

Hurricanes Katrina & Rita: Harbingers of the Future?



Definition of a Hurricane



Nickname for a tropical cyclone, which is an intense tropical low pressure system with maximum sustained winds of 74 mph or higher. See also typhoon.

Hurricane Damage...

Wind



Heavy Rain/Floods



Storm surge



Saffir-Simpson Scale for Hurricane Strength

Category	Max sustained wind speed		
	mph	knots	damage
1	74-95	64-82	Tree damage, small boats torn from moorings, roads flooded
2	96-110	83-95	Roofing, windows, doors boats, piers, mobile homes
3	111-130	96-113	Some structural damage to buildings, flooding, wave damage
4	131-155	114-135	Lots of structural damage, major flooding, storm surge
5	156+	136+	Catastrophic, building failures

Category 1+
Miami 2005



The Great Galveston Hurricane



Category 4 Damage: Galveston 1900



**SEARCHING RUINS
ON BROADWAY, GALVESTON,
FOR DEAD BODIES**

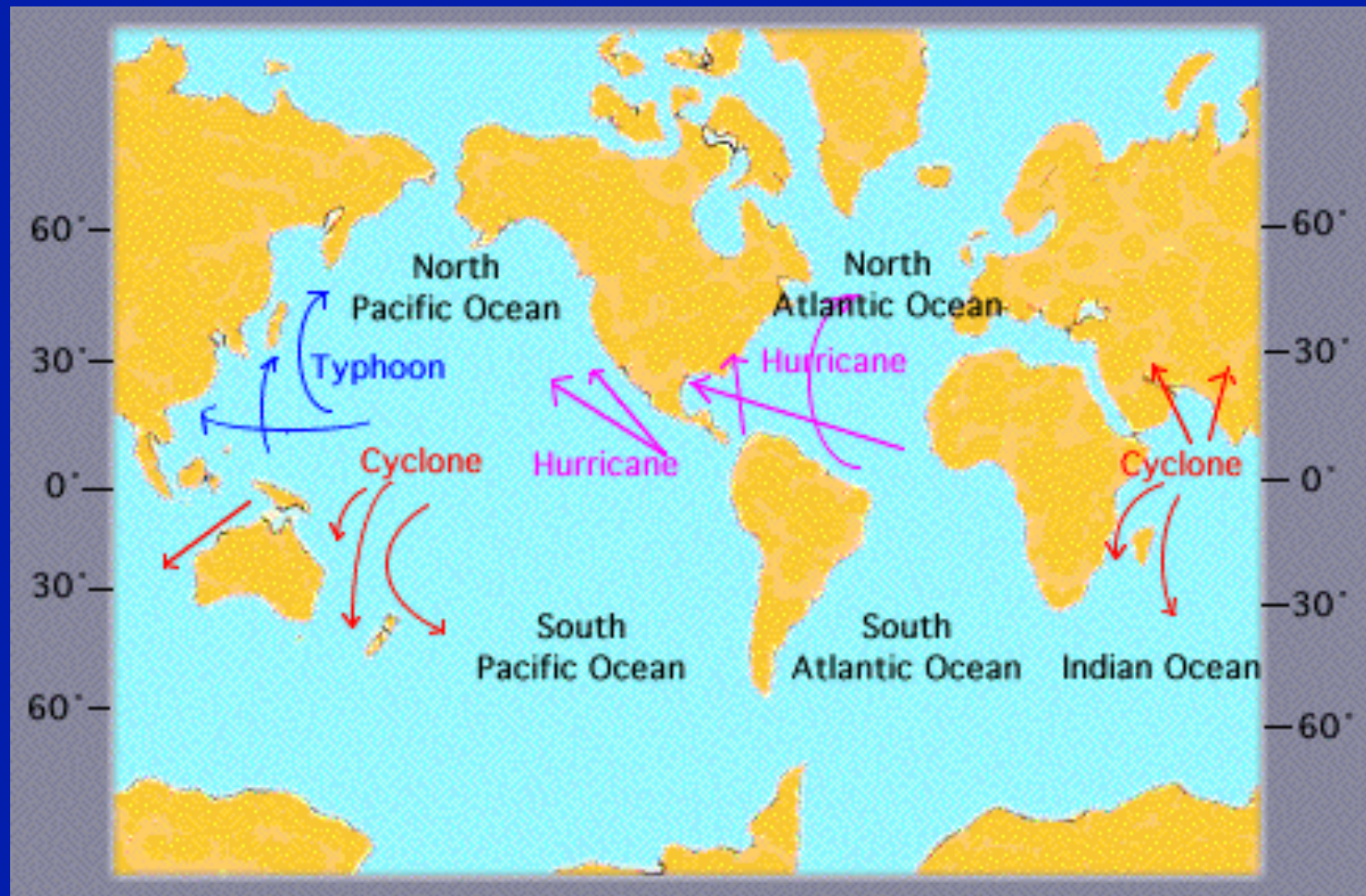
(C) Edison, 1900 - D18566

**“...more dreadful than is possible for me
to find the words to express.”**

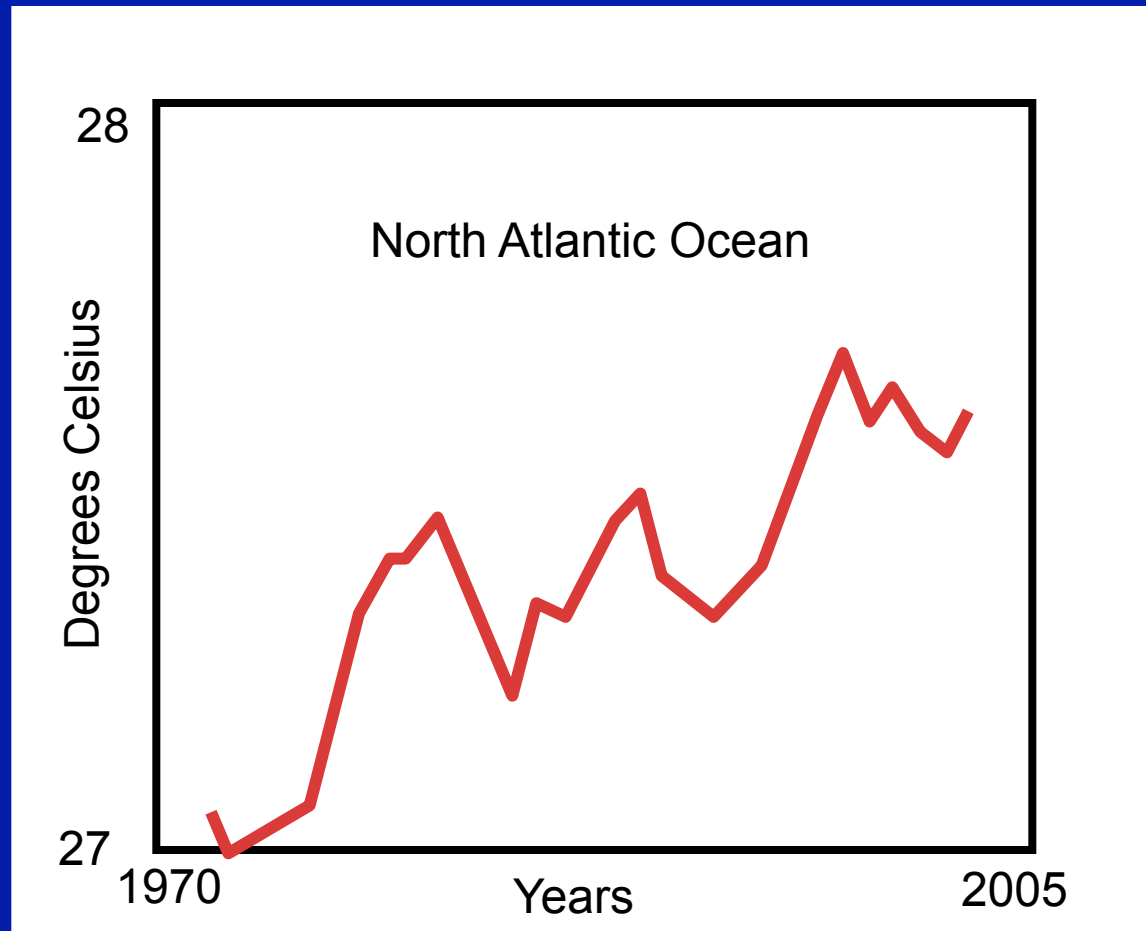
Sir George Rodney, on the Barbados
hurricane of October, 1780



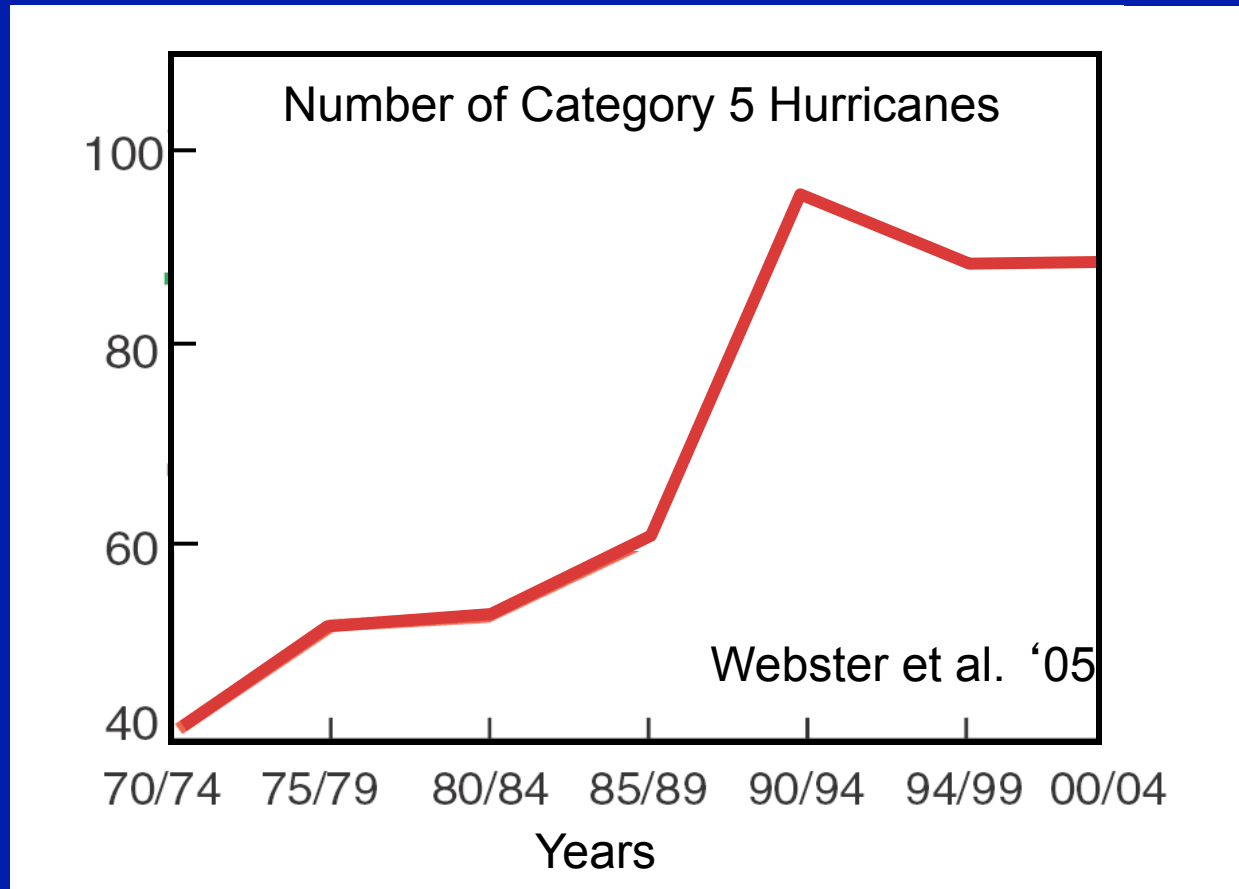
Tropical Cyclones include: *Hurricanes*, *Typhoons*, and *Cyclones* .



