

ATM S 103

Hurricanes and Thunderstorms

Their Science and Impacts



Hurricane Patricia near Mexico, 2015

Class Overview

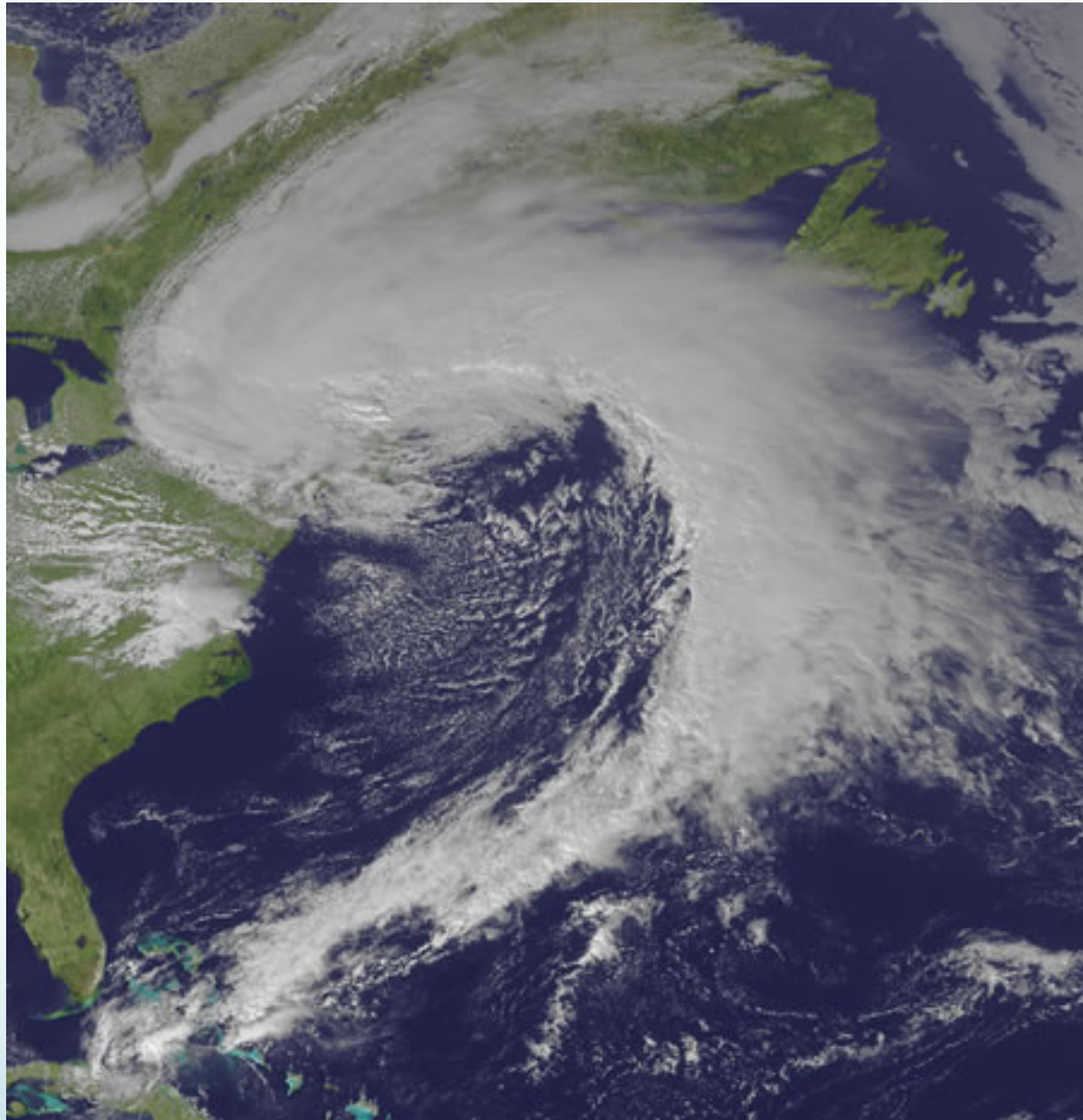
- Goal: To explore science, history, and impacts of thunderstorms and hurricanes
 - Clouds (Weeks 1-2)
 - Thunderstorms (Weeks 3-5)
 - Tornados (Weeks 6-7)
 - **Hurricanes/Tropical Cyclones** (Weeks 8-10)

