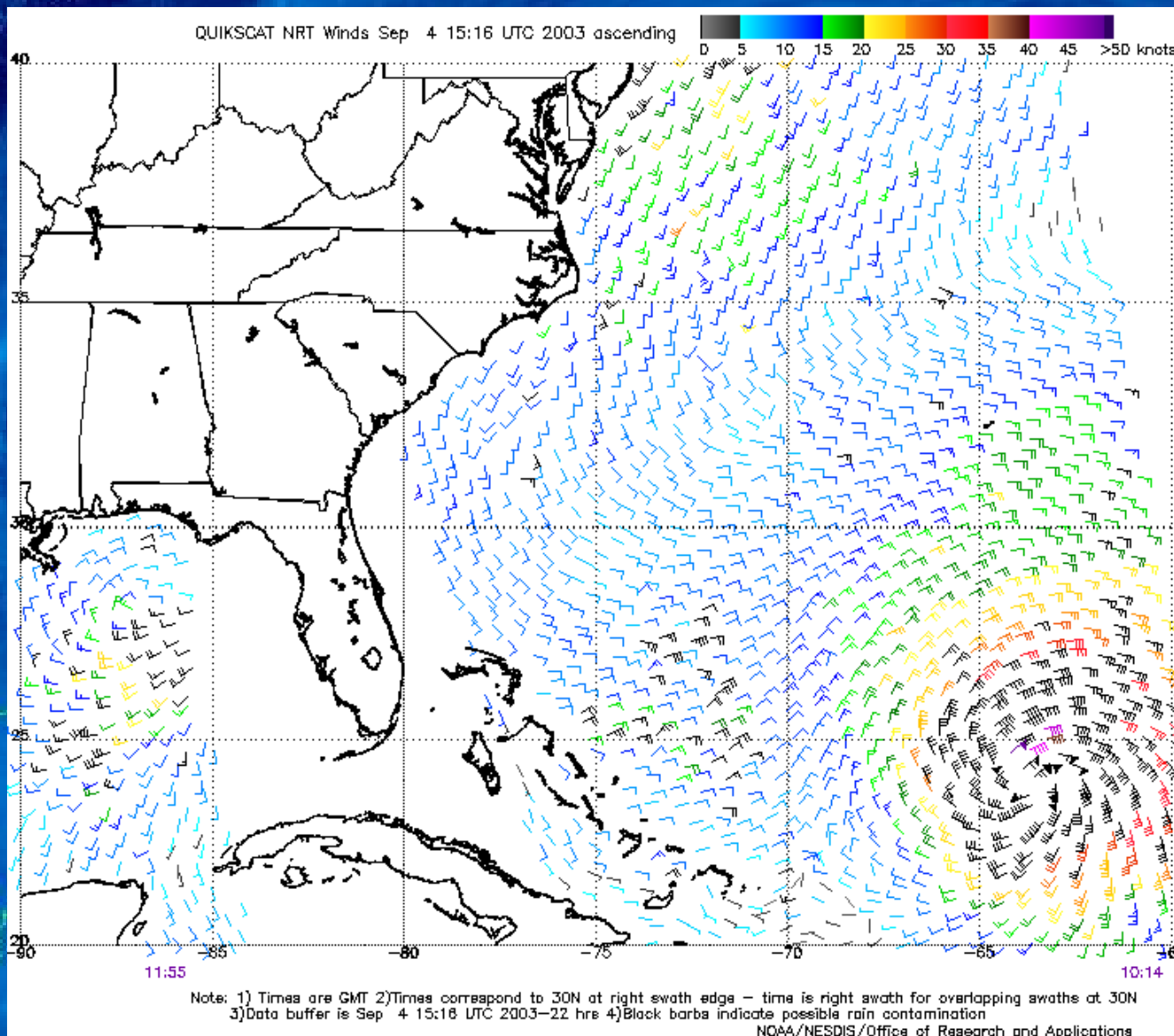




# Hurricane Katrina at Landfall



# Example QuikSCAT Swath

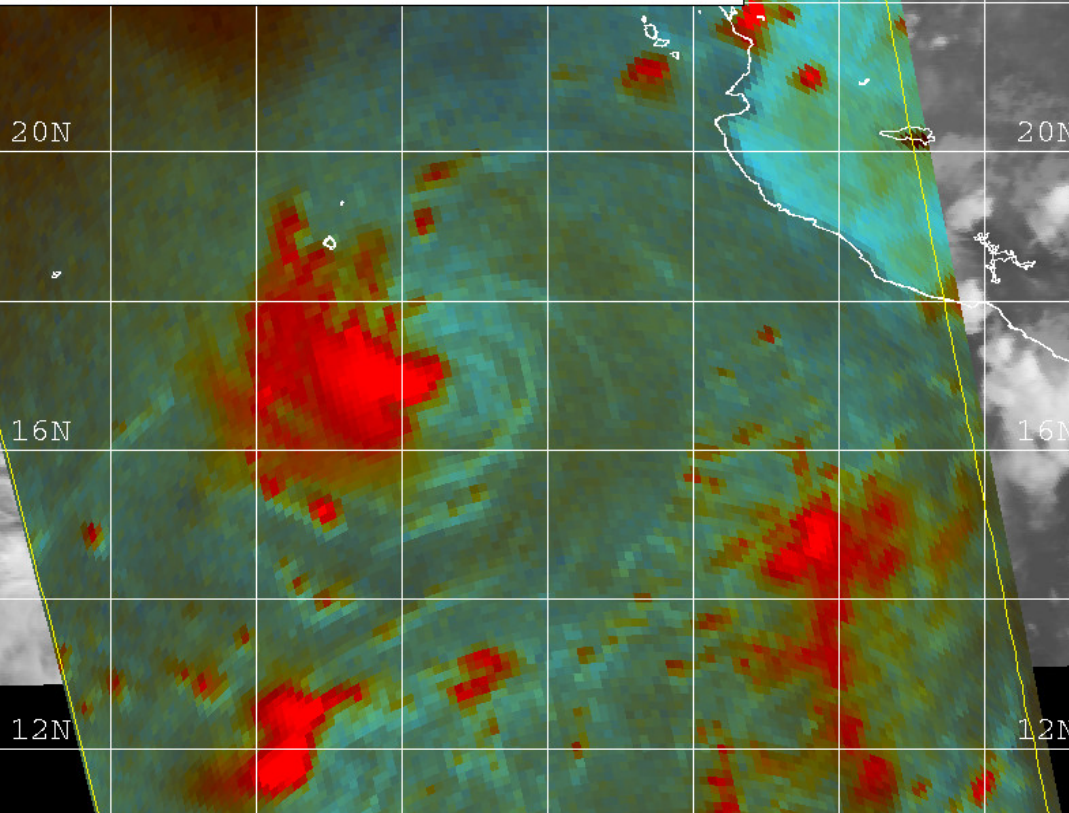


**Hurricane Fabian (2003)**



# 0430 UTC 27 August GOES-10 IR

08/27/04 0000Z 10E GEORGETTE  
08/27/04 0411Z SSMI F-15 COMPOSITE  
08/27/04 0245Z GOES-10 IR



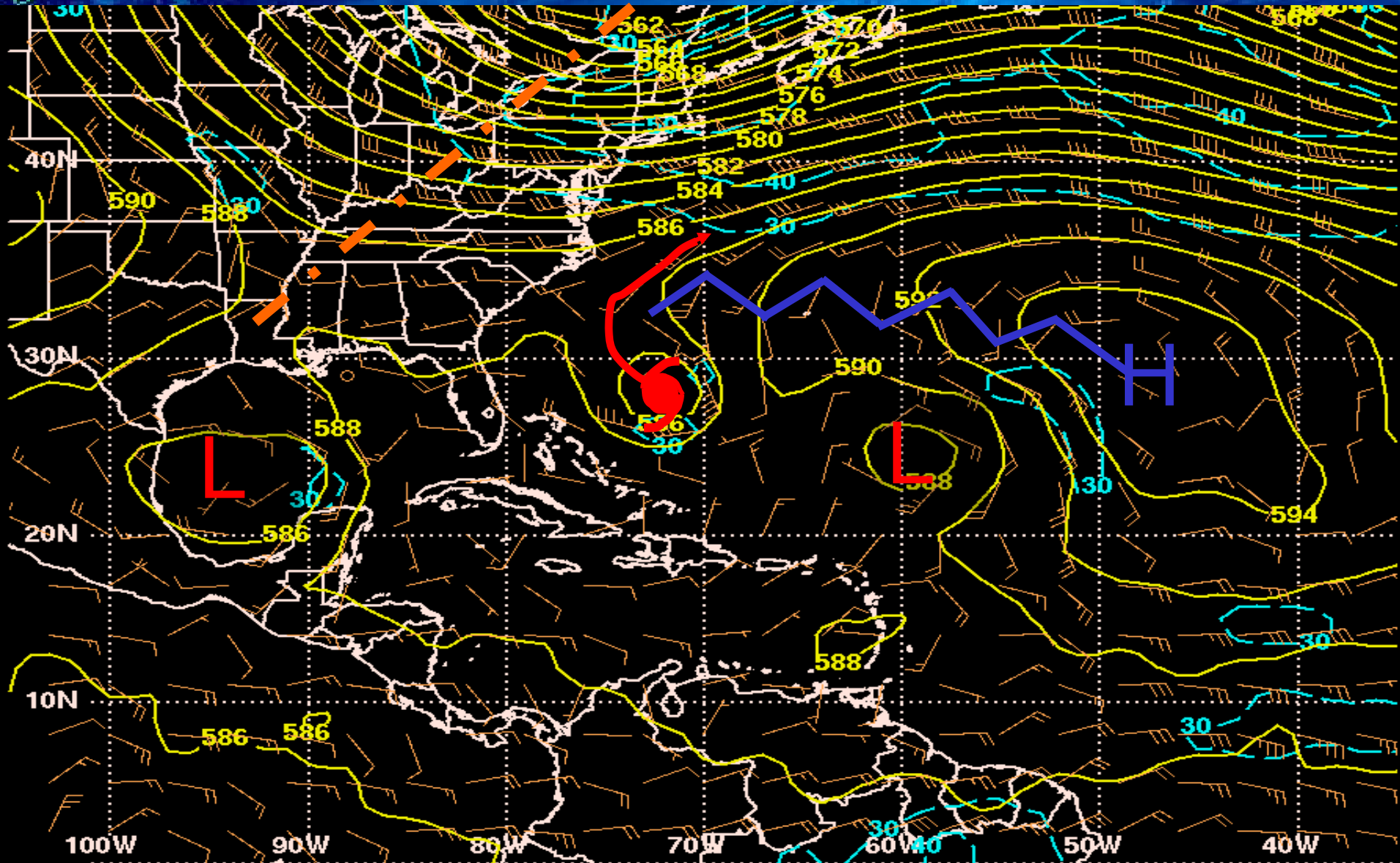
**0600 UTC Classification**  
**“Really an embedded center but**  
**constrained to not use it”**  
 **$3.5/3.5 = 55$  kt**