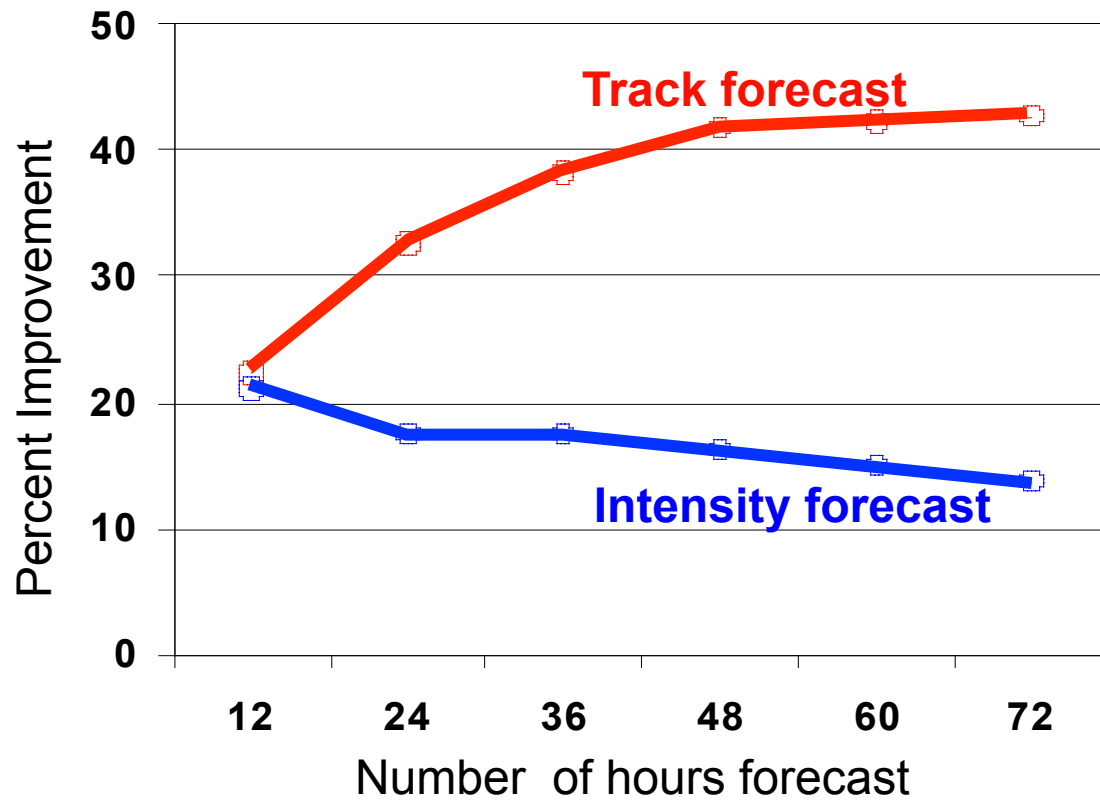
Oceans are getting warmer...



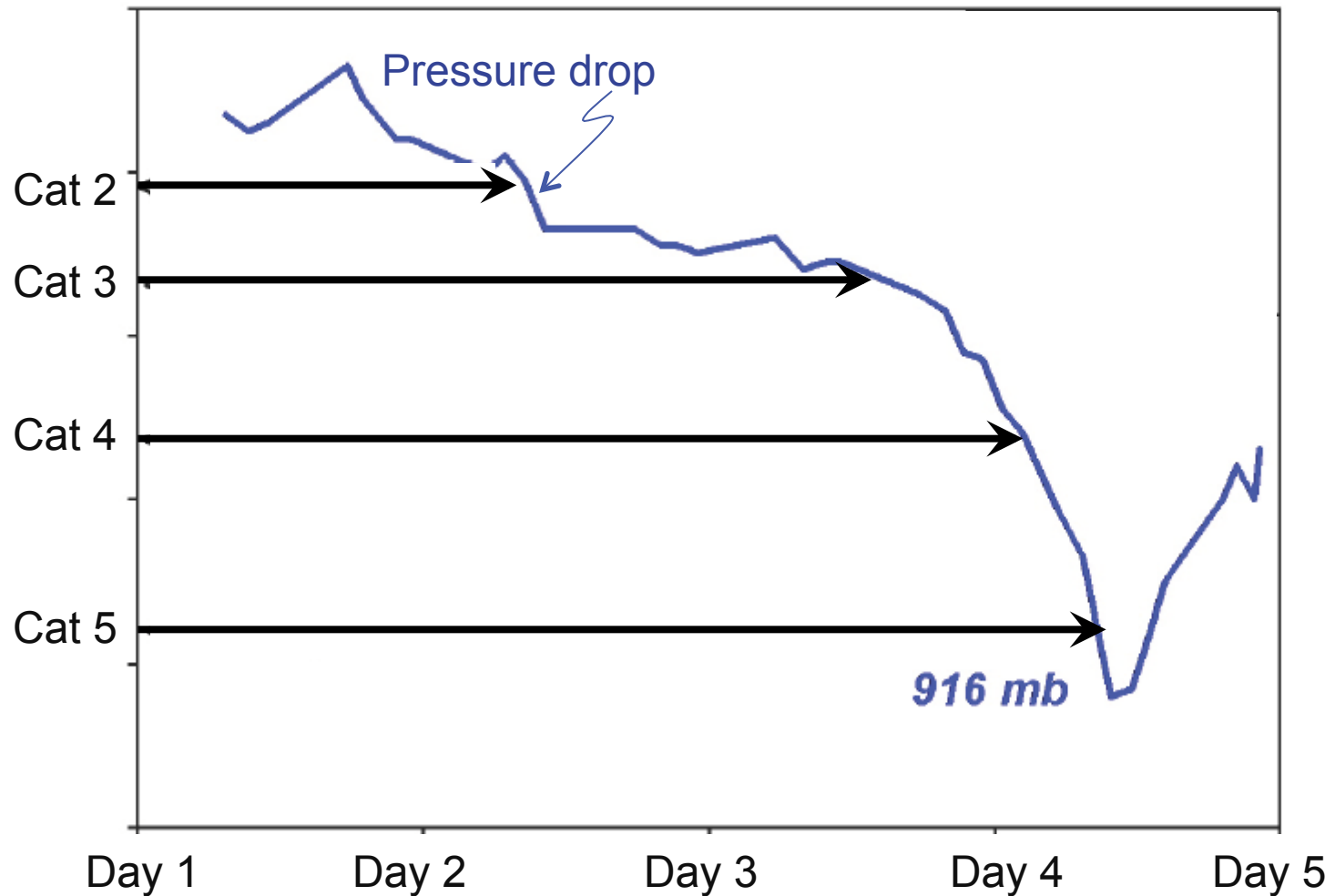
We are getting more strong hurricanes...



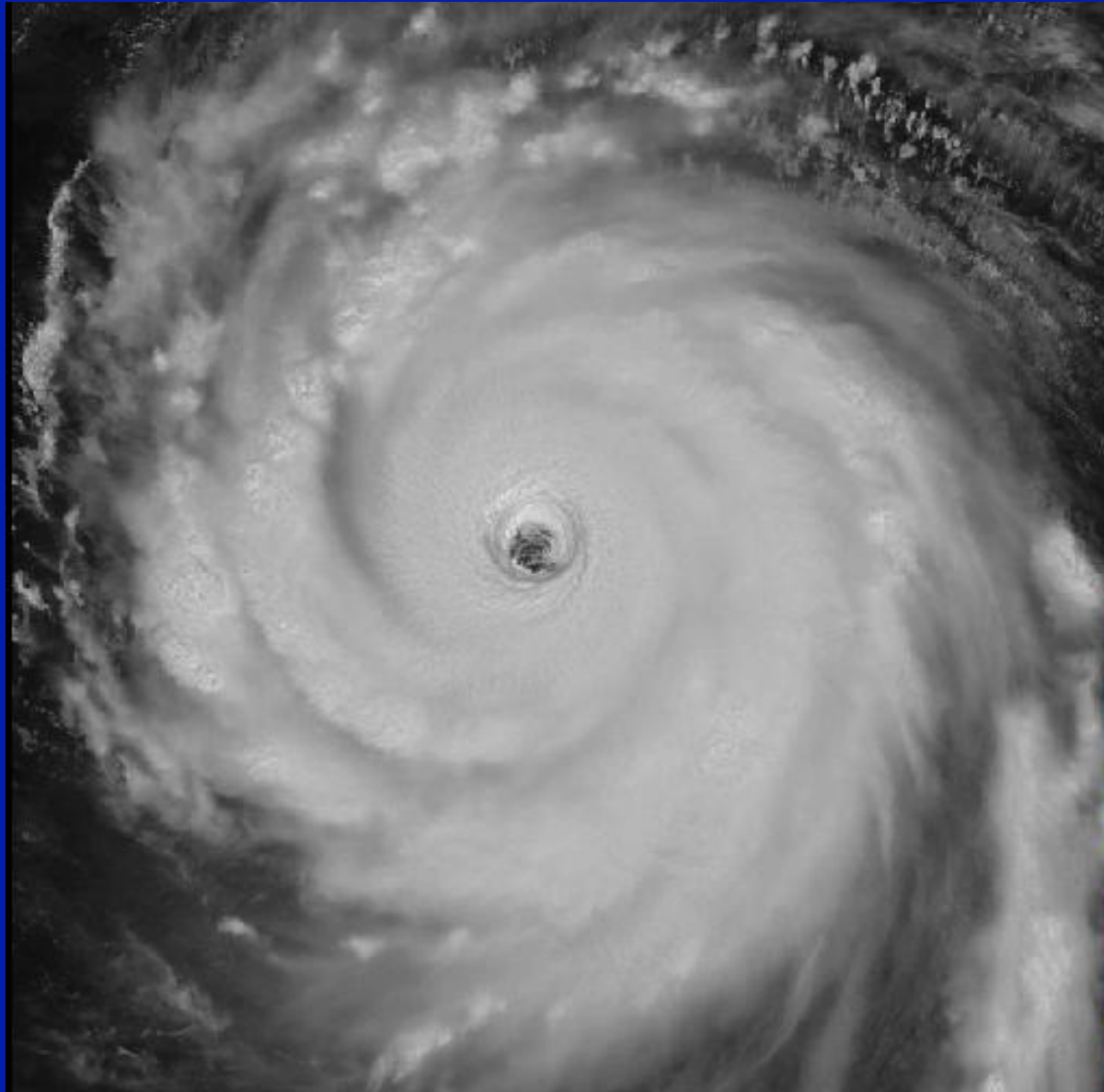
Progress (?) in forecasting hurricanes



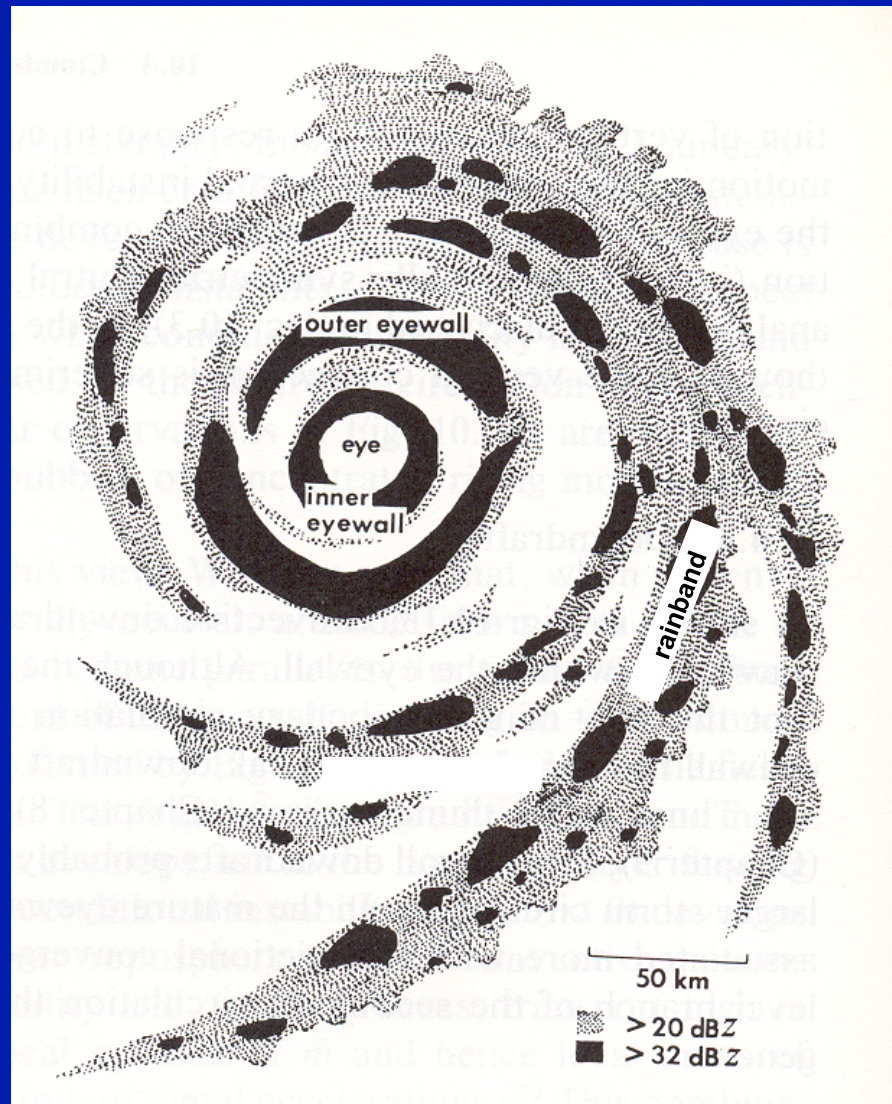
Famous Rapidly Intensifying Storm Hurricane Opal (1995)