Topics for today

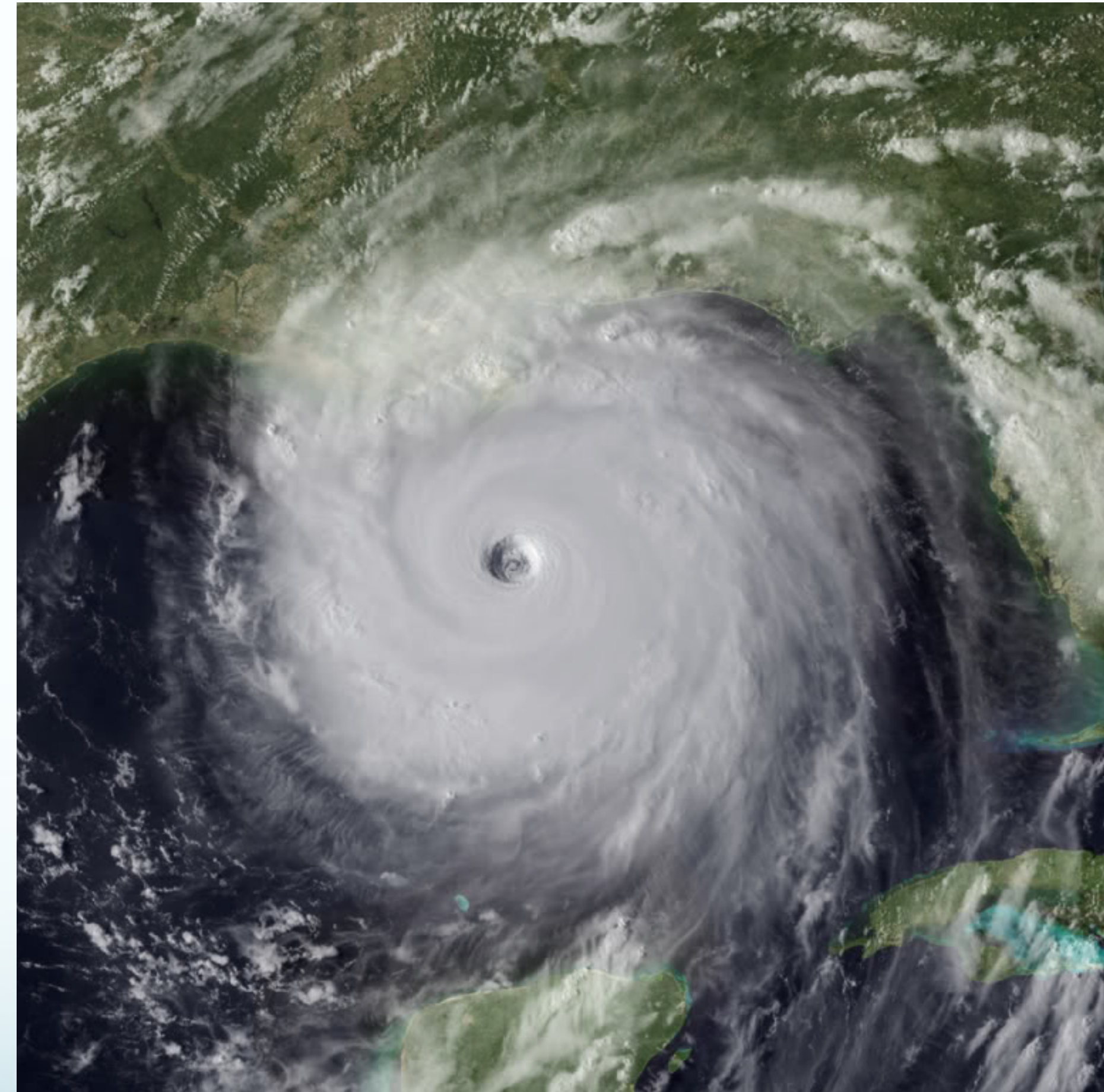
- A brief overview of hurricanes
- Saffir-Simpson scale
- Comparison of recent hurricane impacts
- Basic hurricane structure