acts.html



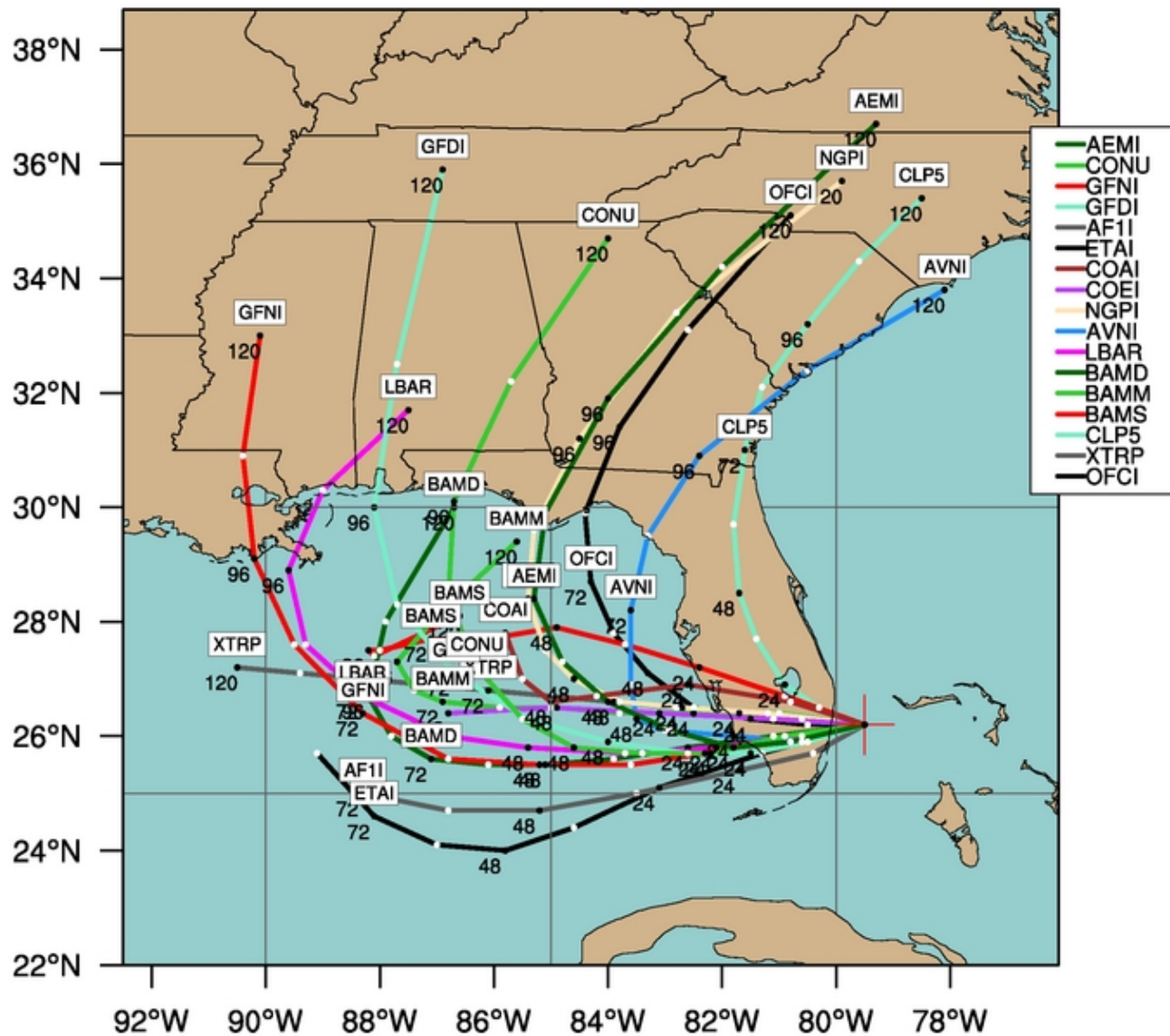


# The Large-scale Steering Flow is the Main Contributor to Hurricane Motion



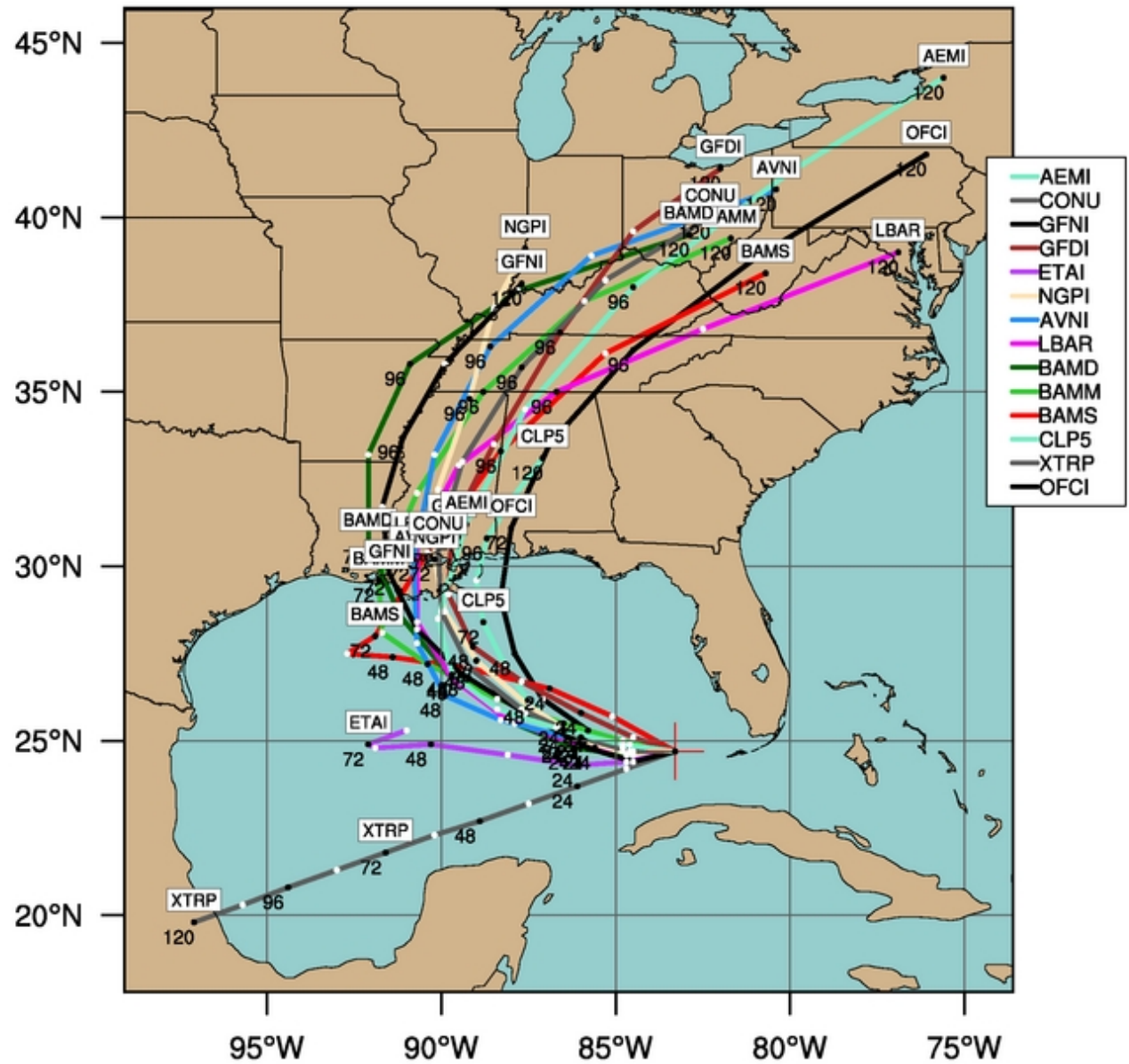
AVN 980831/1200V036 500 MB HEIGHTS, ISOTACHS & WINDS (KTS)