Hurricane Katrina--seen from space



Radar view of a hurricane





The Collaborators





Intensity Change Experiment

NOAA P3 Aircraft



Navy P3 Aircraft



Survival Training



The Right Stuff





RAINEX aircraft instruments







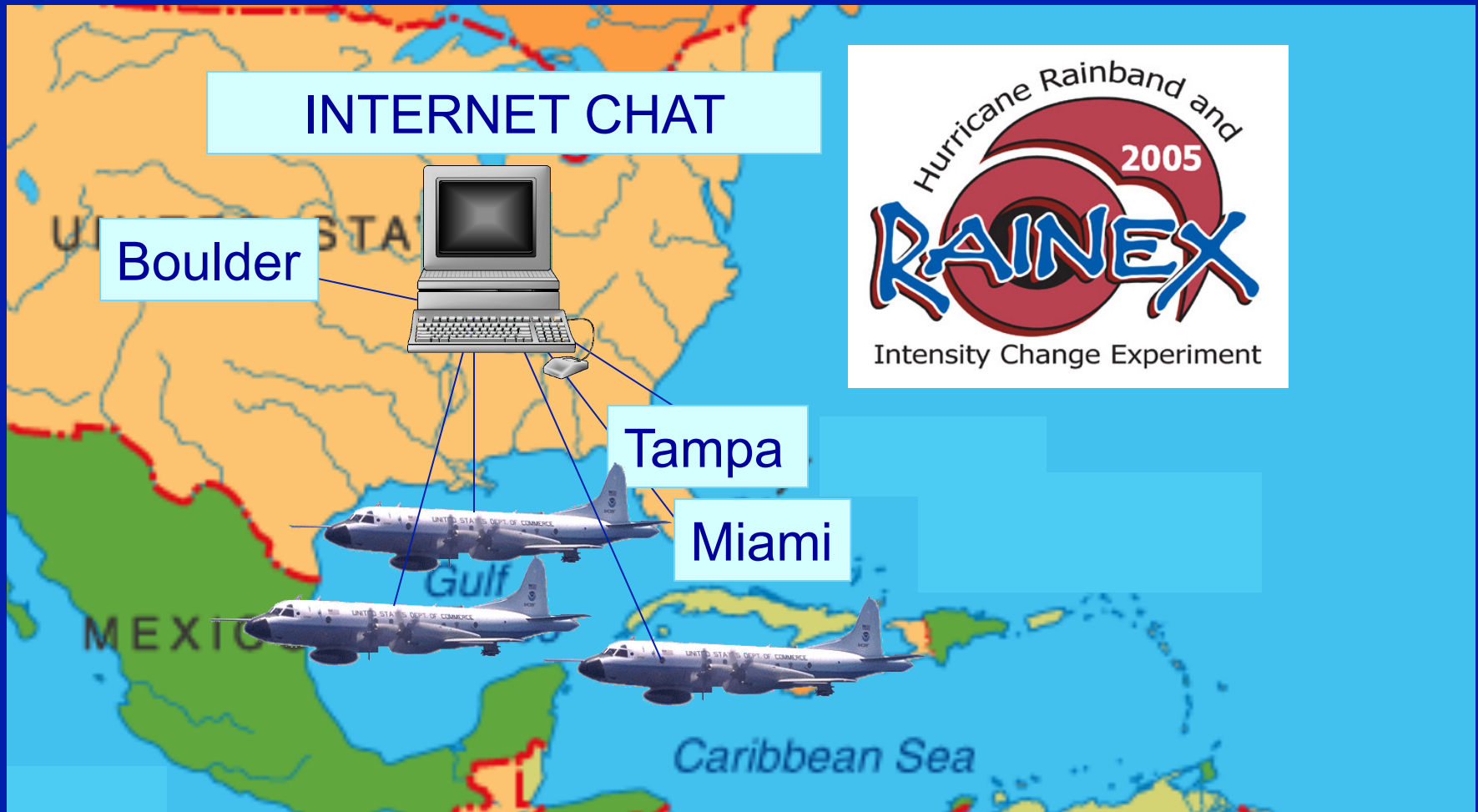


A green rectangular sign with gold lettering is mounted on a concrete base. The sign is surrounded by tall green grass and several palm trees with distinctive braided trunks. In the background, a chain-link fence and a white vehicle are visible.

University of Miami
Rosenstiel School of Marine and
Atmospheric Science



Communications--the key to success



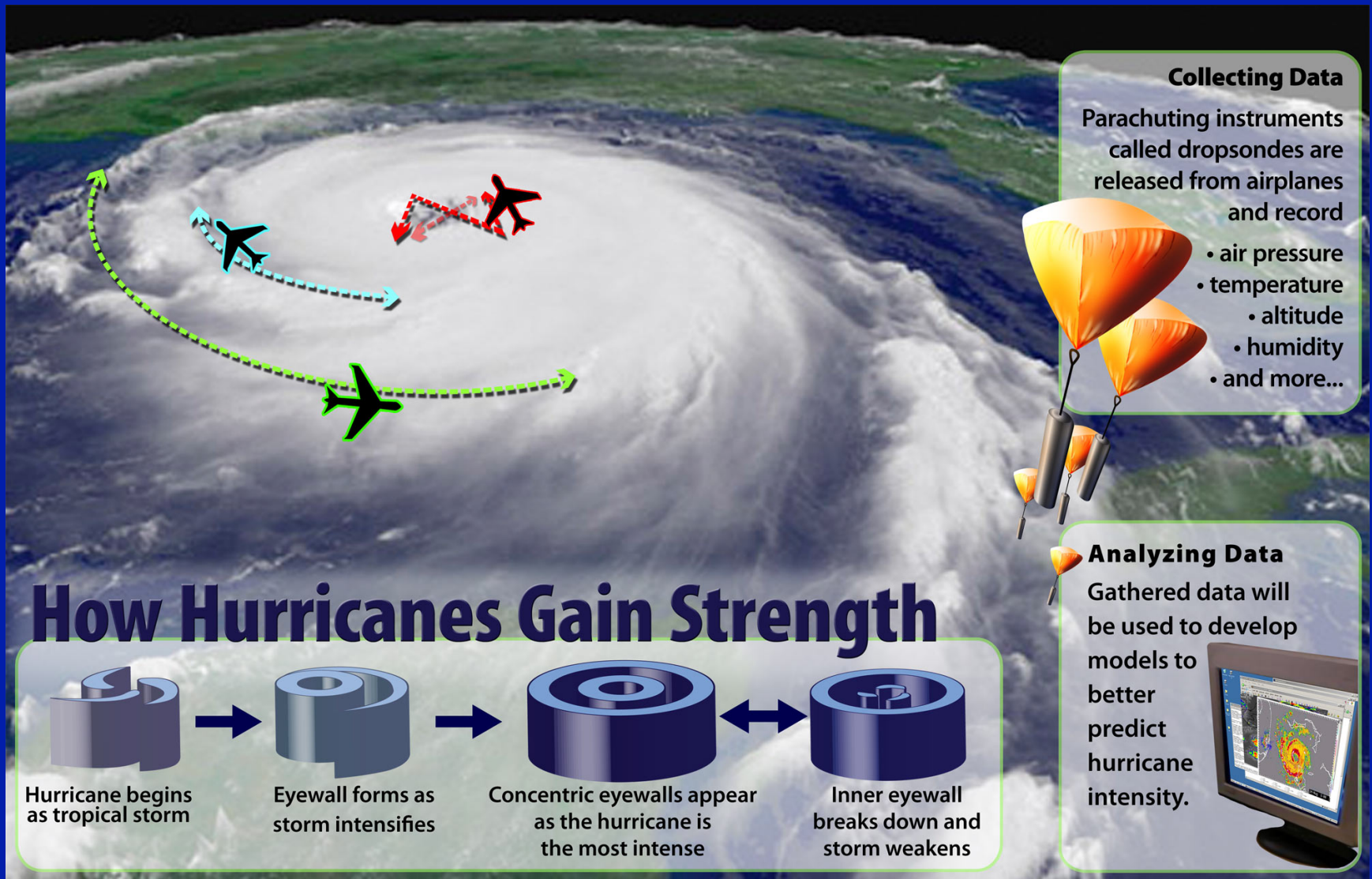




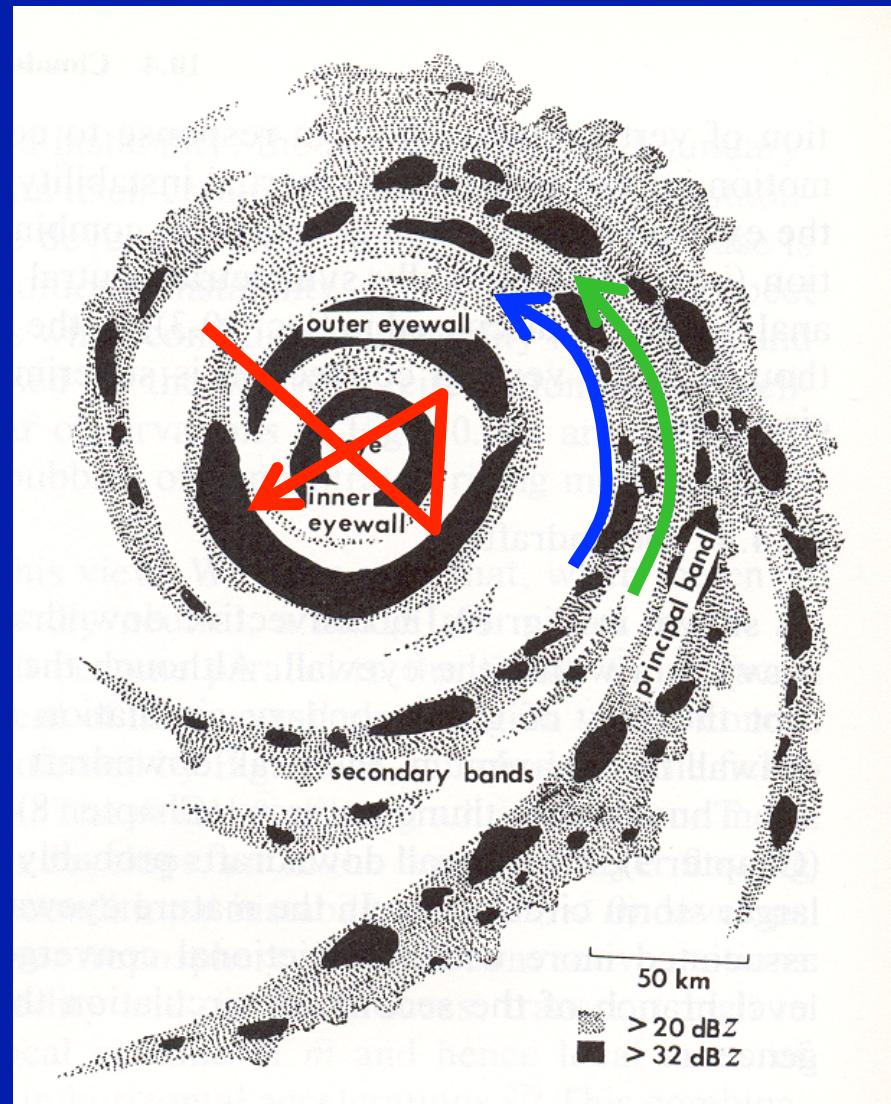
“Hi
Grandad”