A Brief Overview of Hurricanes

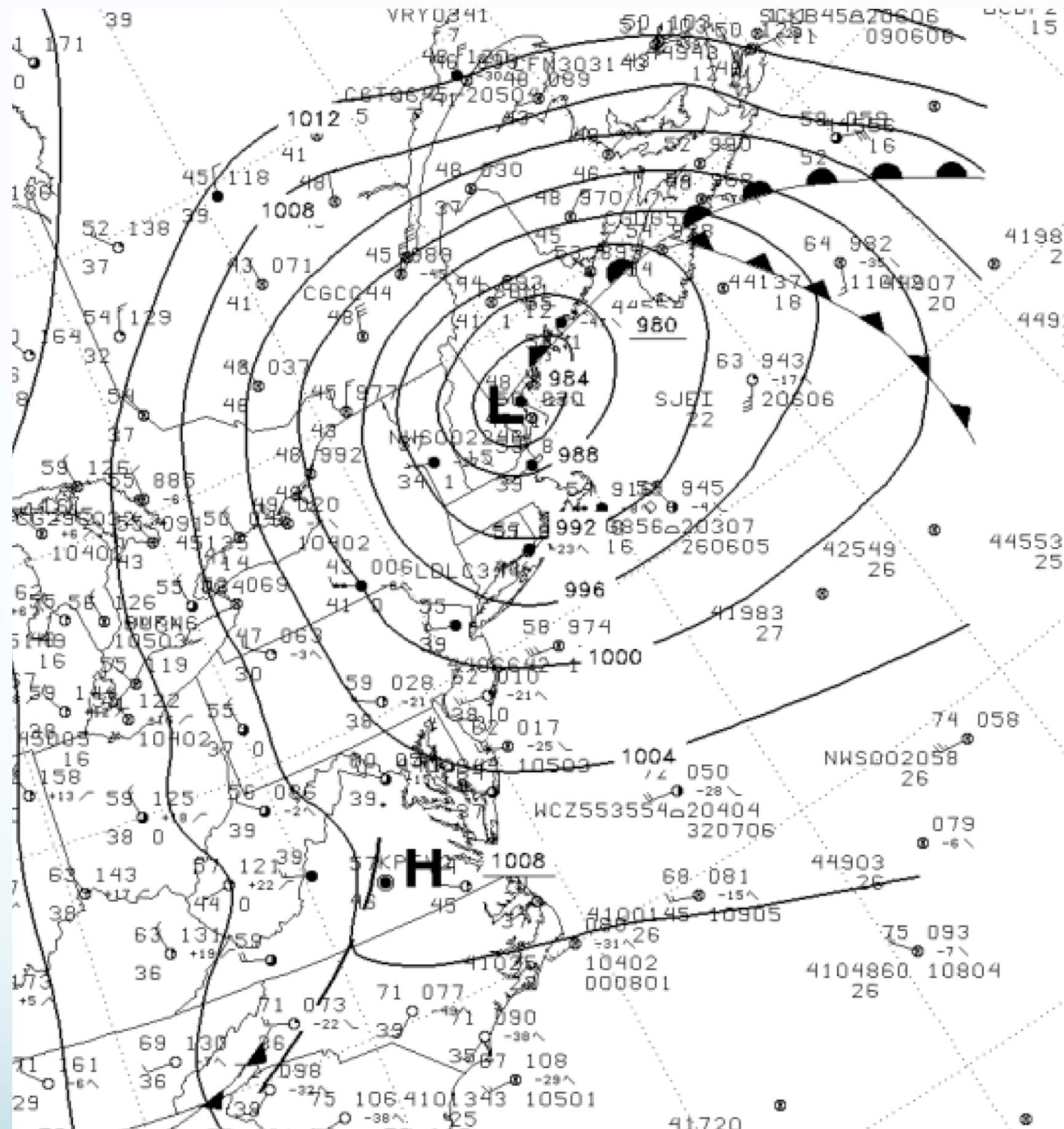
Midlatitude-Cyclone



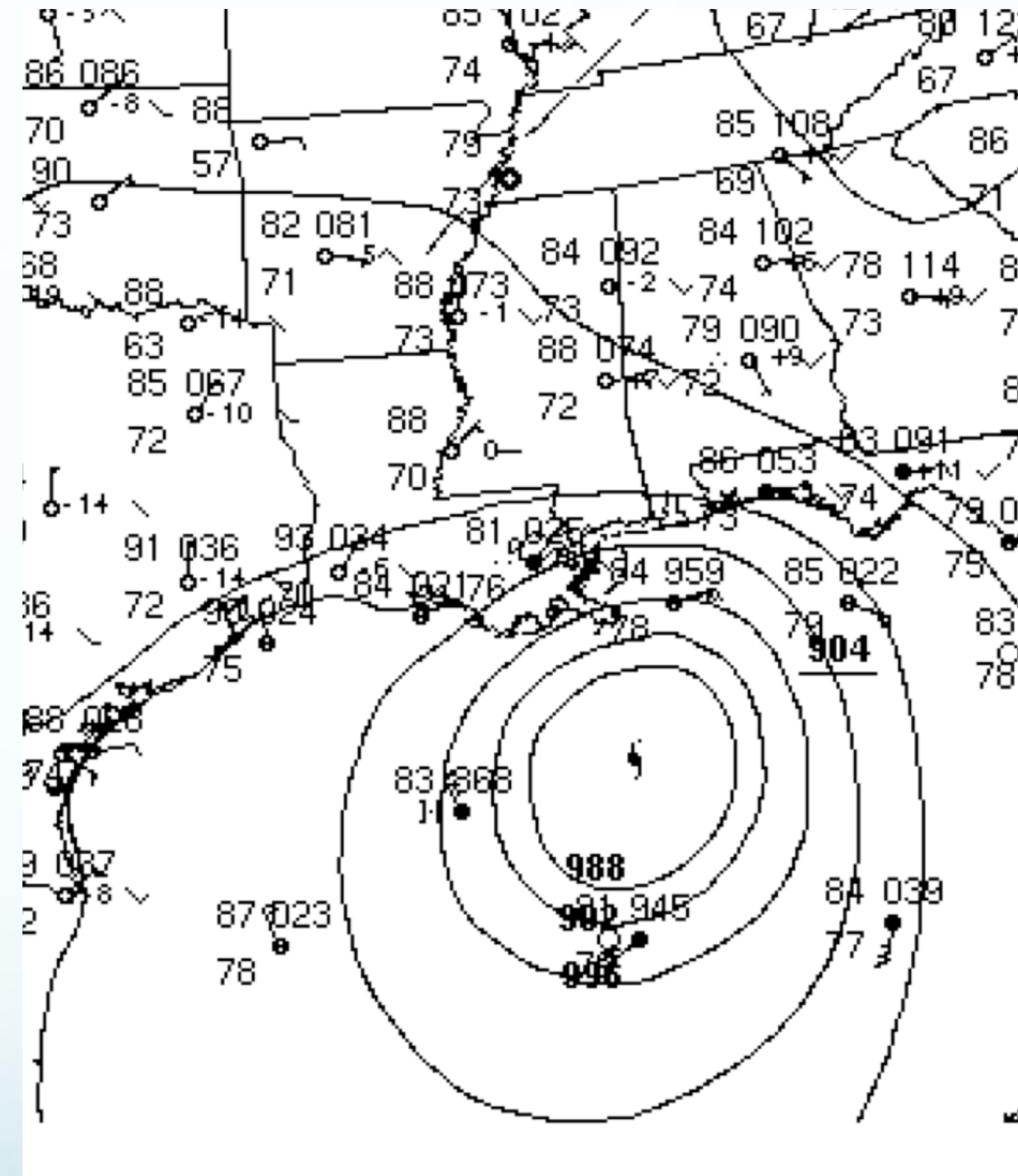
Tropical Cyclone



Midlatitude-Cyclone



Tropical Cyclone



(Surface weather maps: inner isobars not drawn for the Tropical Cyclone)

What's different?

- Visually, the midlatitude cyclone has
 - No circular symmetry
 - No eye
 - Does have fronts
- Also the midlatitude cyclone
 - Has strong winds aloft: it's near the jet stream
 - Is powered by “north-south” horizontal temperature differences.
- The tropical cyclone is powered by ?

W Hurricanes are powered by latent heat released in thunderstorms.