# NHC Track Guidance 18Z 25AUG05



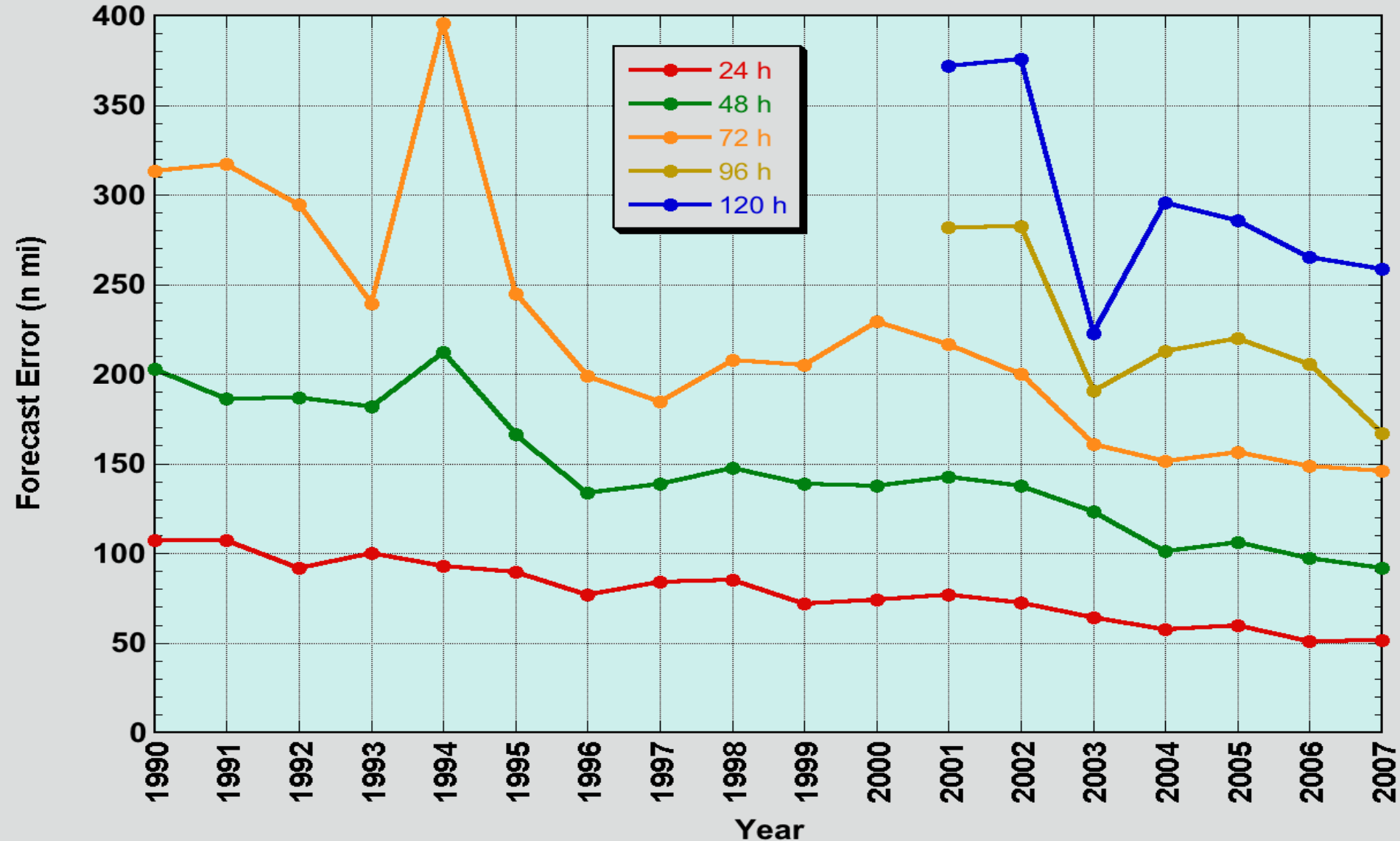


# NHC Track Guidance 00Z 27AUG05

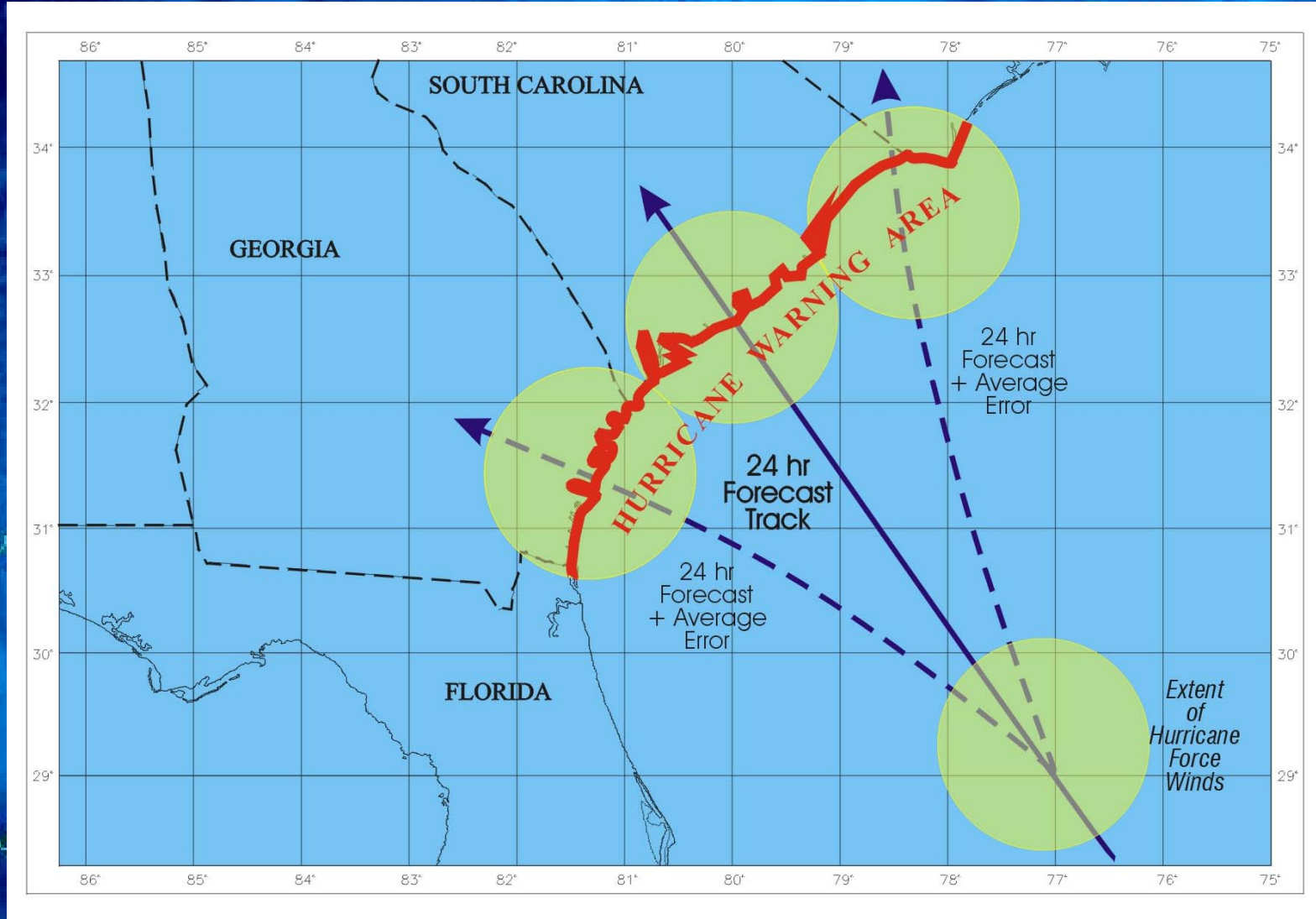


# Track forecast errors cut in half in 15 years

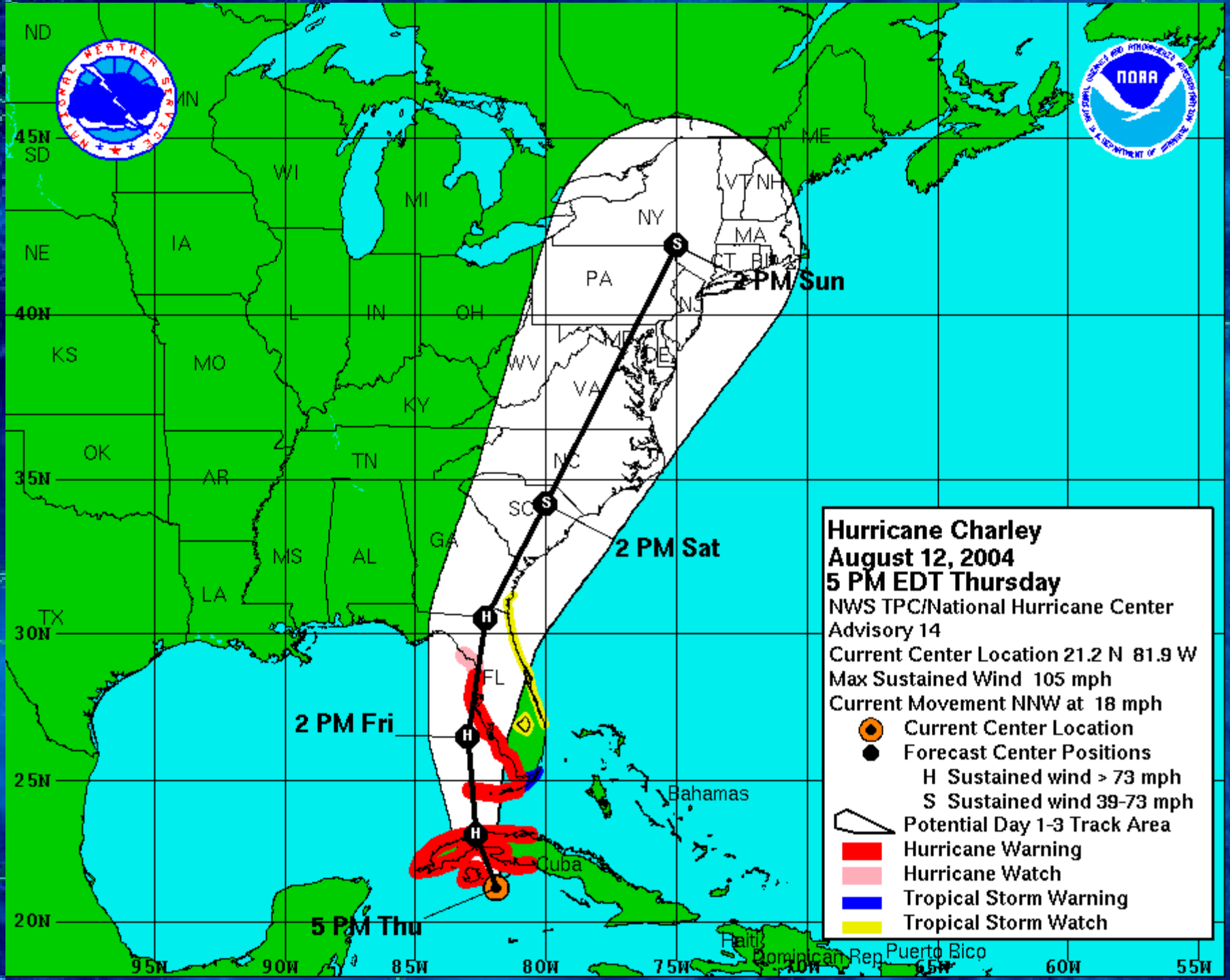
NHC Official Track Error Trend  
Atlantic Basin