NSF media graphic for RAINEX

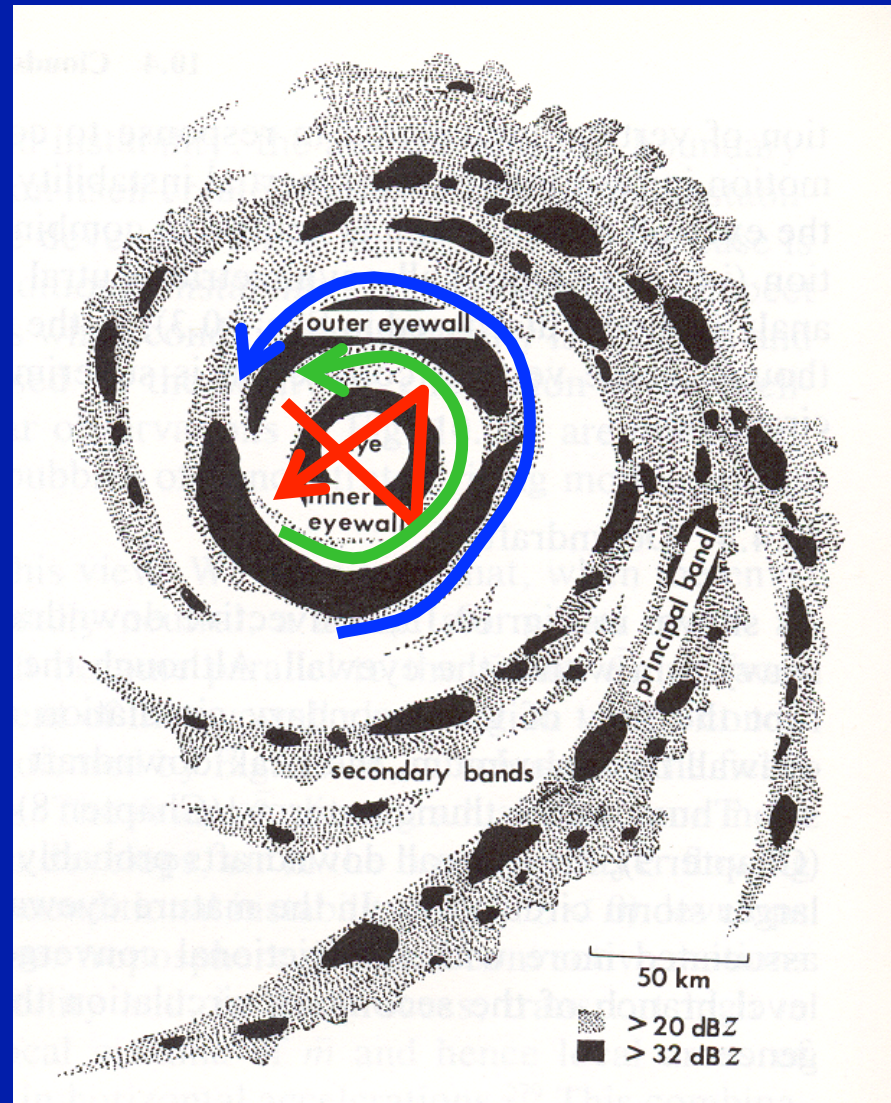


Positioning the aircraft to target the key storm features

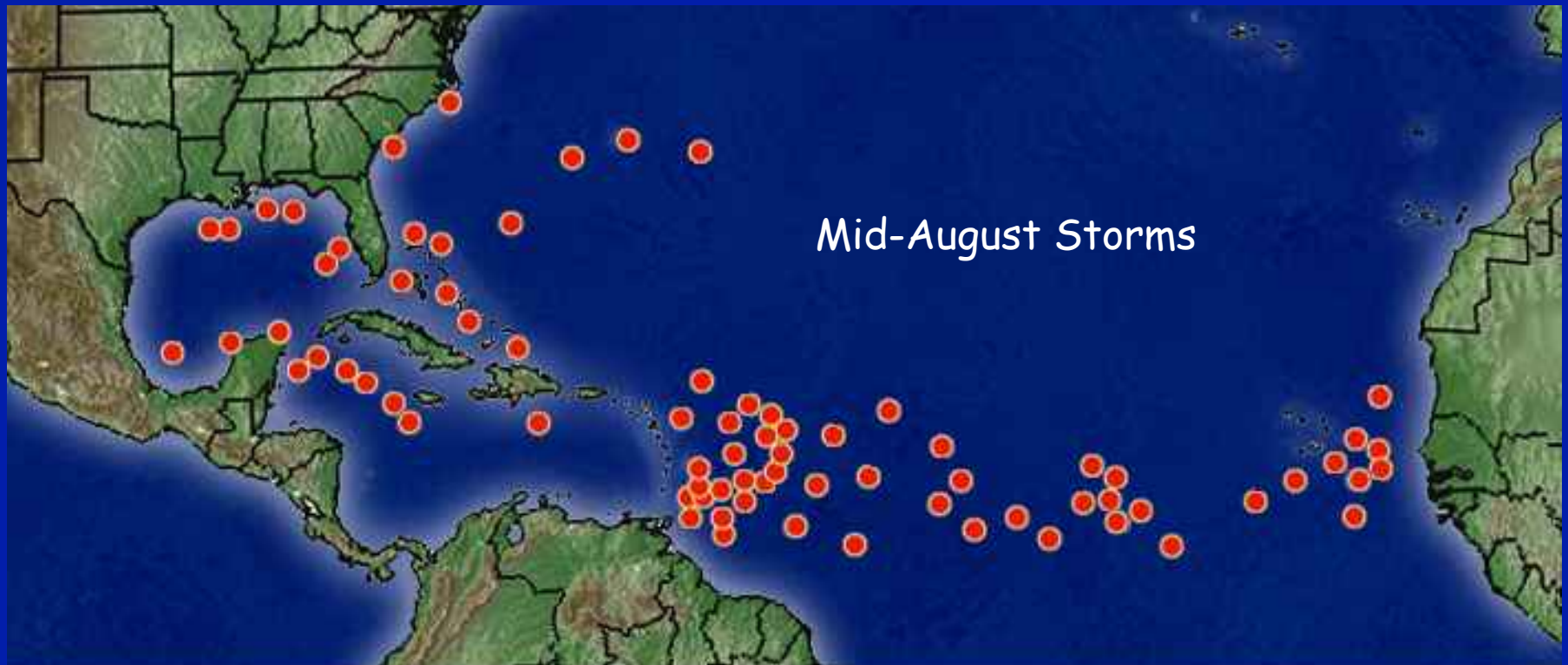


Positioning the aircraft to target the key storm features

“Plan B”

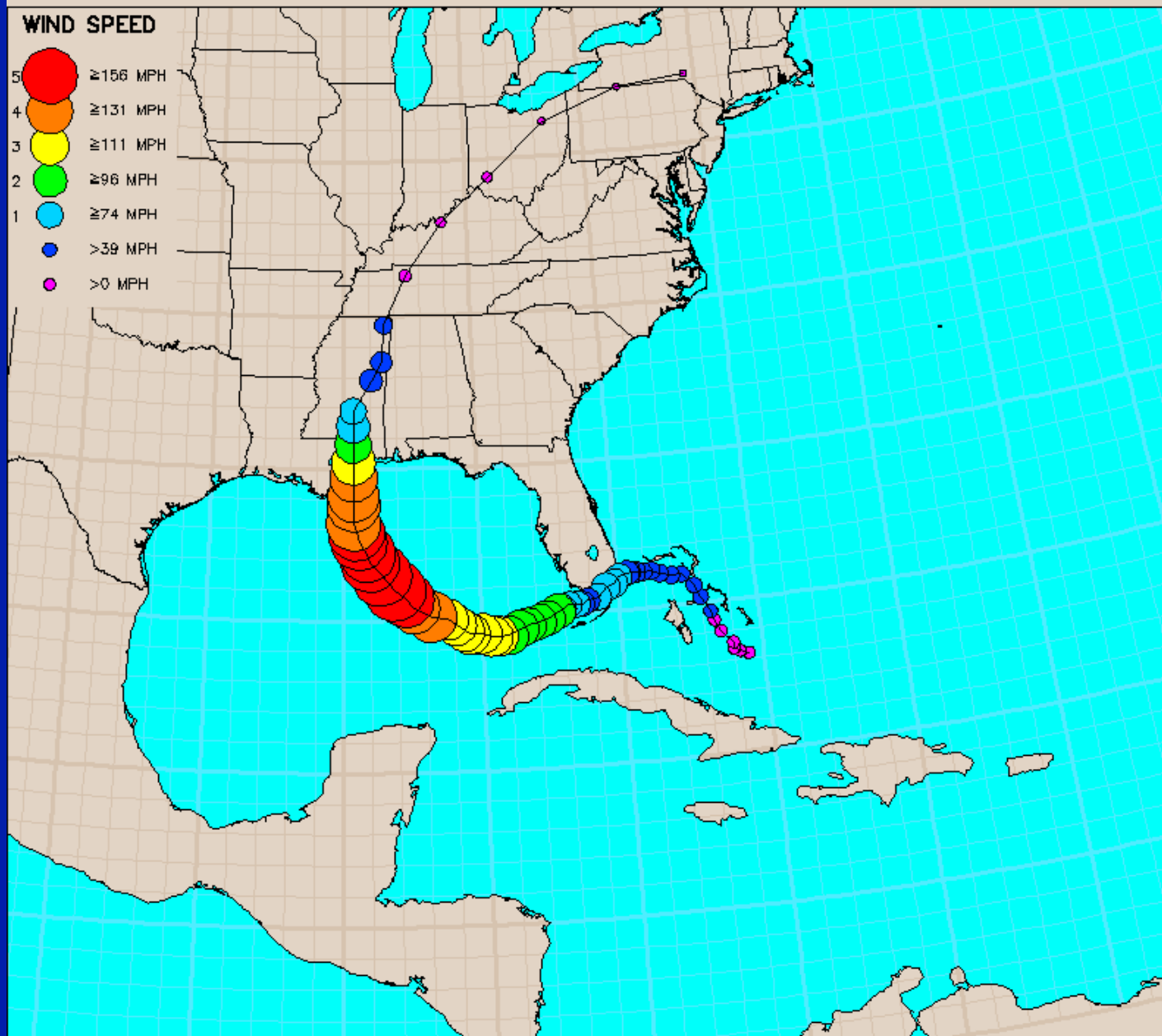


Where do Atlantic Hurricanes originate?