True

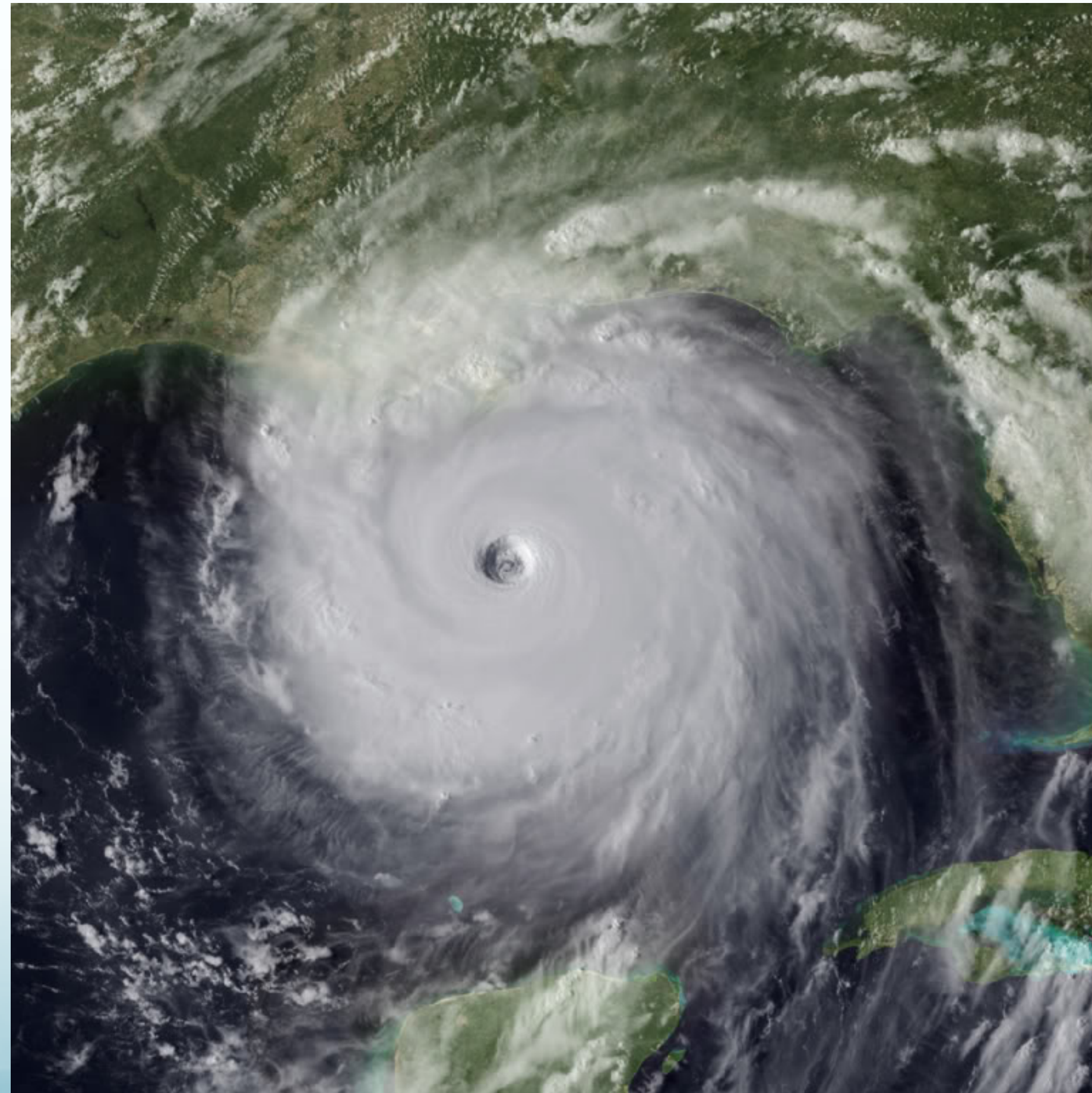
Falase

Start the presentation to see live content. Still no live content? Install the app or get help at PollEv.com/app

Total Results

Answer

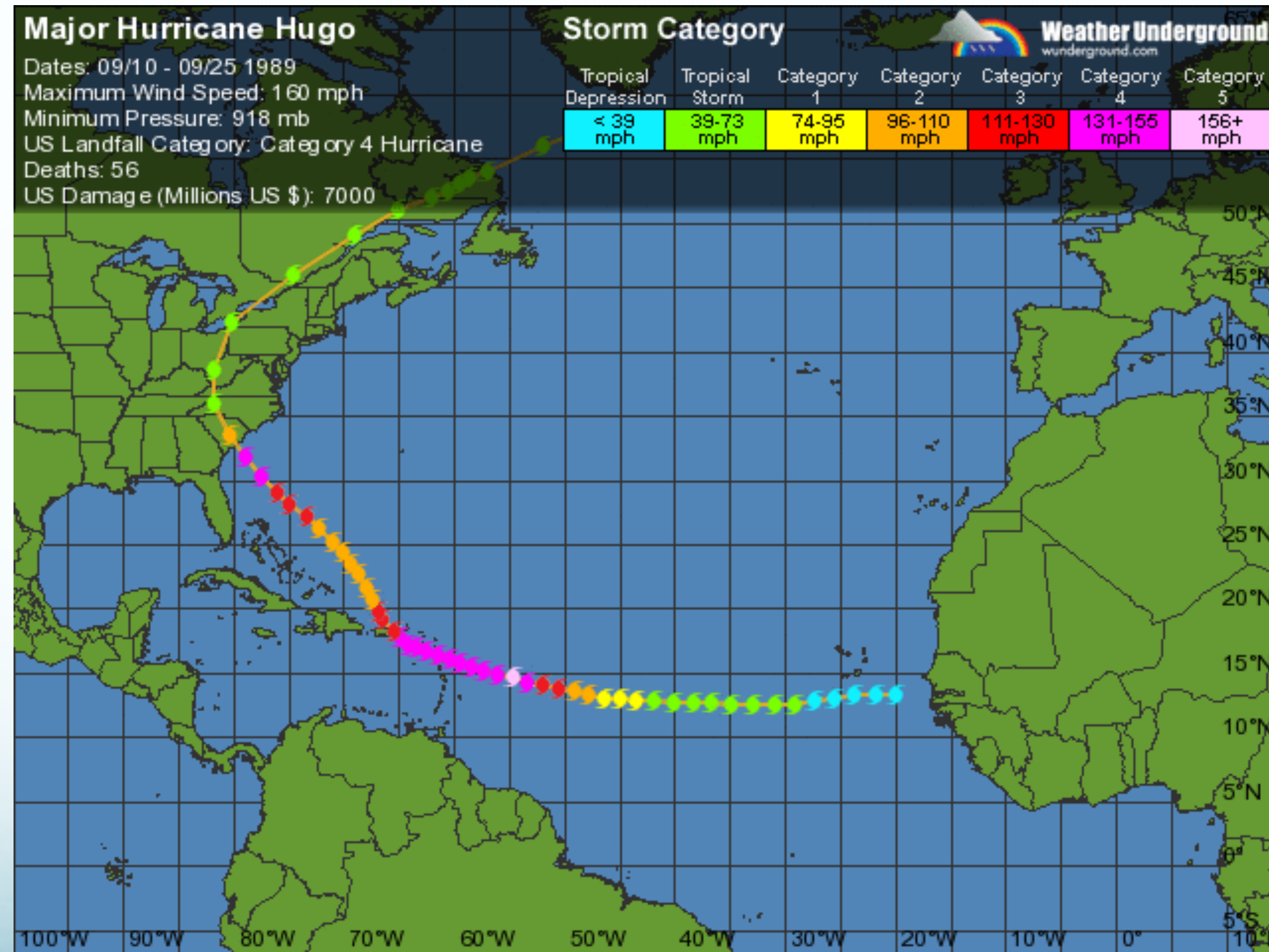
- Hurricanes are powered by latent heat released in thunderstorms
 - Surrounding the eye
 - In spiral bands