# Over-warning a necessity due to forecast uncertainties





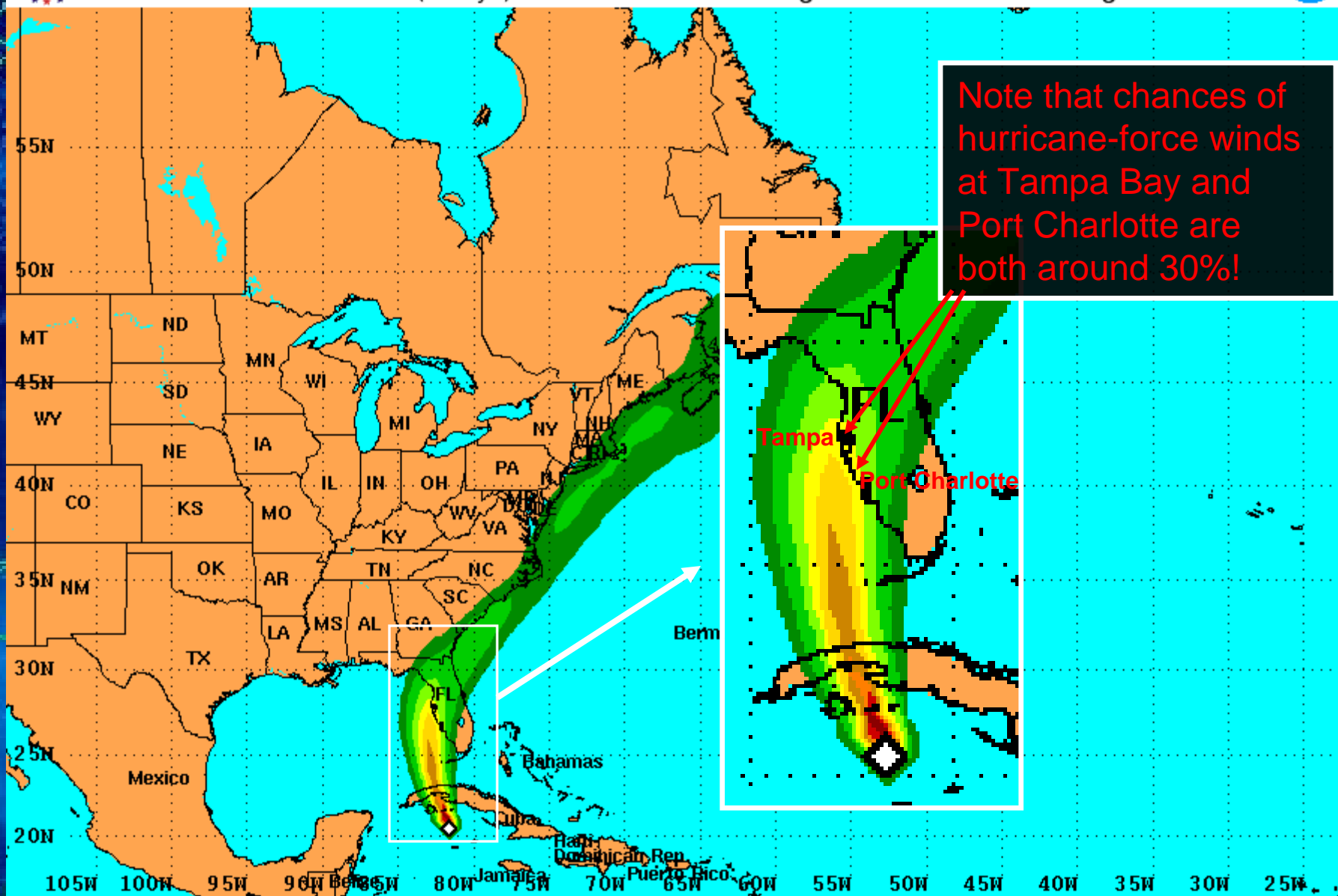


**Hurricane Charley**  
**August 12, 2004**  
**5 PM EDT Thursday**  
NWS TPC/National Hurricane Center  
Advisory 14  
Current Center Location 21.2 N 81.9 W  
Max Sustained Wind 105 mph  
Current Movement NNW at 18 mph

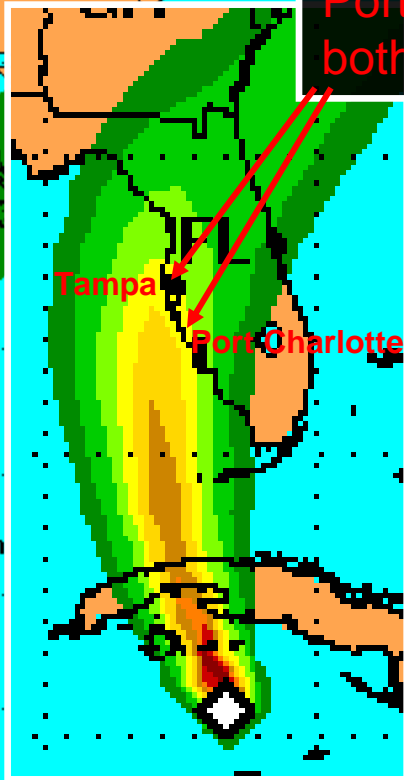
- Current Center Location
- Forecast Center Positions
- H Sustained wind > 73 mph
- S Sustained wind 39-73 mph
- ▭ Potential Day 1-3 Track Area
- Hurricane Warning
- Hurricane Watch
- Tropical Storm Warning
- Tropical Storm Watch



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%!

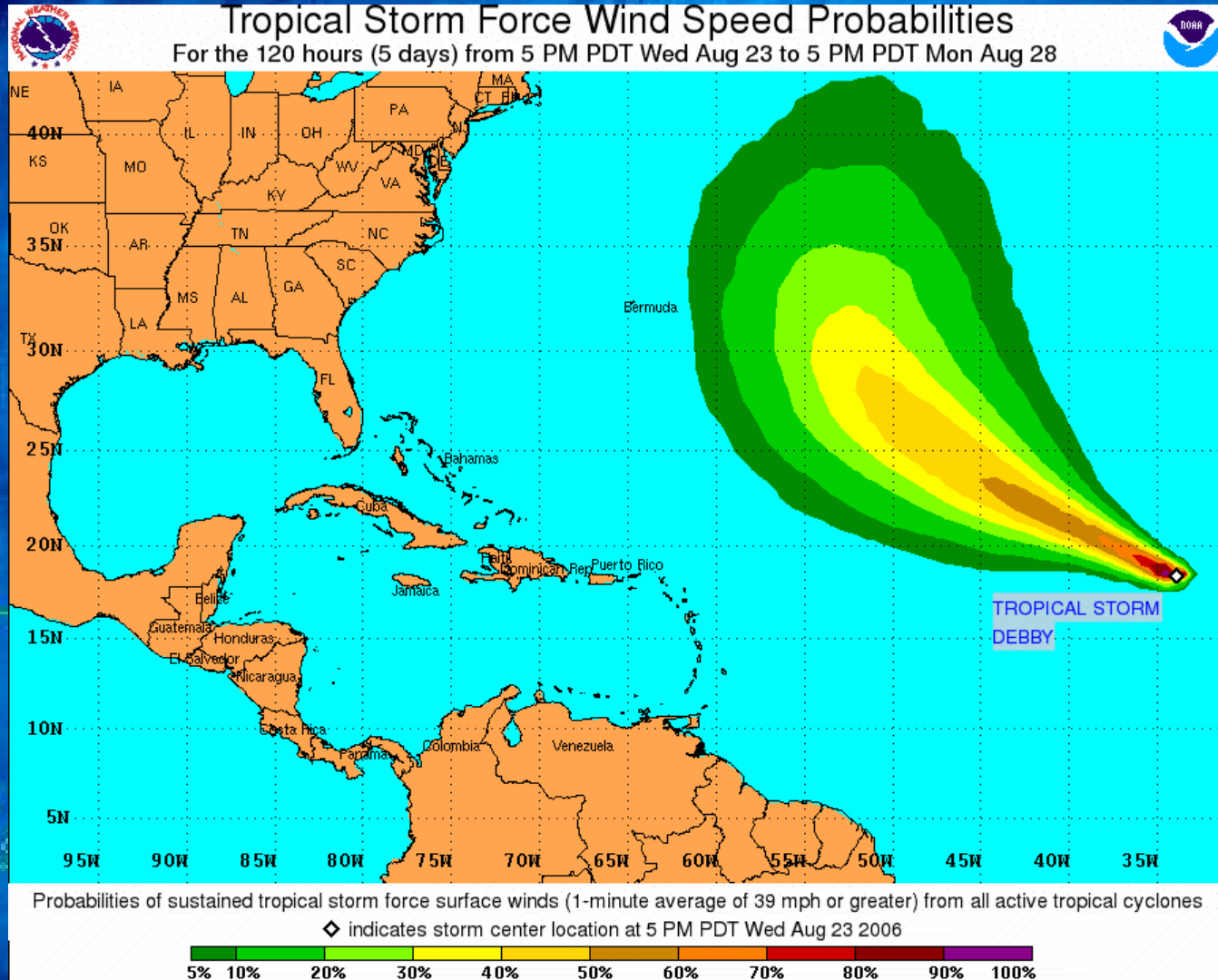


Probabilities of sustained hurricane force surface winds (1-minute average of 74 mph or greater) from all active tropical cyclones

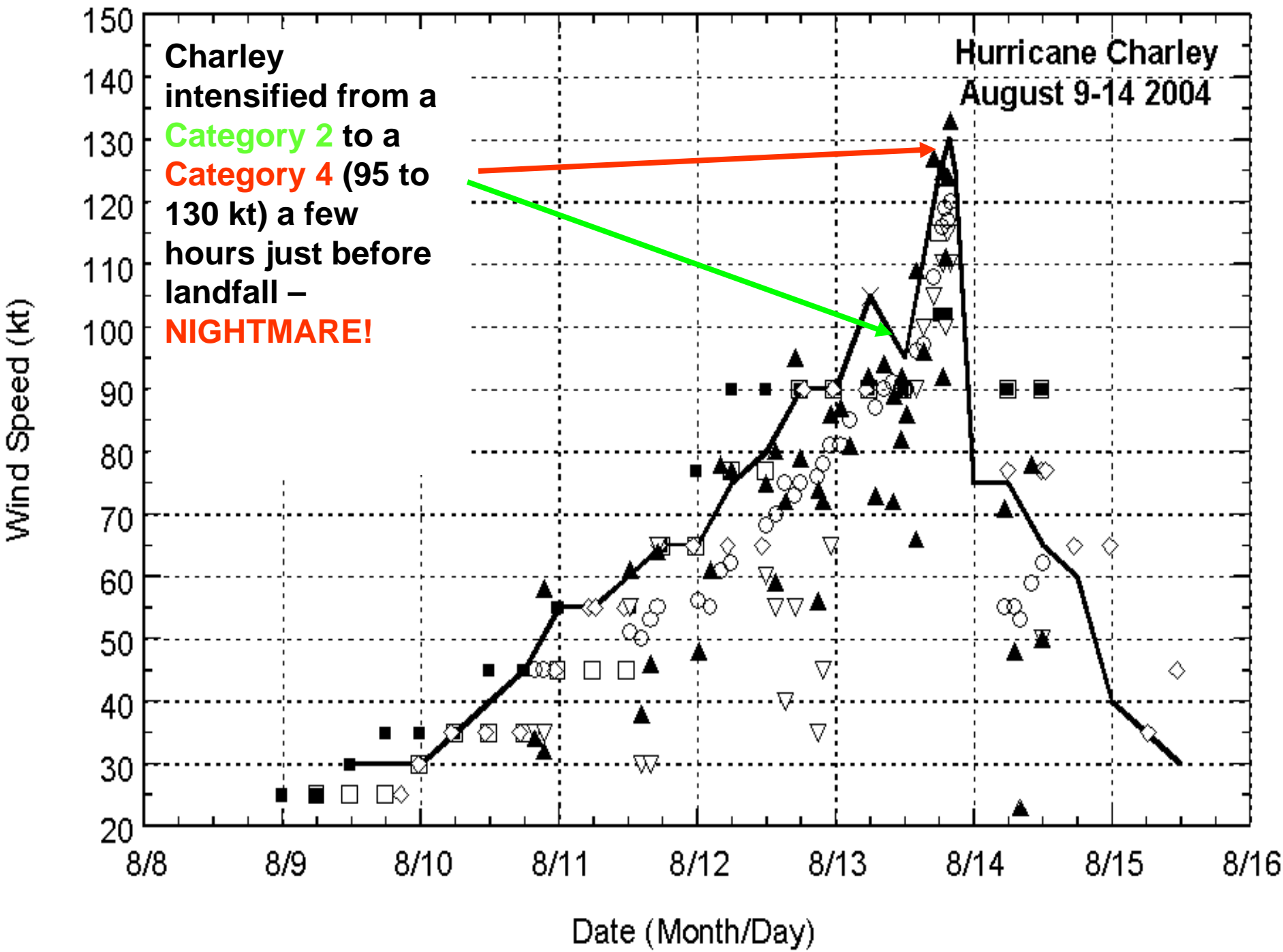
◇ indicates HURRICANE CHARLEY center location at 2 PM EDT Thu Aug 12 2004 (Forecast/Advisory #14)