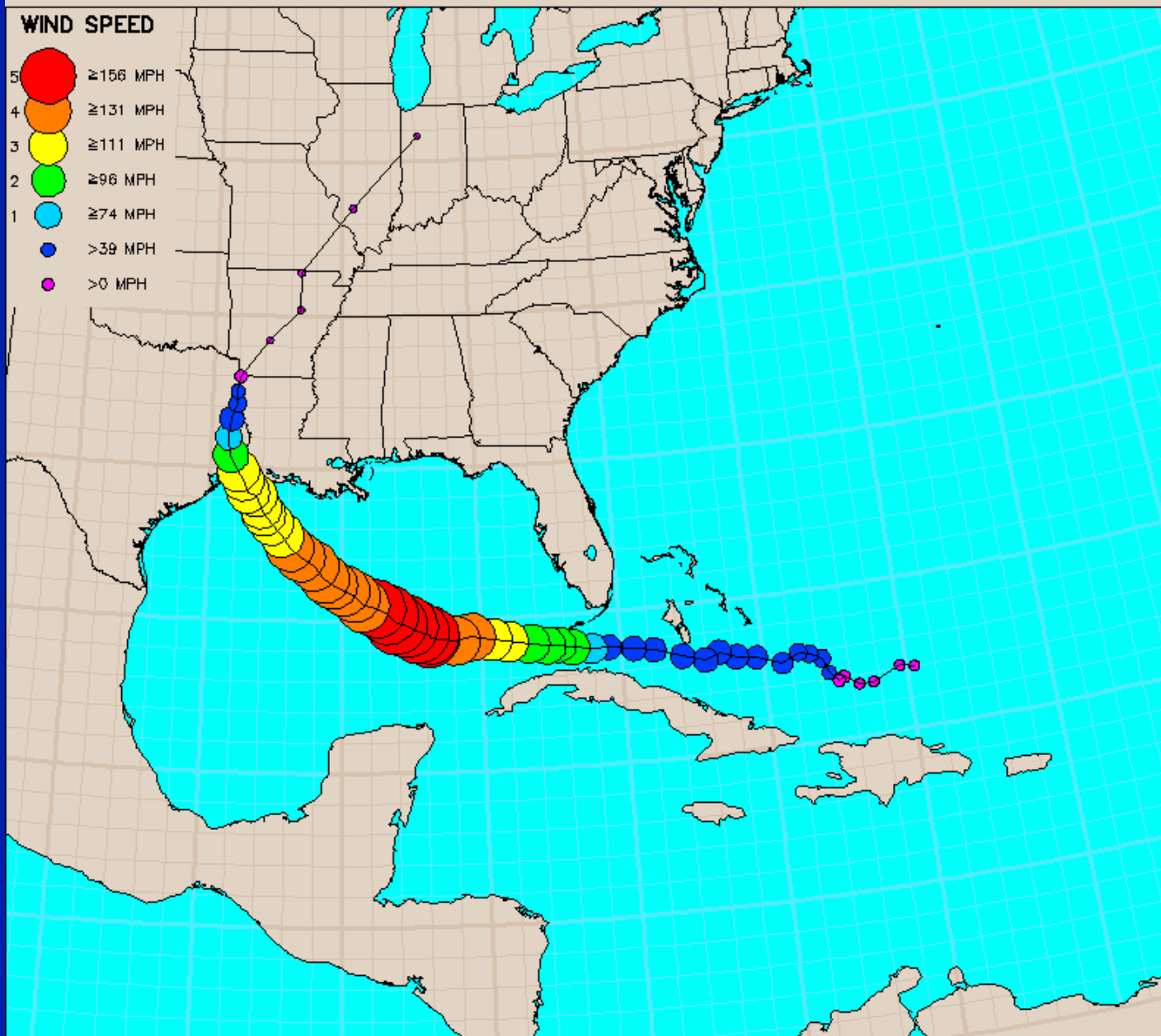
Hurricane Katrina

21:00 Tue August 23, 2005 to 21:00 Wed August 31, 2005 UTC

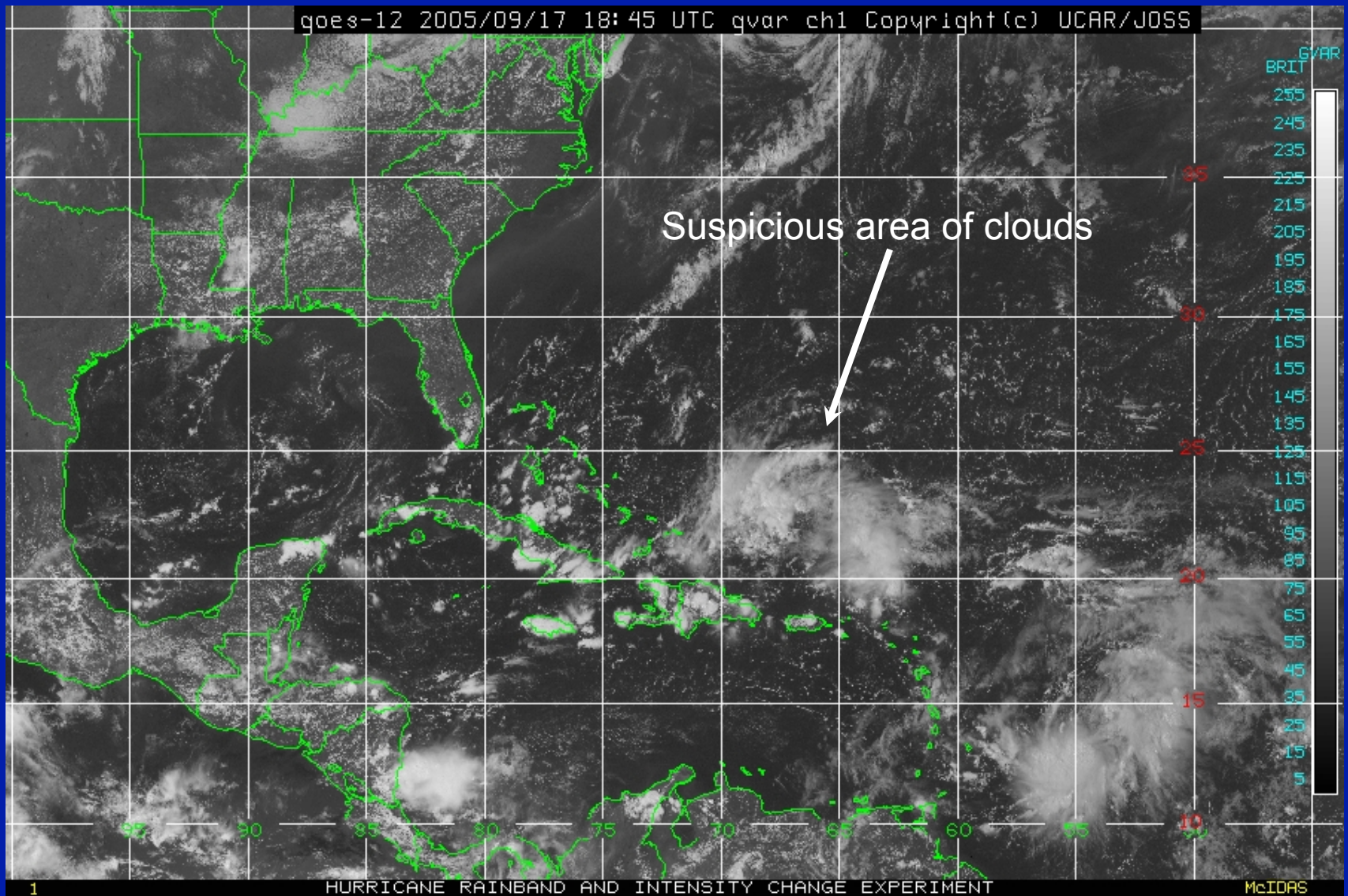


Hurricane Rita

03:00 Sun September 18, 2005 to 09:00 Mon September 26, 2005 UTC



Origin of Rita



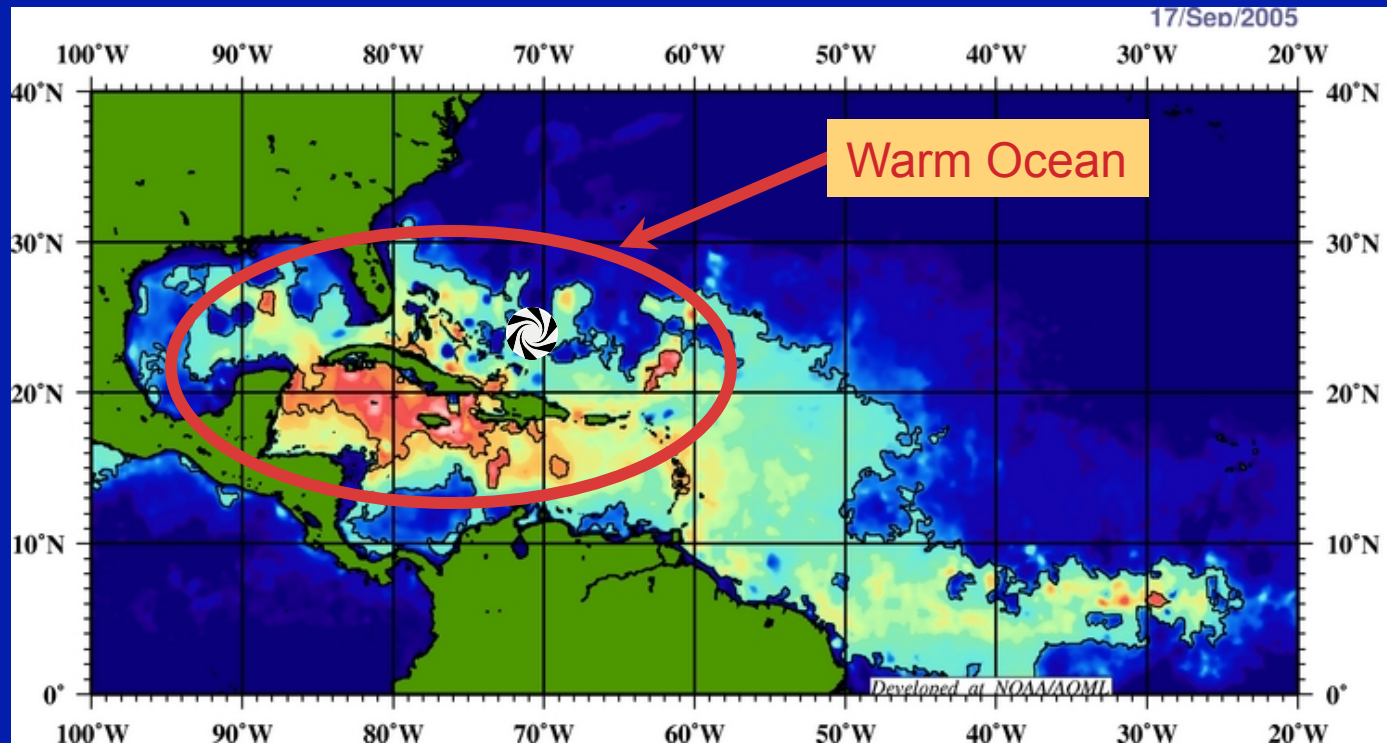
Important factors that make a hurricane develop

Warm ocean--hurricanes get their energy from the ocean

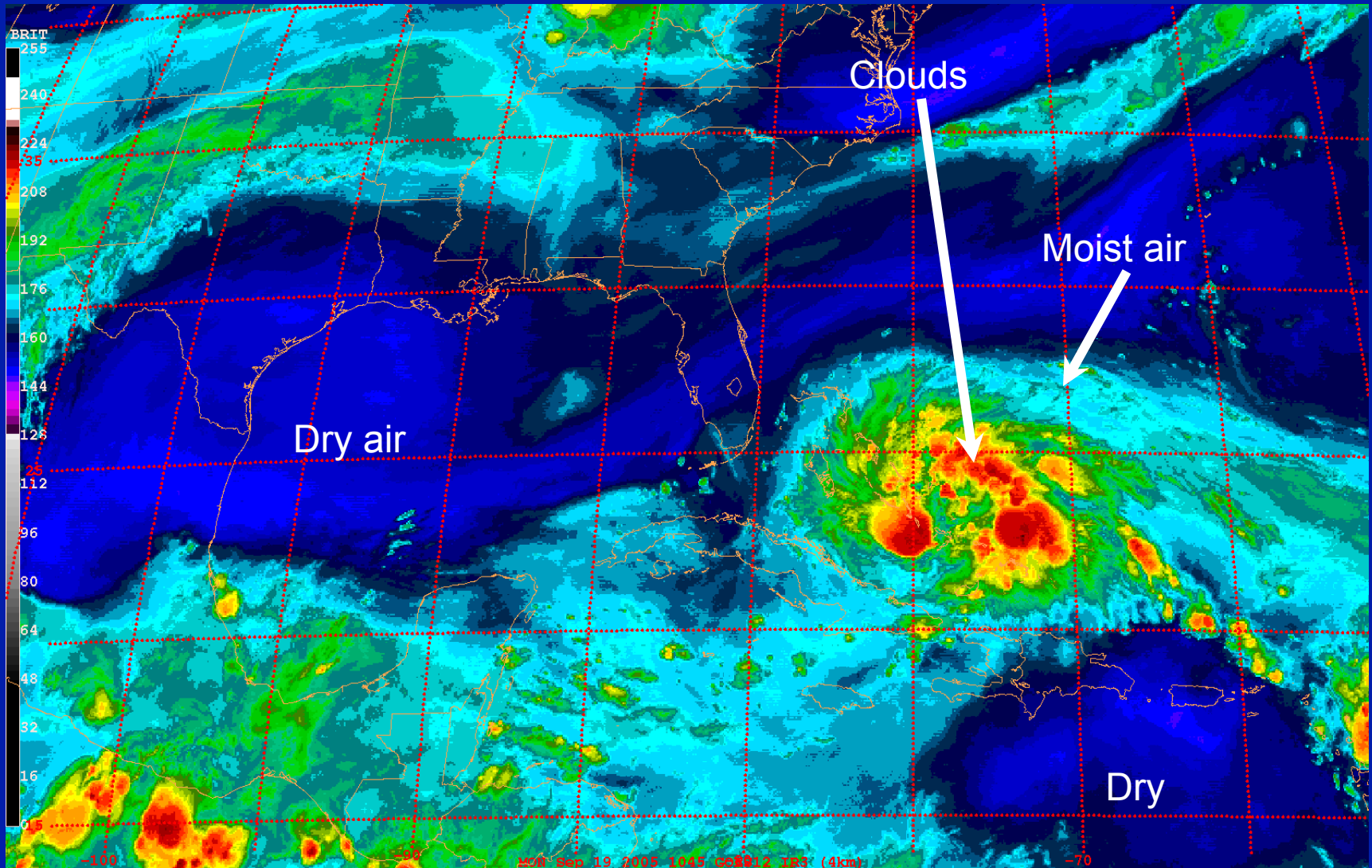
Humid atmosphere--need high humidity to get clouds to develop

Weak "wind shear" --if wind is stronger at upper levels than lower levels, storm top separates from lower part of storm