Hurricane Hugo (1989)

A nice prototype storm for our introductory overview

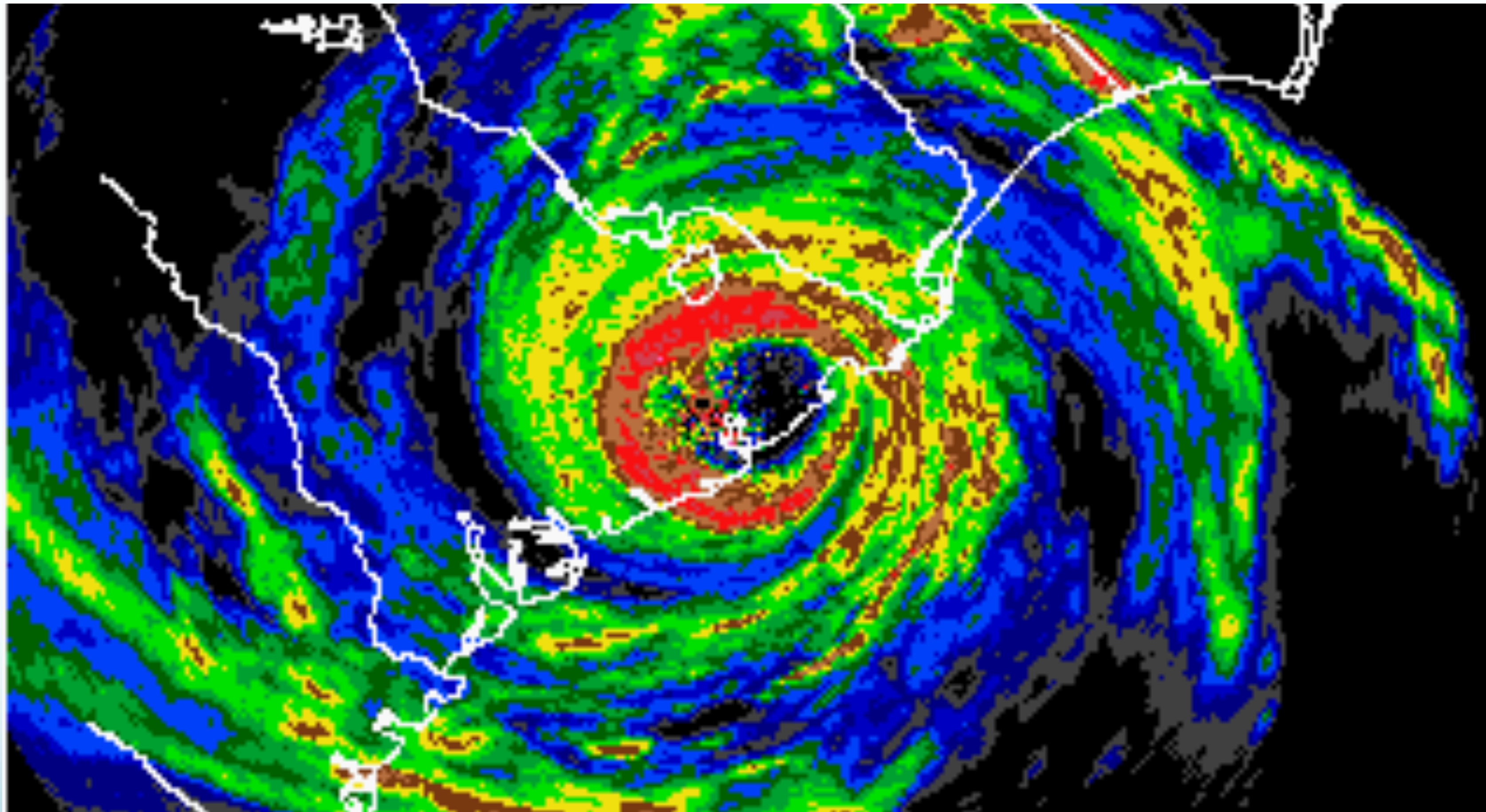
Hugo's Track (15 days)