# Wind Speed Probability Product

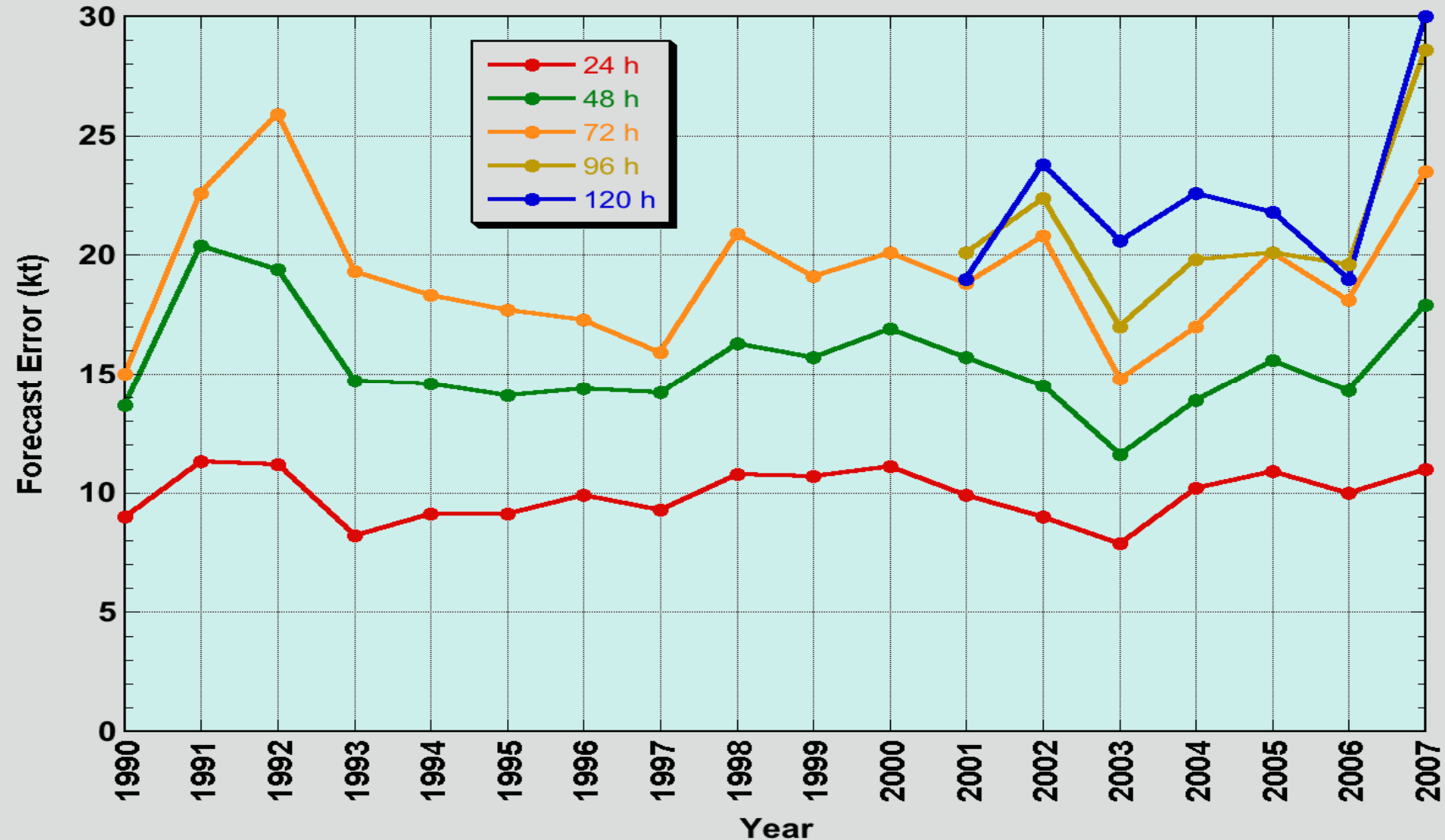






# Little progress with intensity

NHC Official Intensity Error Trend  
Atlantic Basin



# Katrina at Peak Category 5 intensity

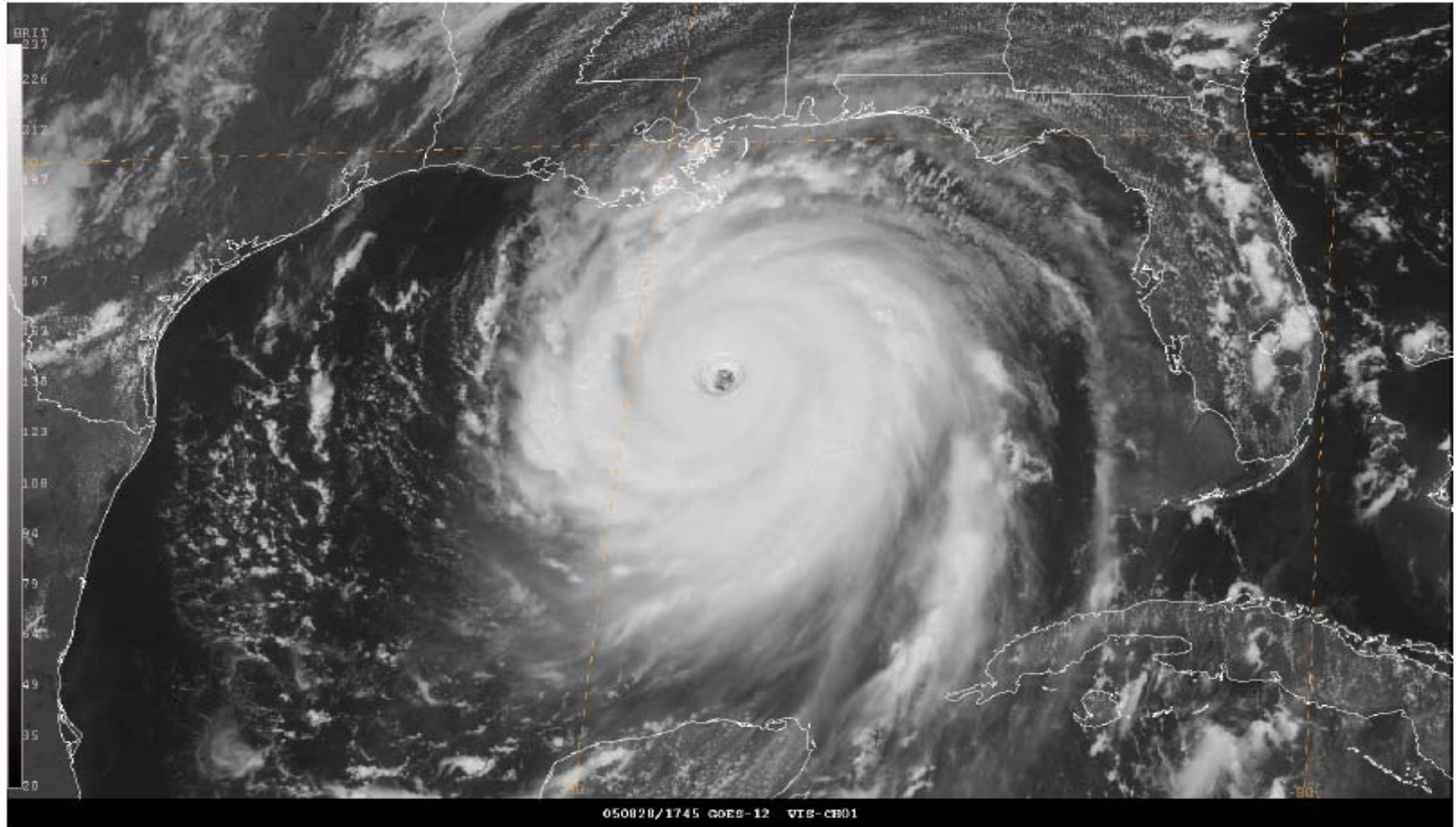


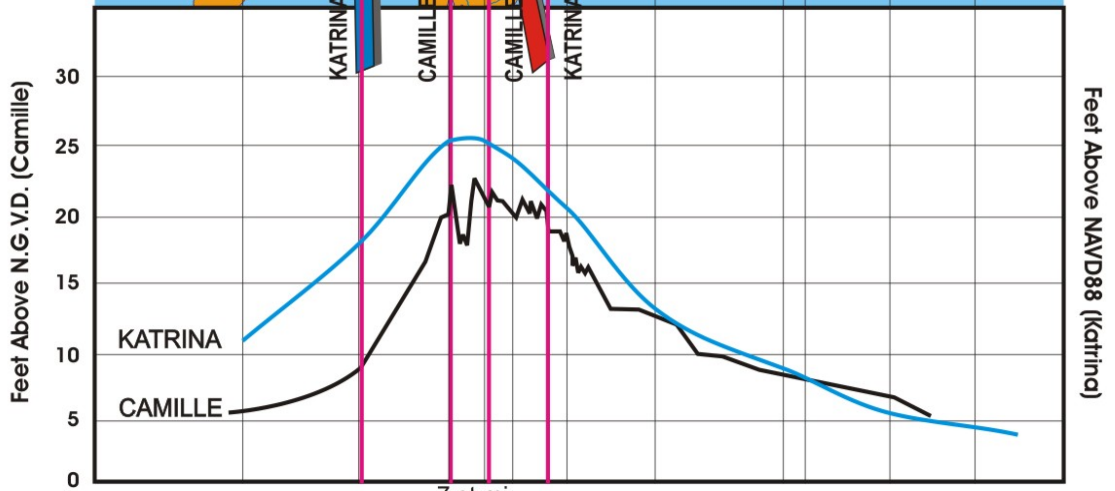
Figure 6. GOES-12 visible image of Hurricane Katrina over the central Gulf of Mexico at 1745 UTC 28 August 2005, near the time of its peak intensity of 150 kt.