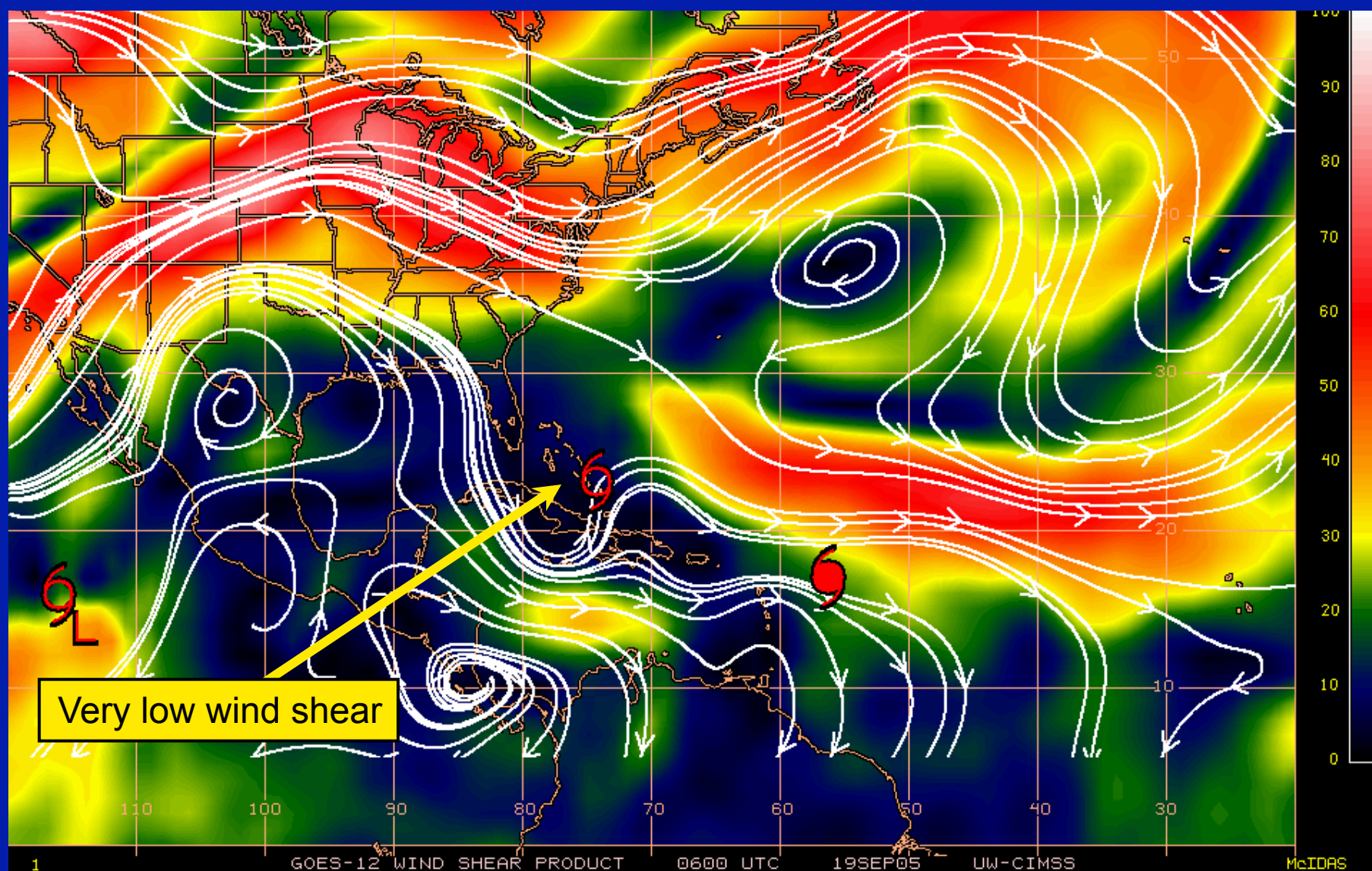
Map of ocean heat content



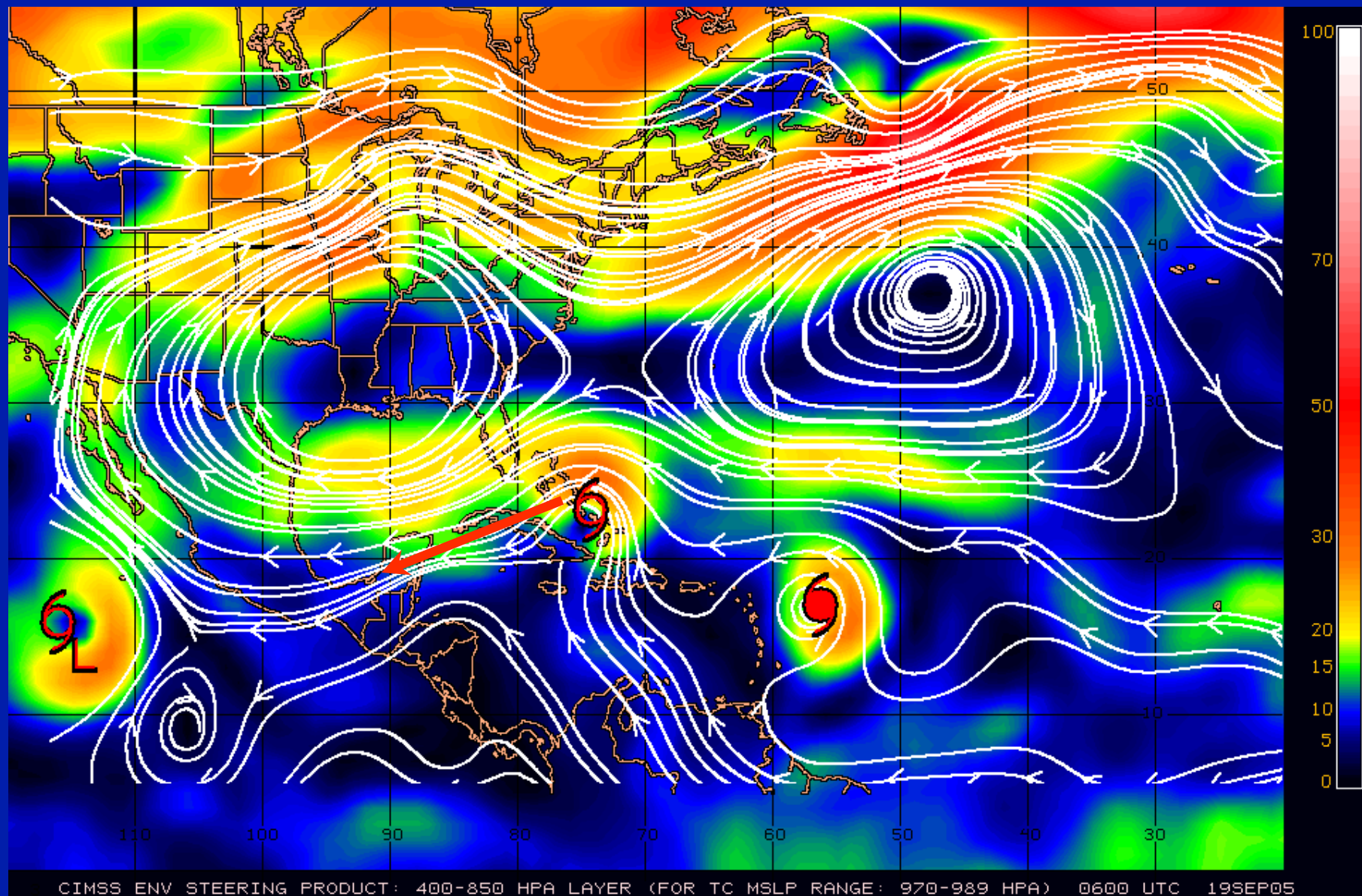
Satellite view of humidity



Map of wind shear



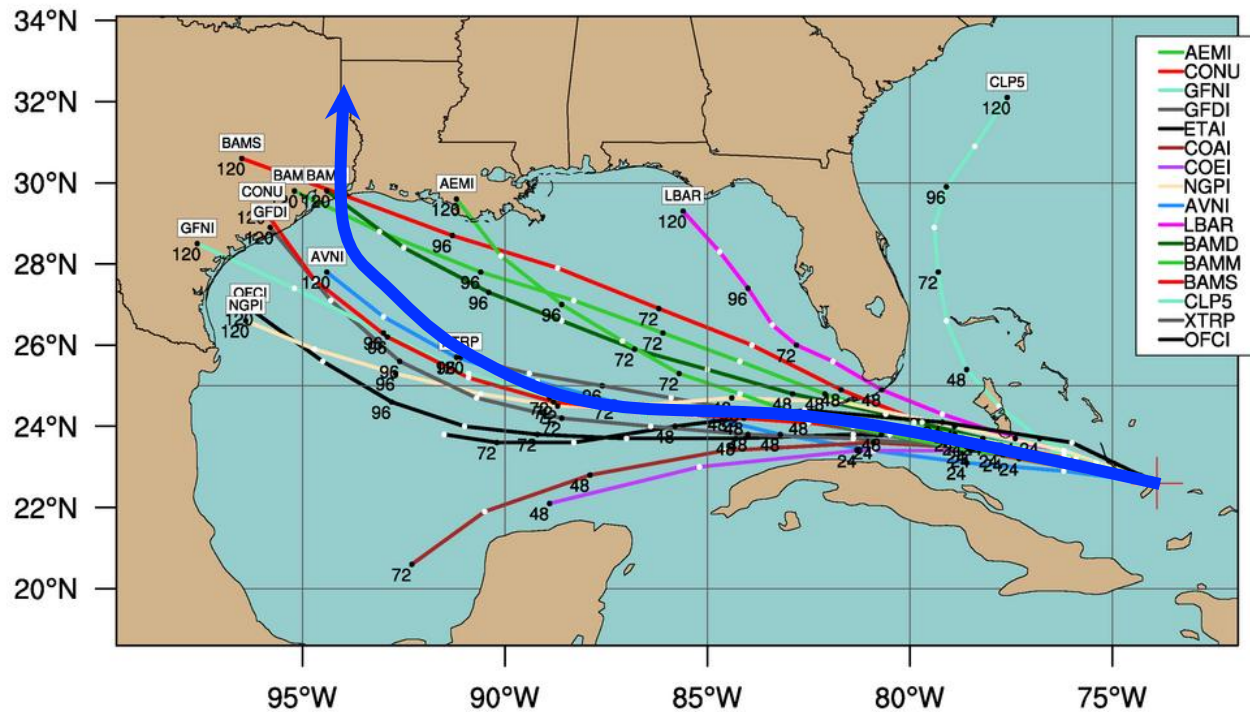
Map of steering winds



Model forecasts of Rita's storm track

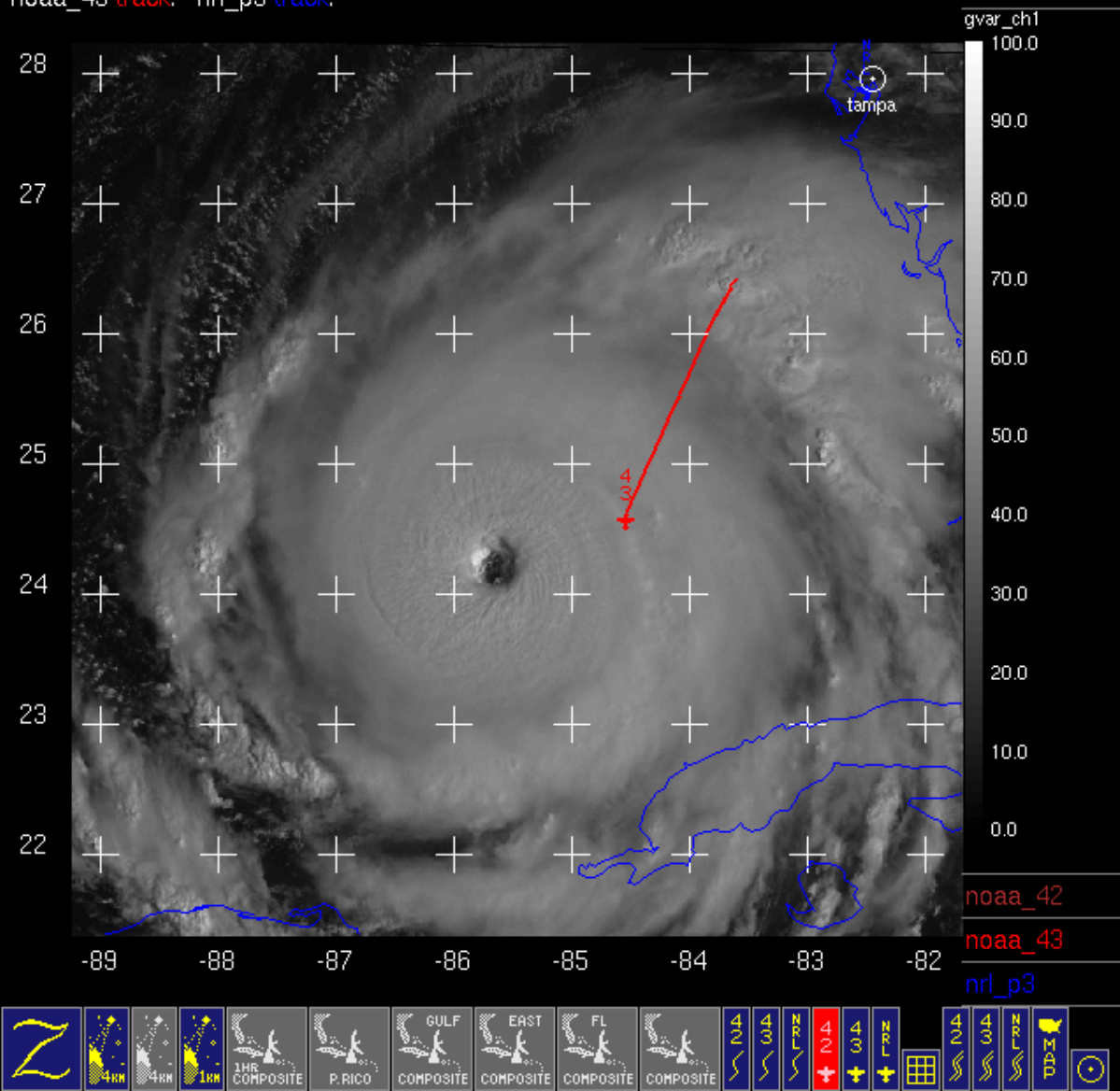
AL18

Early-cycle track guidance valid 0600 UTC, 19 September 2005



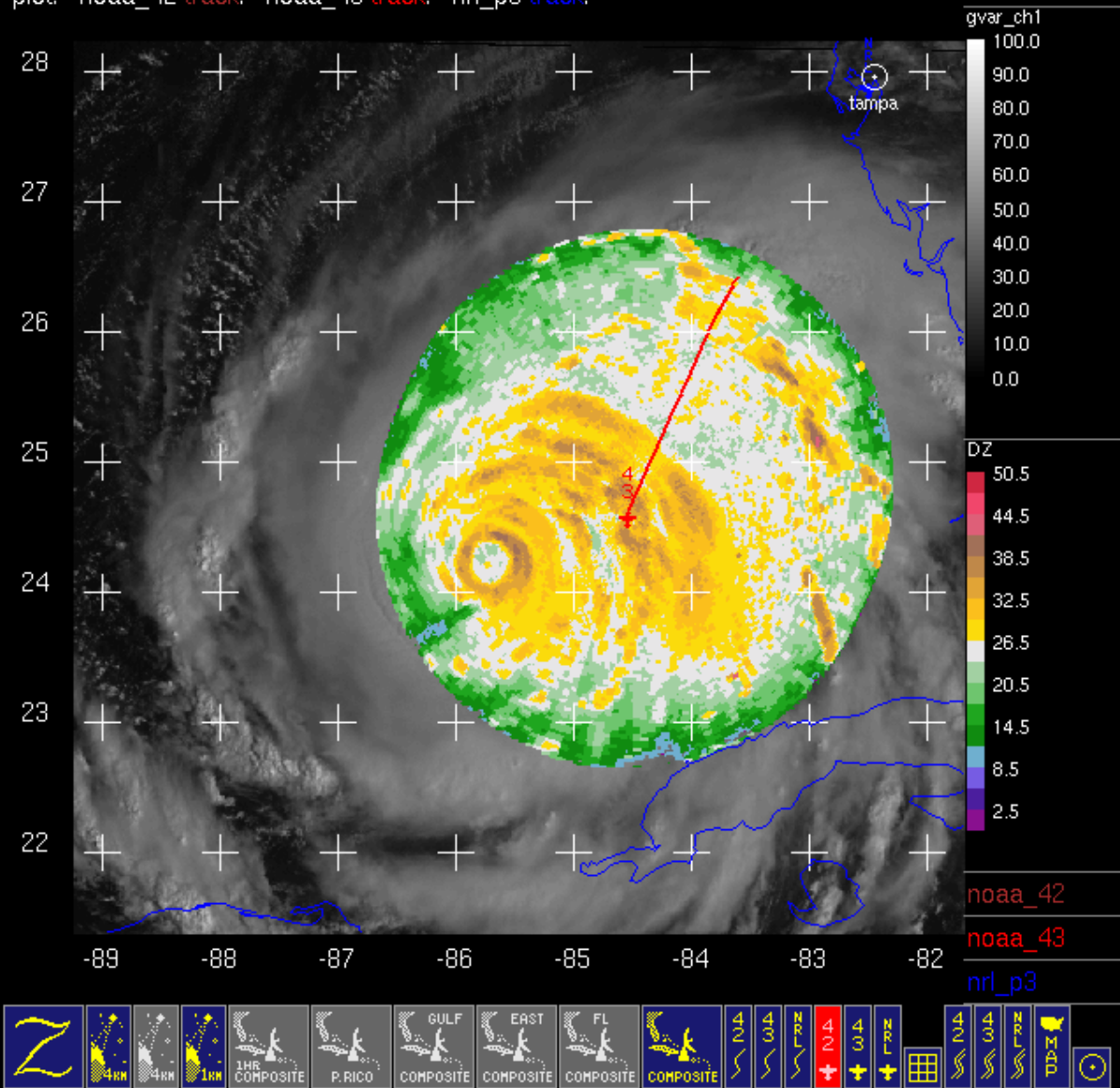
Rita-Day 1

```
21-sep-2005,15:00:00 goes_4km gvar_ch1 plot. goes_1km gvar_ch1 plot. noaa_42 track.  
noaa_43 track. nrl_p3 track.
```