Hurricane Hugo Approaches South Carolina; September 21, 1989



Charlestown, SC Radar: Sept 22, 1989



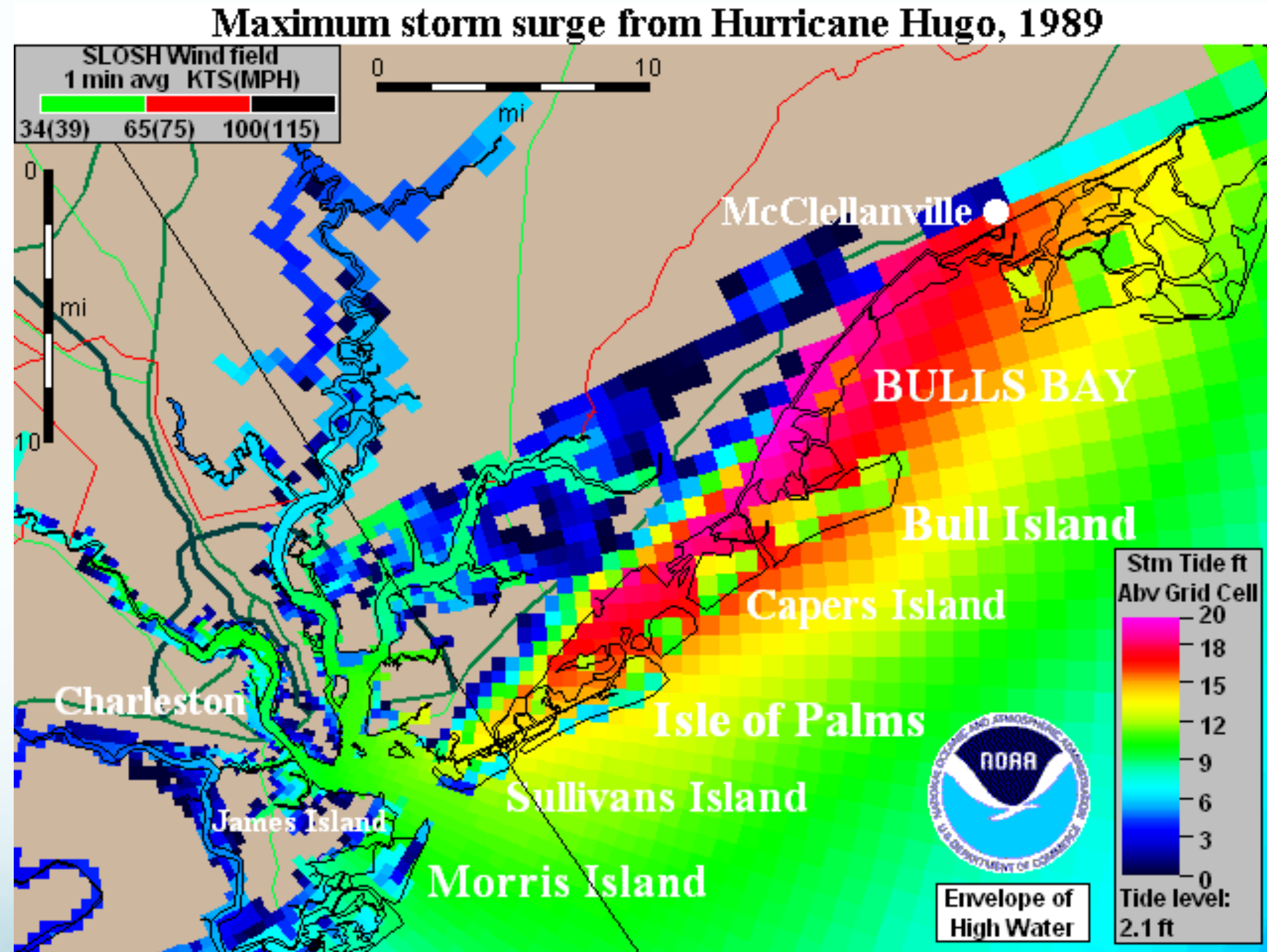
Hurricane Impacts Generated by

- High winds
- Storm surge
- Flooding with heavy rainfall

High Winds



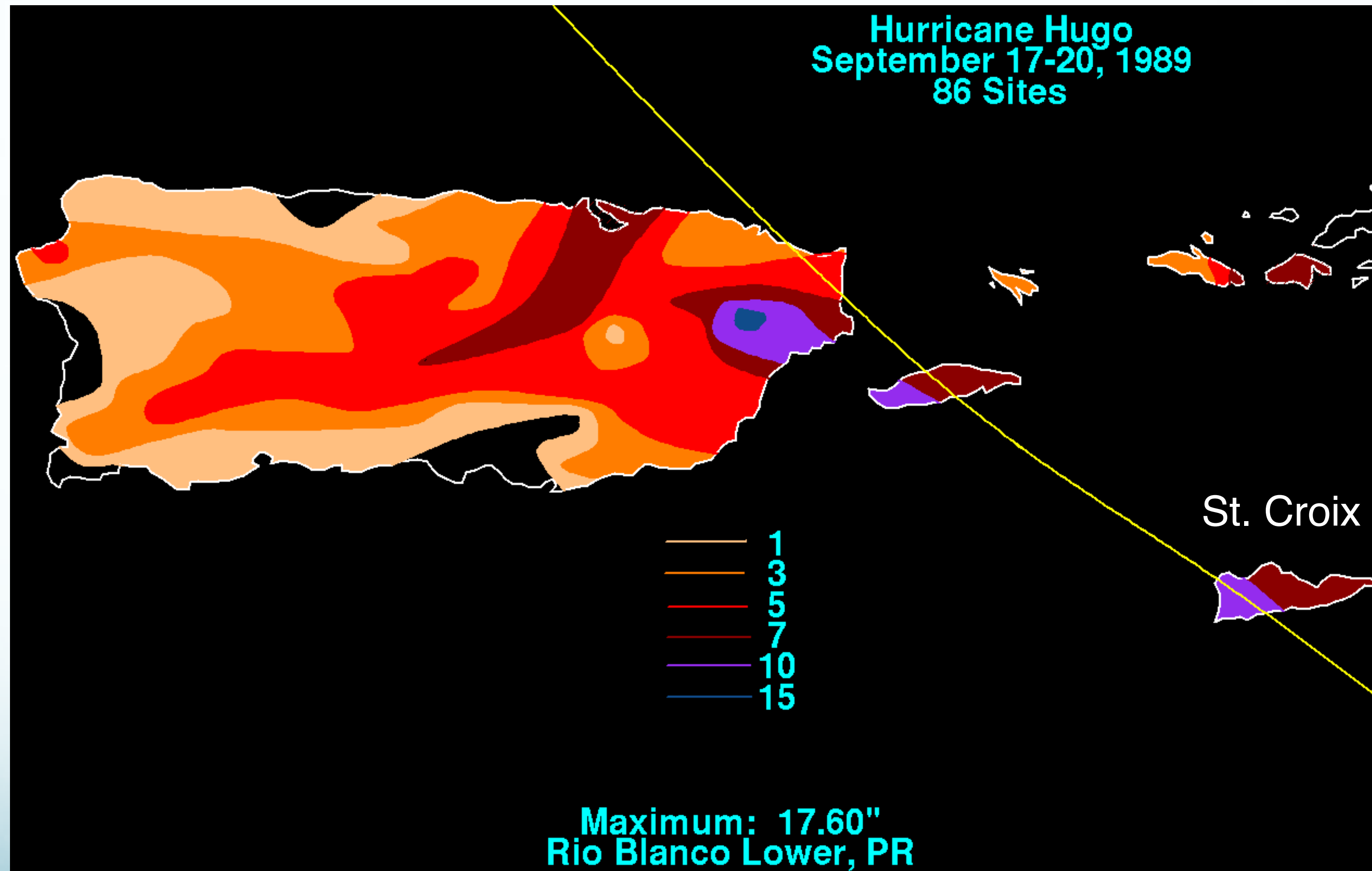
Storm Surge Maximum about 20 ft



Damage in South Carolina



Rainfall in Puerto Rico



St. Croix, September 18th

- Eyewall strikes, bringing sustained winds of 140 mph.
- Wind gusts were extremely violent, and included tornado-like vortices.
- Storm surge of 2–3 ft topped, by battering waves 20–23 ft.
- Two killed, 80 injured, and 90% of the buildings were damaged or destroyed. The island's entire infrastructure was virtually wiped out.
- Six weeks after the hurricane, only 25% of the public roads had been cleared, and only 25% of the island had power.