# Katrina's Storm Surge in Mississippi

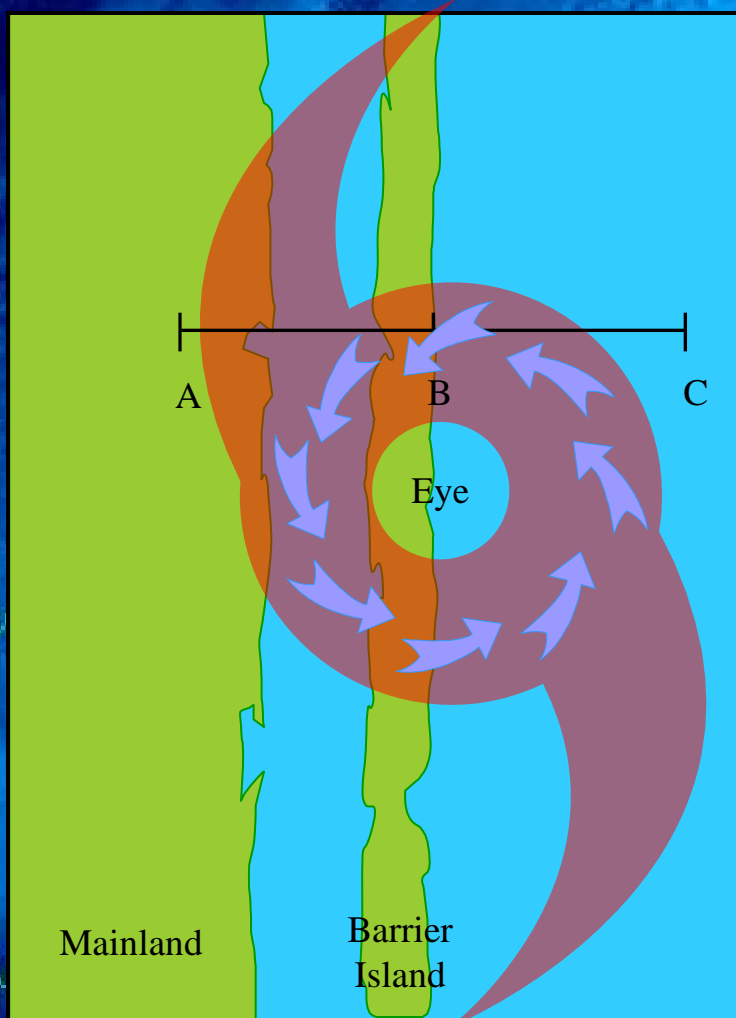
## OBSERVED COASTAL PROFILES FOR

## HURRICANES CAMILLE (1969) and KATRINA (2005)

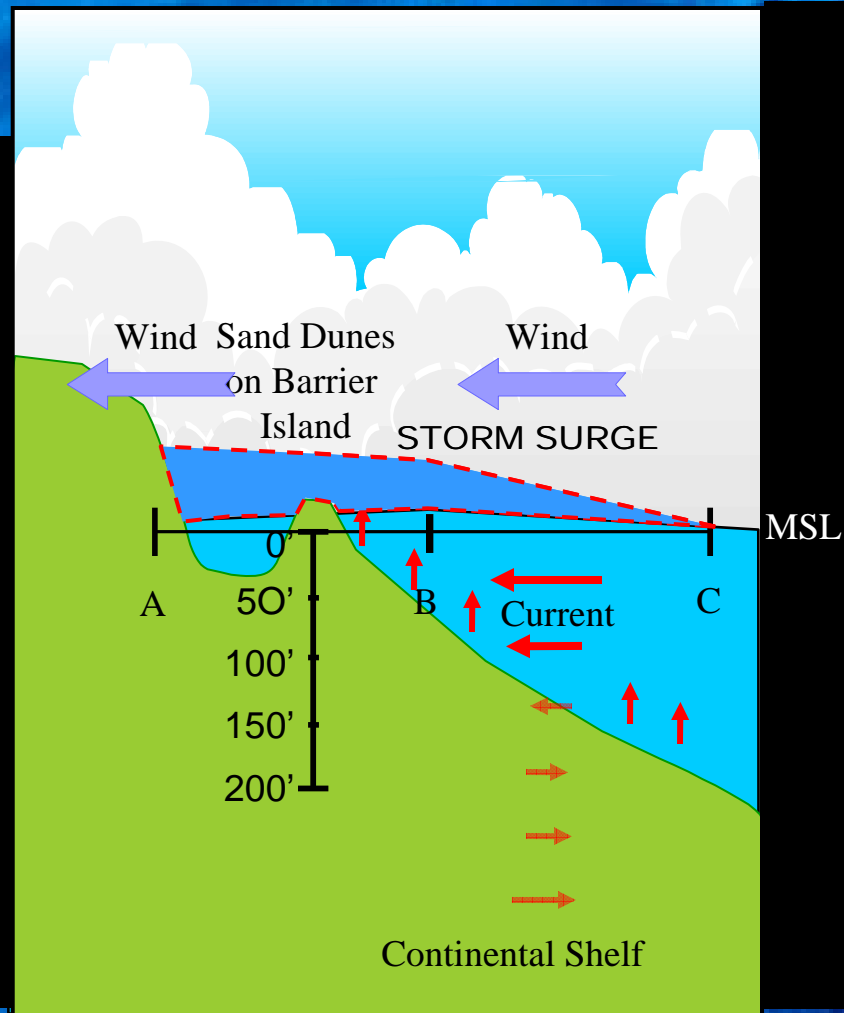


# LANDFALL

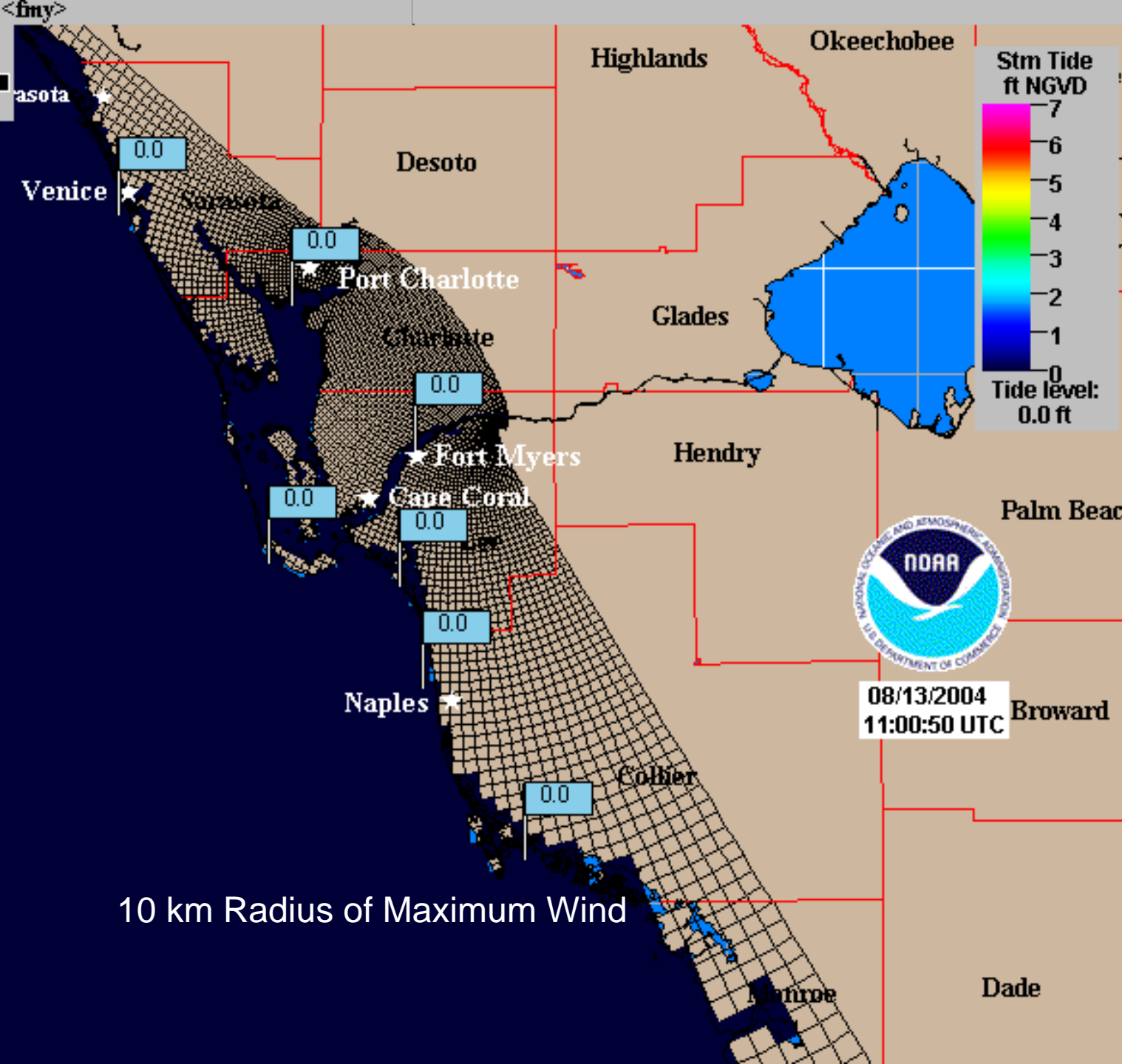
a. Top view of Sea Surface and Land



b. Side view of Cross Section "ABC"



Basin: Elliptical Fort Myers <fmy>  
SLOSH Wind field  
1 min avg KTS(MPH)  
34(39) 65(75) 100(115)