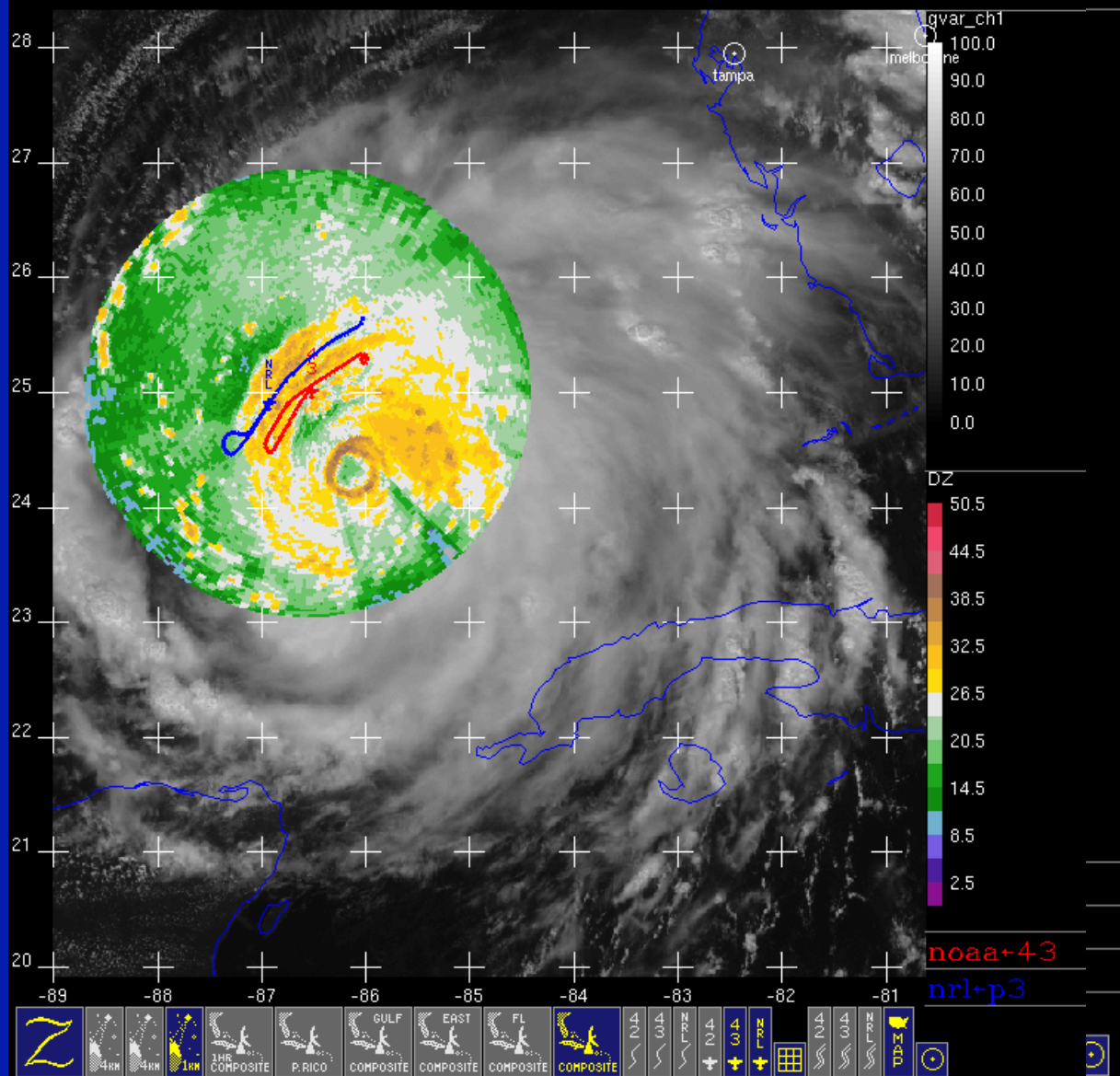
Rita-Day 1

21-sep-2005,15:00:00 goes_4km gvar_ch1 plot. goes_1km gvar_ch1 plot. noaa_lf_composite DZ
plot. noaa_42 track. noaa_43 track. nrl_p3 track.



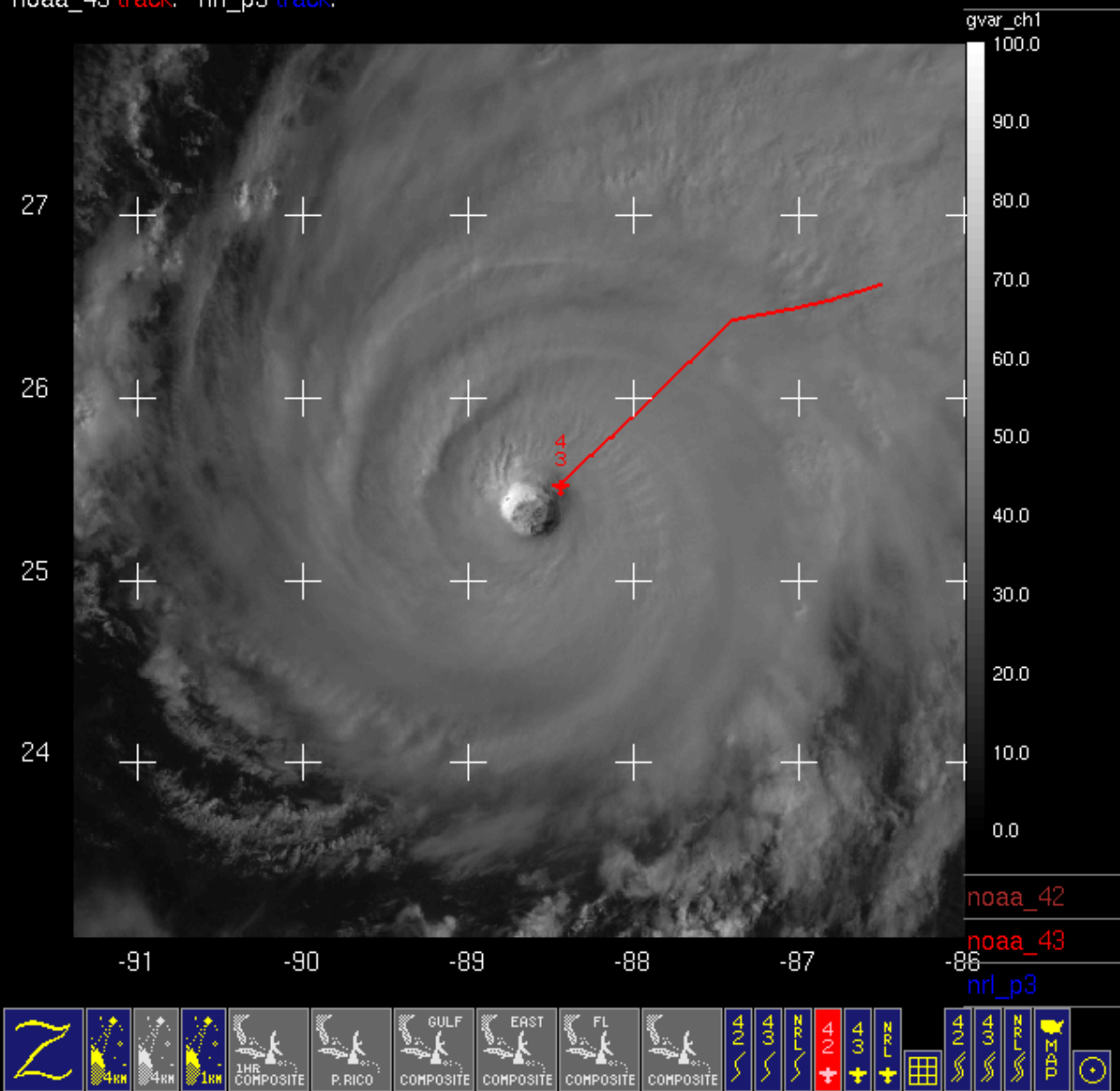
Rita-Day 1

21-sep-2005,18:10:00 goes_1km gvar_ch1 plot. noaa_1f_composite DZ plot. noaa_43 track. nrl_p3 track.



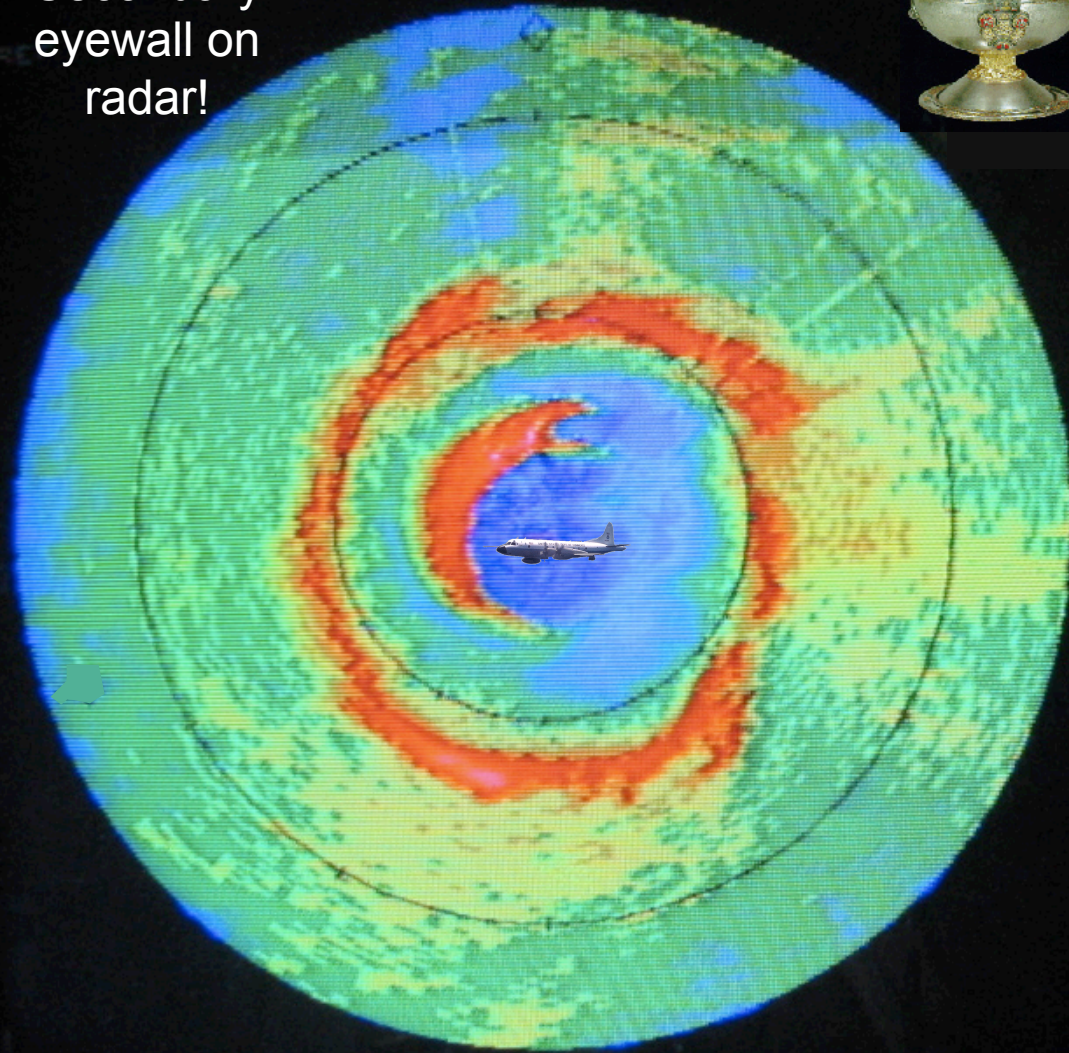
Rita-Day 2

22-sep-2005,14:45:00 goes_4km gvar_ch1 plot. goes_1km gvar_ch1 plot. noaa_42 track.
noaa_43 track. nrl_p3 track.