Saffir-Simpson Scale

Based on measured/estimated **wind speed**
Wind values are **averaged over 1 minute**, at a height 10 m above the surface.

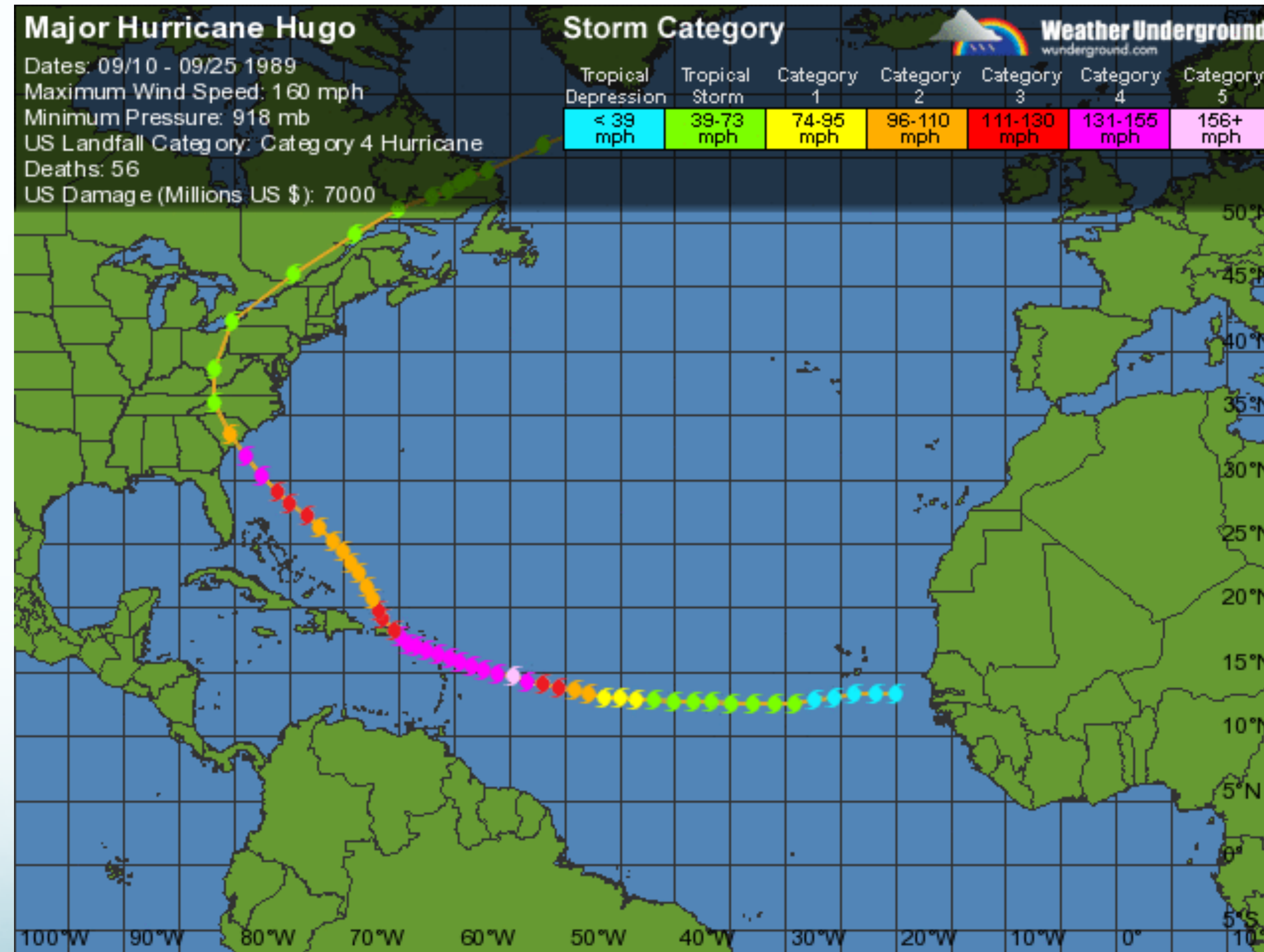
EF Rating	Wind Speeds
EF-0	65-85 mph
EF-1	86-110 mph
EF-2	111-135 mph
EF-3	136-165 mph
EF-4	166-200 mph
EF-5	> 200 mph

Saffir-Simpson Hurricane Scale			
Category	Winds (MPH)	Damage	Storm Surge
1	74 - 95	Minimal: Damage to unanchored mobile homes, vegetation & signs. Coastal road flooding. Some shallow flooding of susceptible homes.	4 - 5 feet
2	96 - 110	Moderate: Significant damage to mobile homes & trees. Significant flooding of roads near the coast & bay.	6 - 8 feet
3	111 - 130	Extensive: Structural damage to small buildings. Large trees down. Mobile homes largely destroyed. Widespread flooding near the coast & bay.	9 - 12 feet
4	131 - 155	Extreme: Most trees blown down. Structural damage to many buildings. Roof failure on small structures. Flooding extends far inland. Major damage to structures near shore.	13 - 18 feet
5	More than 155	Catastrophic: All trees blown down. Some complete building failures. Widespread roof failures. Flood damage to lower floors less than 15 feet above sea level.	Greater than 18 feet

Not accurate

[Weather Channel video](#)

Hugo's Track (15 days)



Winds are determined by

- The occasional direct observation
- Occasional related observations of surface pressures
- Winds aloft observed by hurricane-hunter aircraft
- Estimates from satellite imagery.

W Comparing the Saffir-Simpson and Enhanced Fujita Scales,

One is for hurricanes and the other for tornadoes.

One surveys damage to estimate winds; the other uses wind data to anticipate damage.

Both of the above.

Answer

- Both of the above
- Enhanced Fujita scale is for tornadoes and uses damage to estimate wind speeds.
- Saffir-Simpson scale is for hurricanes and uses wind-speeds to estimate damage.