10 km Radius of Maximum Wind

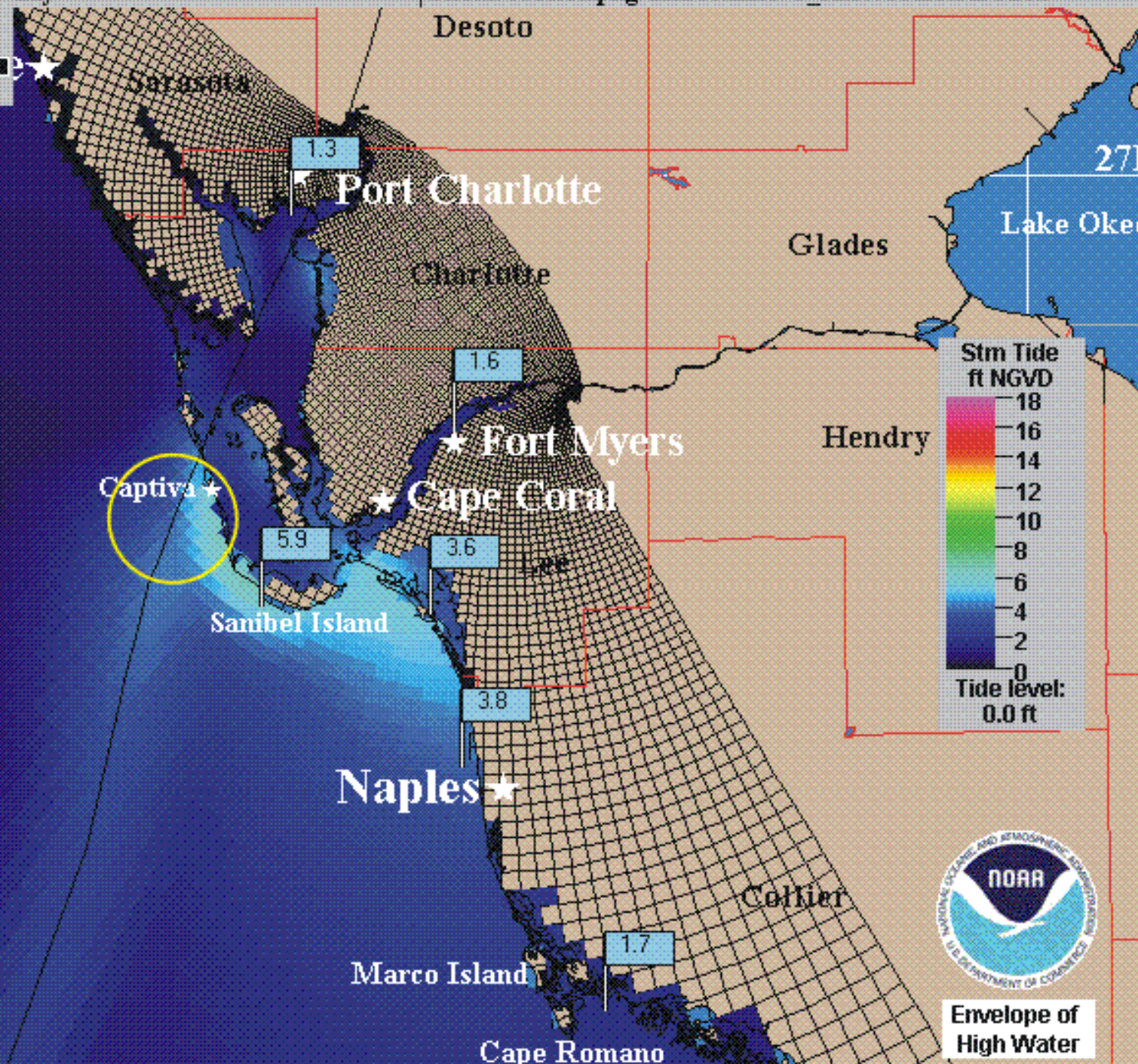


08/13/2004  
11:00:50 UTC



Basin: Elliptical Fort Myers <fmy>  
SLOSH Wind field  
1 min avg KTS(MPH)  
34(39) 65(75) 100(115)

Storm: c:/slosh/pkg/data/rexfiles/C\_RMWO6\_BRJ.B1.rex



1.3

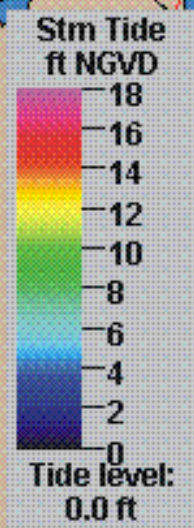
1.6

5.9

3.6

3.8

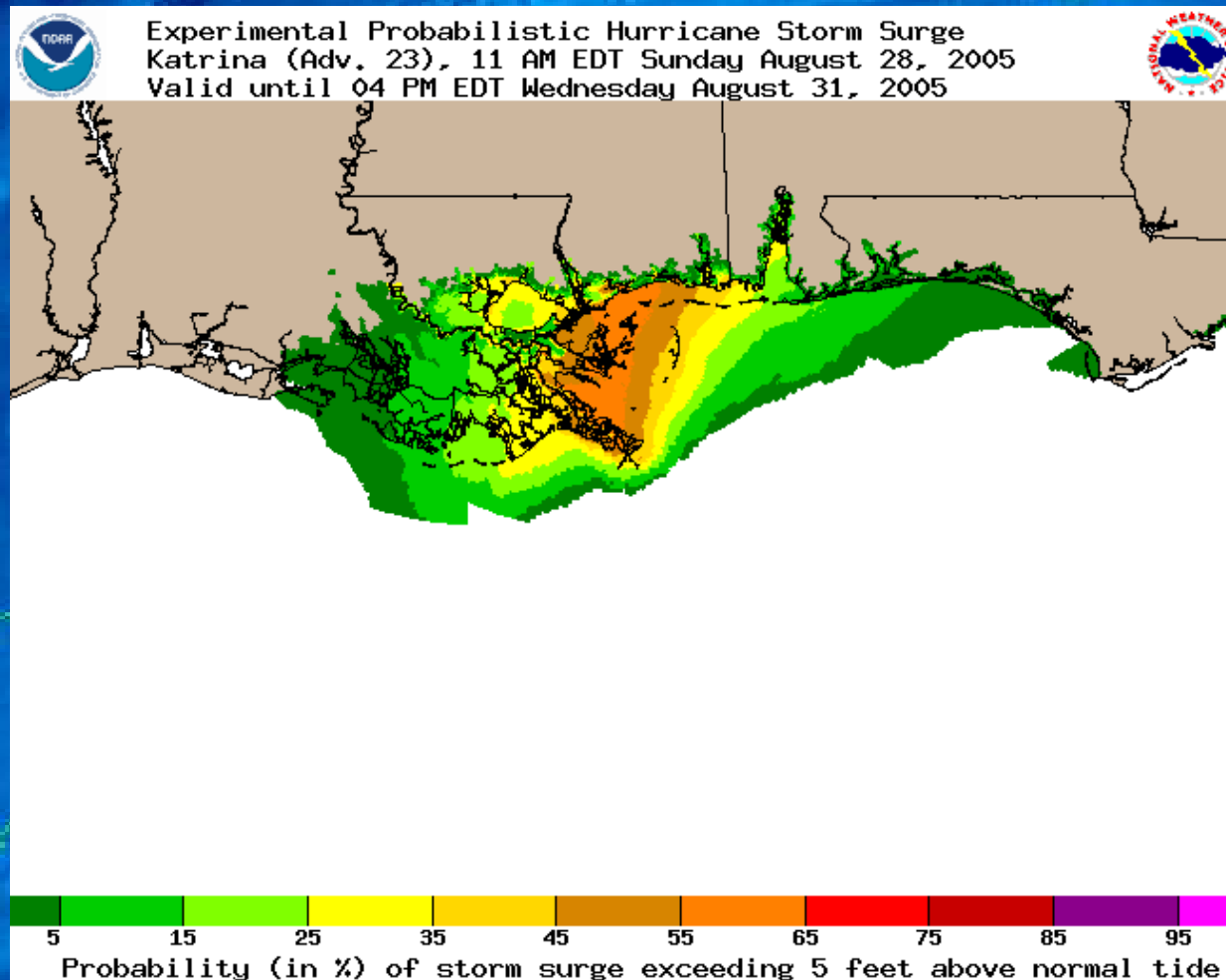
1.7



Envelope of  
High Water



# Example product: probability of storm surge greater than five feet



[www.weather.gov/mdl/psurge](http://www.weather.gov/mdl/psurge)

# The Forecasters (us):

**National Hurricane Center**  
**Tropical Prediction Center**

A satellite image of a hurricane, showing a distinct eye and spiral cloud bands, centered in the lower half of the white box.

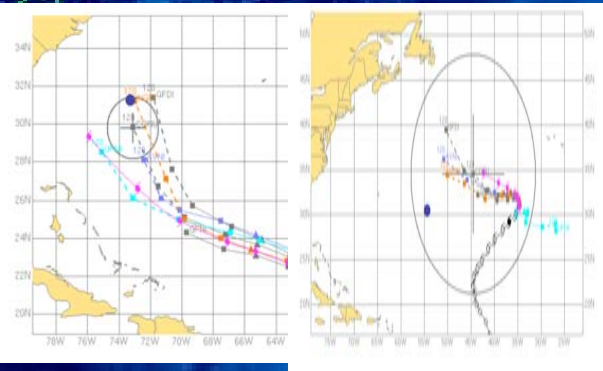
# The Researchers (them):



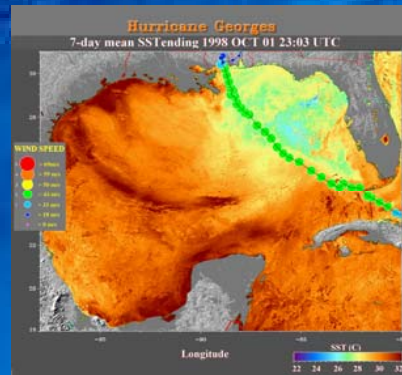
How to  
bridge  
the  
“valley of  
death”?