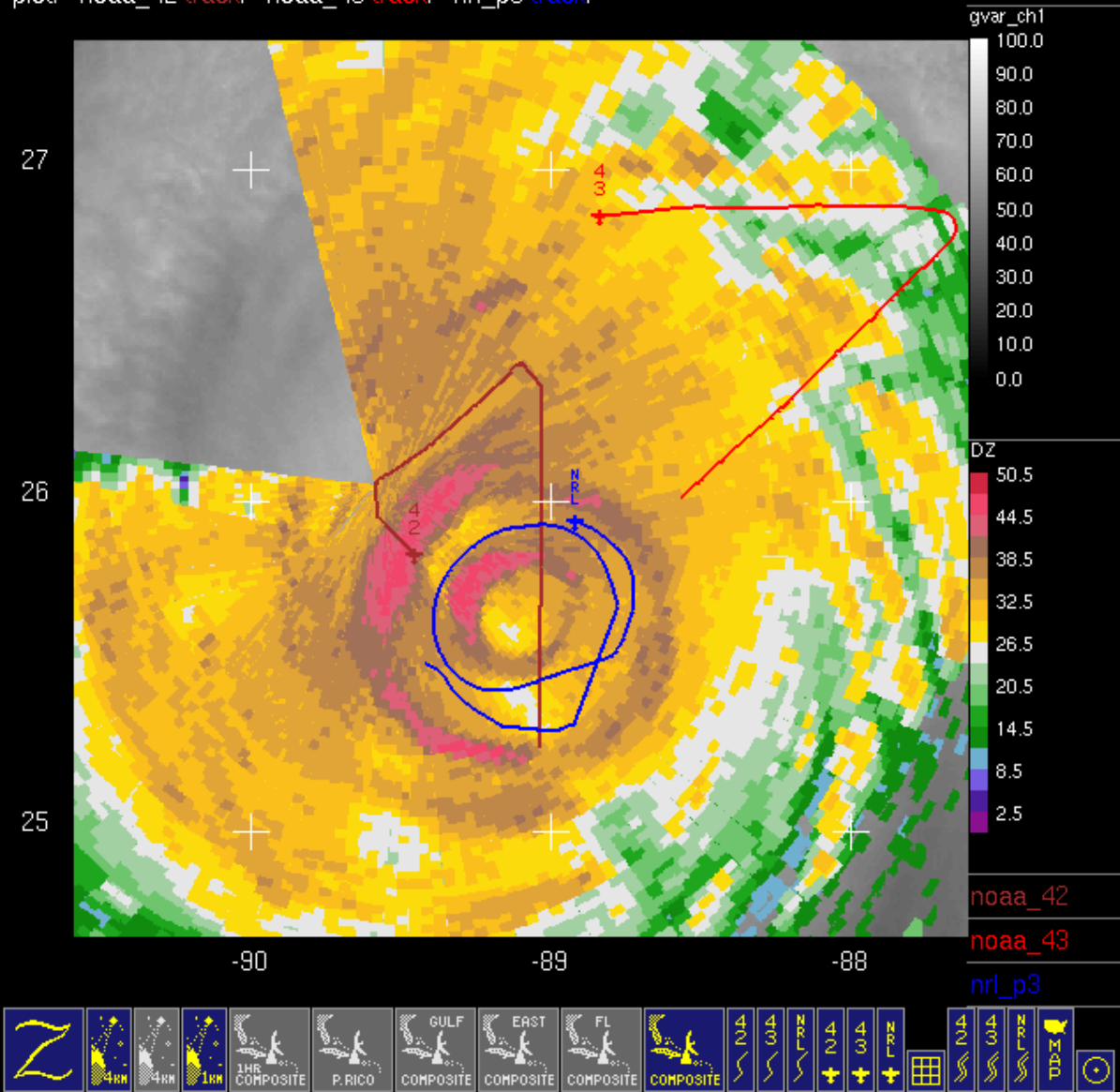
Rita-Day 2

Secondary
eyewall on
radar!



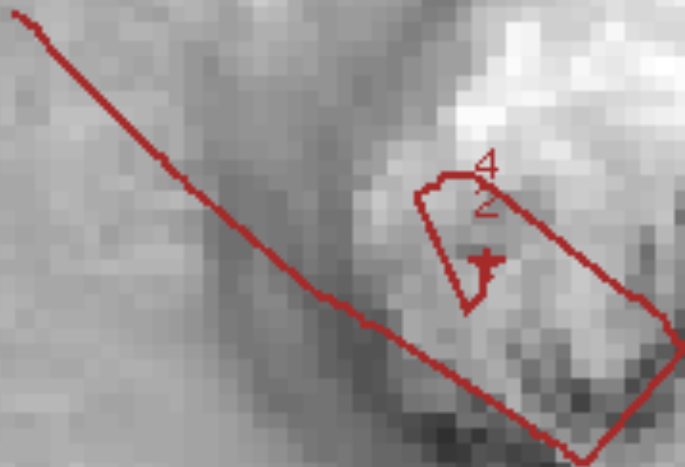
Rita-Day 2

22-sep-2005,18:30:00 goes_4km gvar_ch1 plot. goes_1km gvar_ch1 plot. noaa_lf_composite DZ
plot. noaa_42 track. noaa_43 track. nrl_p3 track.



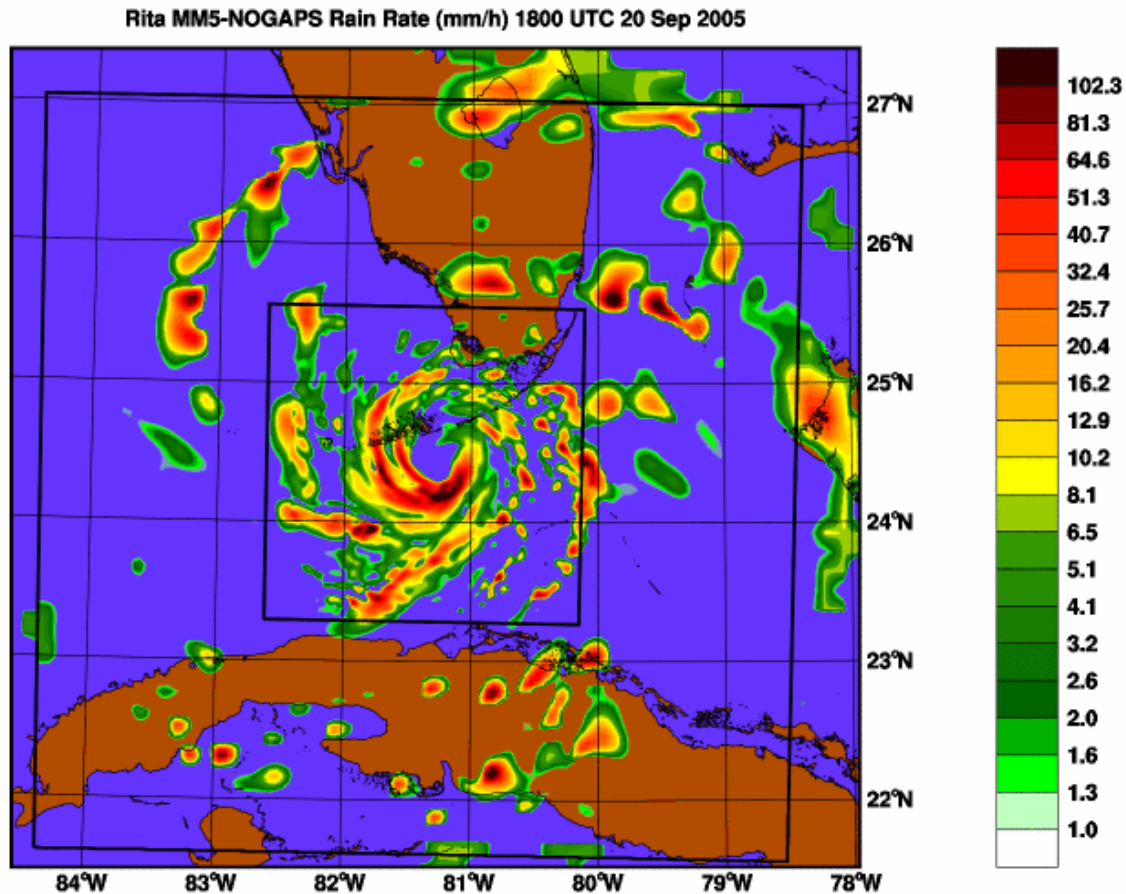
Flying around
between and
through the
primary and
secondary
eyewalls

Inside the eye of Rita





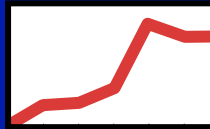
Numerical Model Simulation of Rita



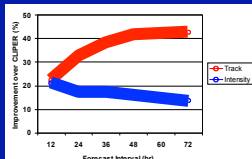
RECAP



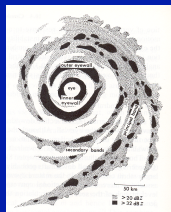
Strong hurricanes--indescribably destructive by water and wind



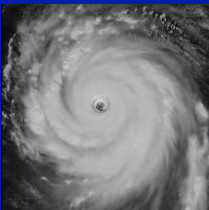
As oceans warm up--more hurricanes are reaching category 5



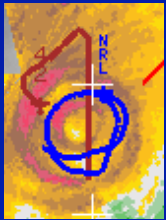
Hurricane track forecasting has improved--intensity forecasting has not



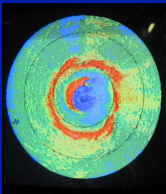
Intensity changes depends on internal storm structure



RAINEX flew 3 planes in Katrina and Rita to address the intensity change problem



Successfully targeted the internal features with Doppler radar and dropsondes



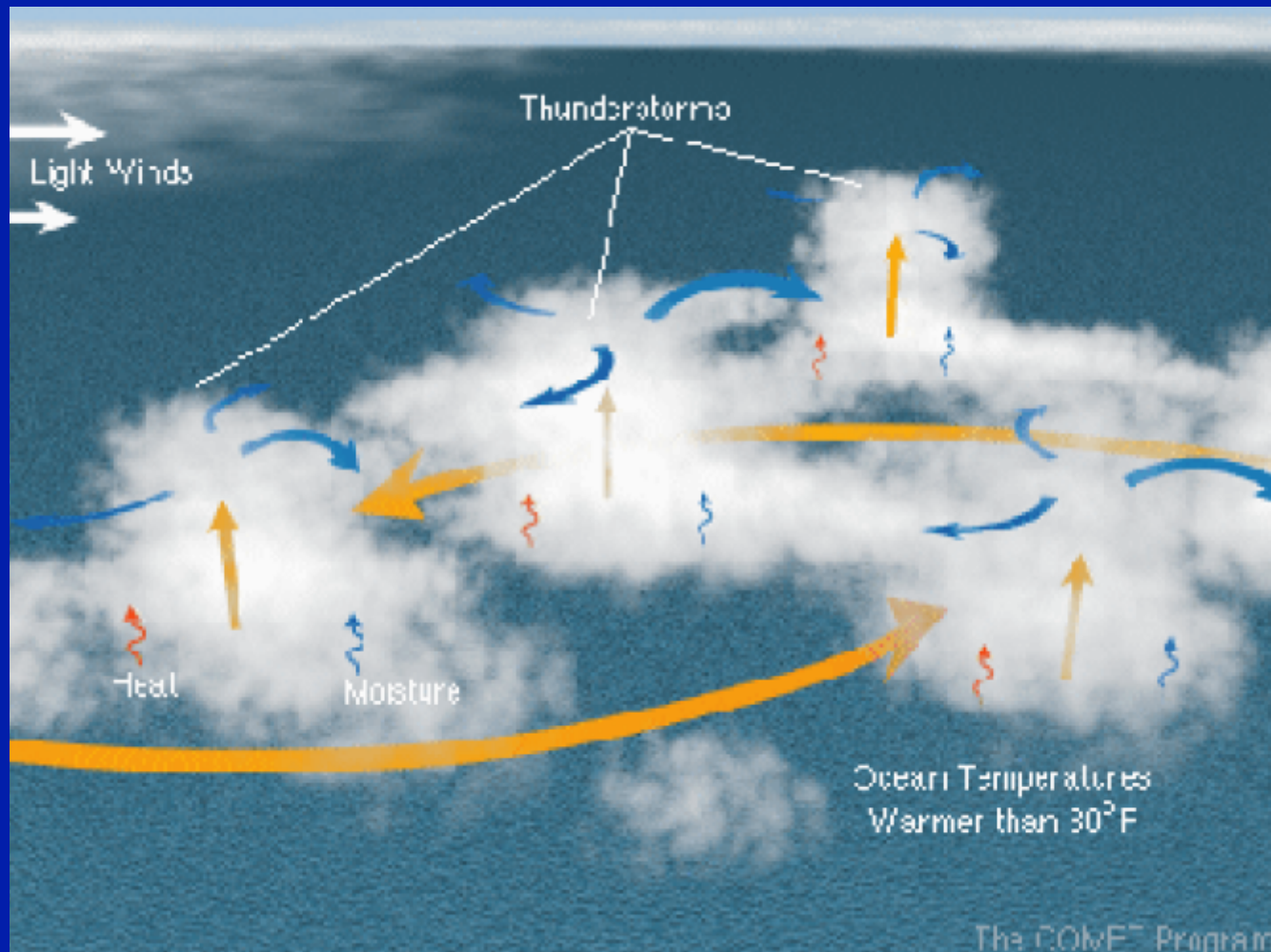
In Hurricane Rita--RAINEX observed the secondary eyewall and eyewall replacement

When will we know the answers?

6 Years!



Hurricane forms when several mesoscale convective systems
“organize” into a common storms



A schematic of a mature hurricane