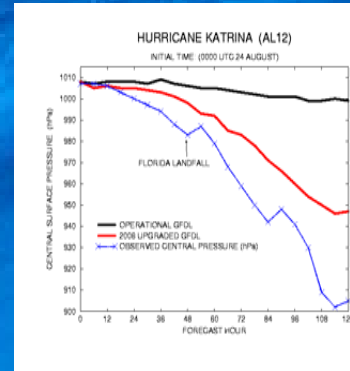
# JHT 2nd Round Implemented Projects



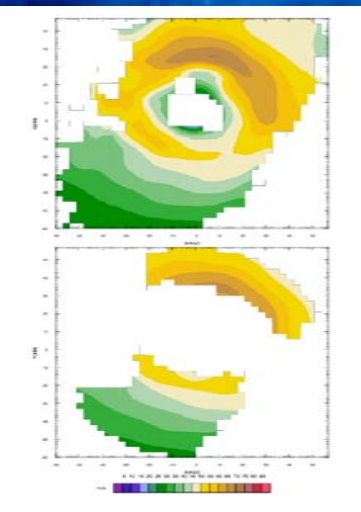
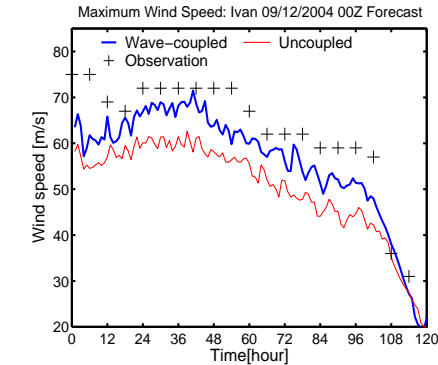
Track Uncertainty Estimates (Goerss)



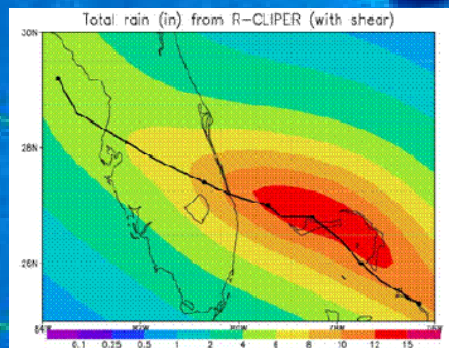
Inner Core SSTs (Cione)



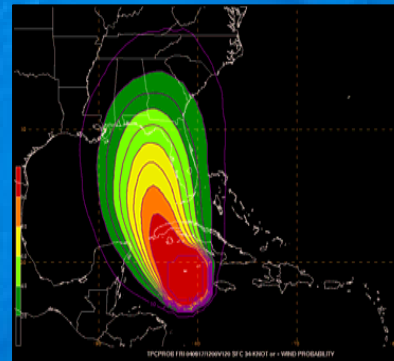
GFDL/URI Hurricane Model upgrades (Bender; Ginis)



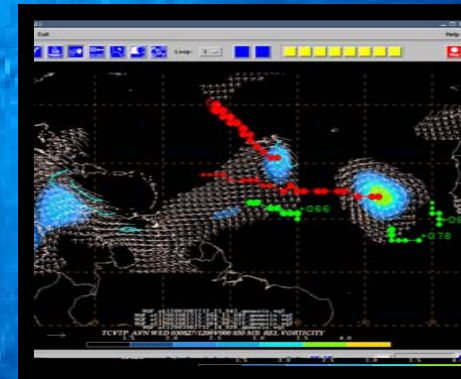
Doppler Winds (Gamache)



Rain-CLIPER & rainfall verification (Rogers)

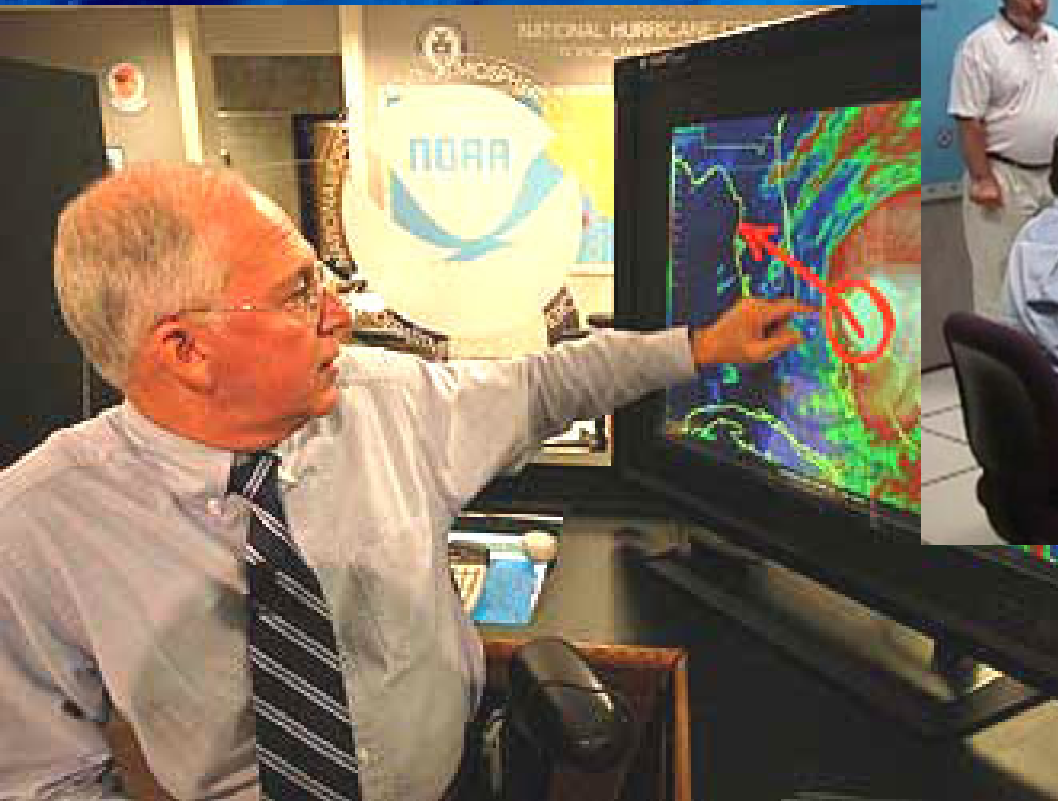


SHIPS & Wind Probabilities (DeMaria/Knaff)



Genesis forecasting assessments (Harr)

# Communicating with the Media





# Communicating with Decision-makers



White House Photo



President George W. Bush is handed a map by Deputy Chief of Staff Joe Hagin, center, during a video teleconference with federal and state emergency management organizations on hurricane Katrina from his Crawford, Texas ranch on Sunday August 28, 2005.



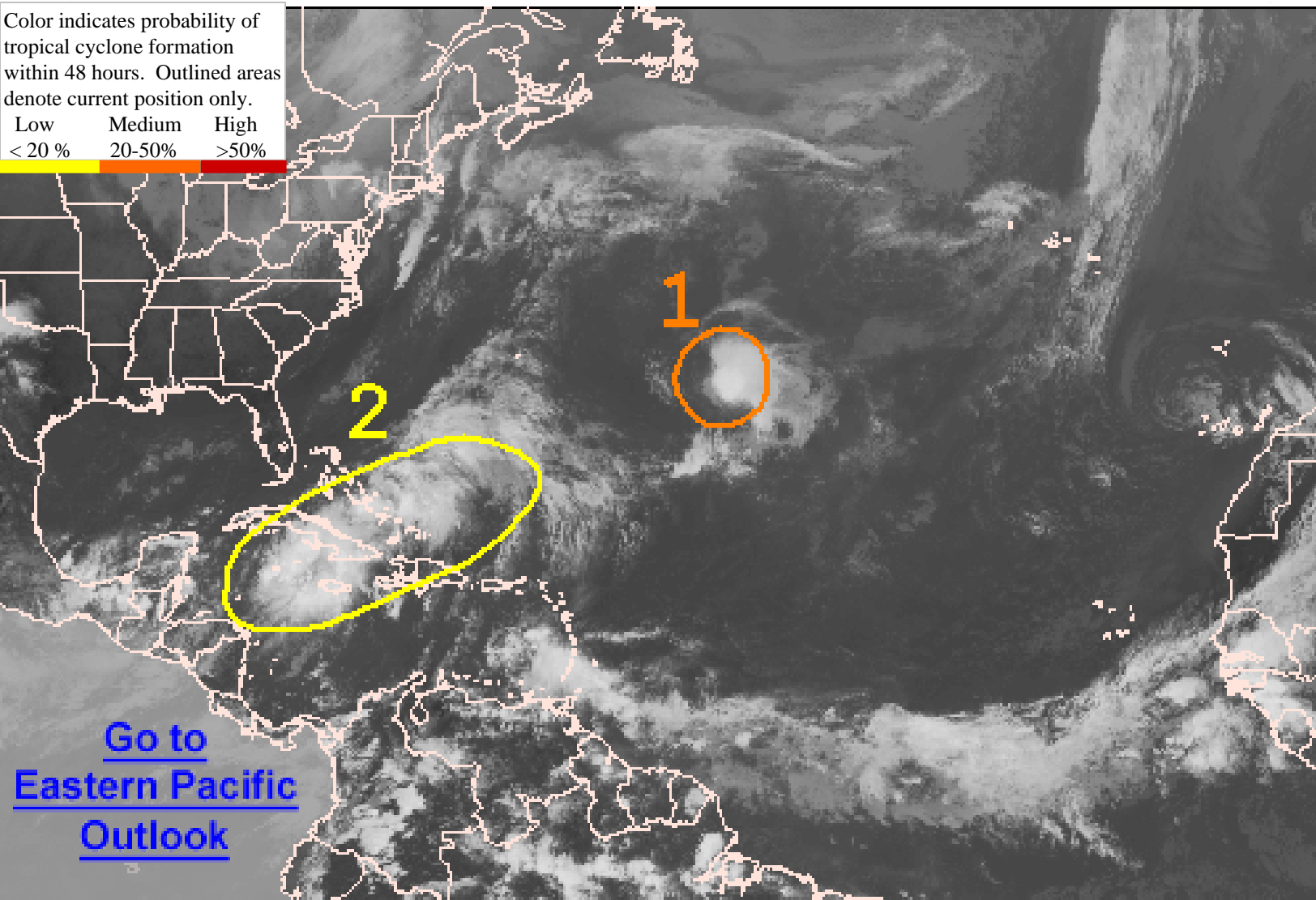


# Experimental Graphical Tropical Weather Outlook



Color indicates probability of tropical cyclone formation within 48 hours. Outlined areas denote current position only.

Low	Medium	High
< 20 %	20-50%	>50%



[Go to Eastern Pacific Outlook](#)

200 PM EDT THU OCT 11 2007

Satellite Image: 0322 PM EDT

The highlighted and numbered areas, if any, indicate current locations of weather systems discussed in the Tropical Weather Outlook below.

2005

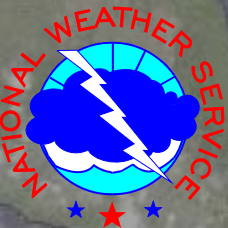
# Hurricane Analysis and Forecasting at the National Hurricane Center

12 November, 2008

Katrina  
28 August

Chris Landsea

National Hurricane Center, Miami



Wilma  
21 October