Hugo (1989): Impacts Summary

- Killed 107 people
- At the time, the damage it produced made it the costliest hurricane in US history.
- It no longer holds the distinction of being the costliest US hurricane.

Costliest US Hurricanes (NOAA, w/o adjusting for inflation)

	Hurricane	Location	Date	Category	Damages
1	Katrina	LA, MS, FL	2005	Cat 3	\$125B
2	Harvey	TX, LA	2017	Cat 4	\$125B
3	Maria	PR, USVI	2017	Cat 4	\$90B
4	Sandy	Mid-Atl and NE US	2011	Cat 1	\$65B
5	Irma	FL	2017	Cat 4	\$50B
6	Ike	TX, LA	2008	Cat 2	\$30B
7	Andrew	FL, LA	1992	Cat 5	\$27B
8	Ivan	AL, FL	2004	Cat 3	\$20.5B
9	Wilma	FL	2005	Cat 3	\$19B
10	Rita	LA, TX	2005	Cat 3	\$18.5B
11	Charley	FL	2004	Cat 4	\$16B
12	Irene	Mid-Atl and NE US	2011	Cat 1	\$13.5B
13	Matthew	SE US	2016	Cat 1	\$10B

Hugo is #17 at \$6B

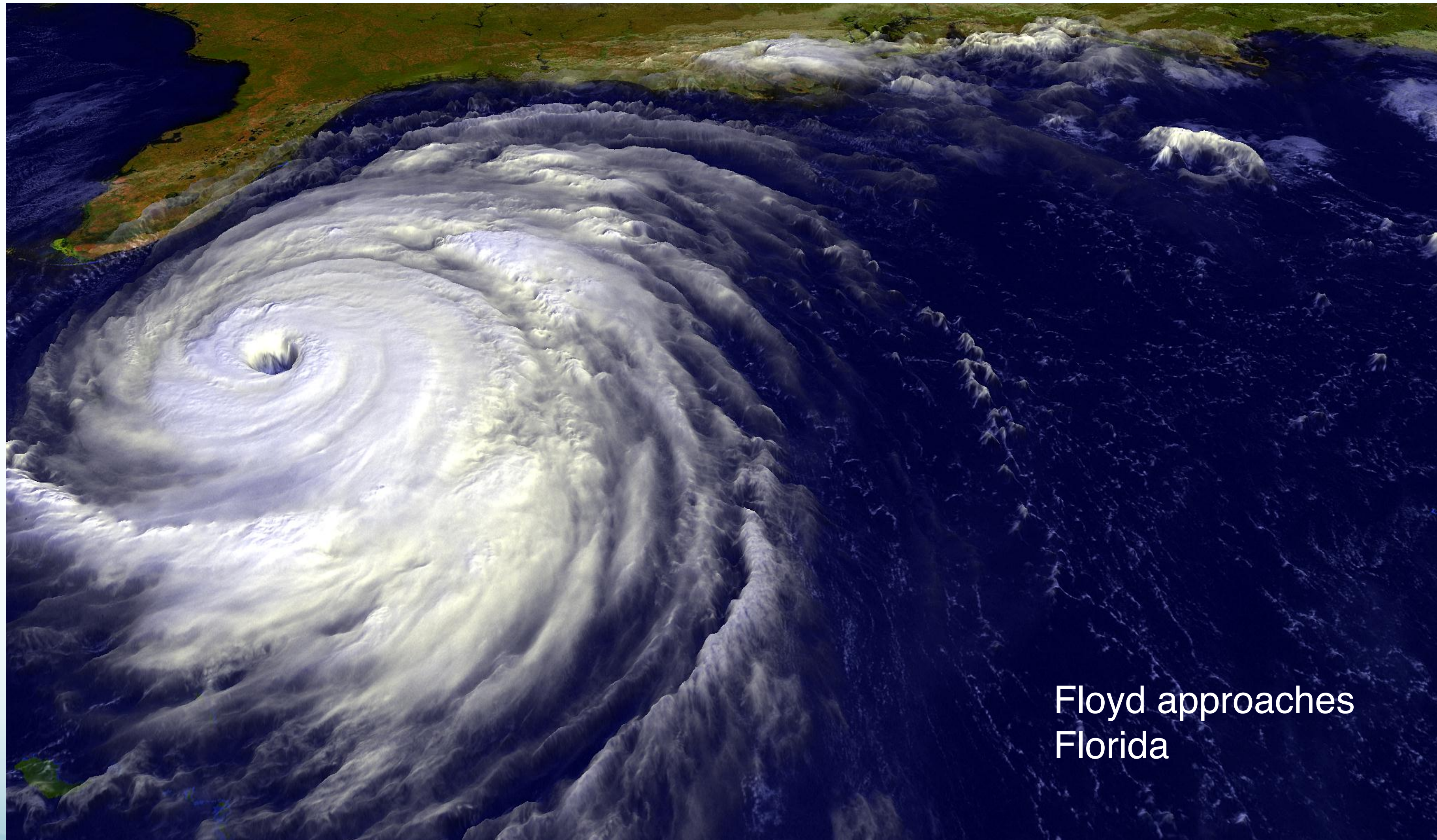
Costliest US Hurricanes (NOAA, with inflation adjustment)

	Hurricane	Location	Date	Category	Damages
1	Katrina	LA, MS, FL	2005	Cat 3	\$160B
2	Harvey	TX, LA	2017	Cat 4	\$125B
3	Maria	PR, USVI	2017	Cat 4	\$90B
4	Sandy	Mid-Atl and NE US	2011	Cat 1	\$70B
5	Irma	FL	2017	Cat 4	\$50B
6	Andrew	FL, LA	1992	Cat 5	\$48B
7	Ike	TX, LA	2008	Cat 2	\$35B
8	Ivan	AL, FL	2004	Cat 3	\$27B
9	Wilma	FL	2005	Cat 3	\$24B
10	Rita	LA, TX	2005	Cat 3	\$24B
11	Charley	FL	2004	Cat 4	\$21B
12	Irene	Mid-Atl and NE US	2011	Cat 1	\$15B
13	Hugo	SC	1989	Cat 4	\$14B

Why are hurricane damages increasing so much?

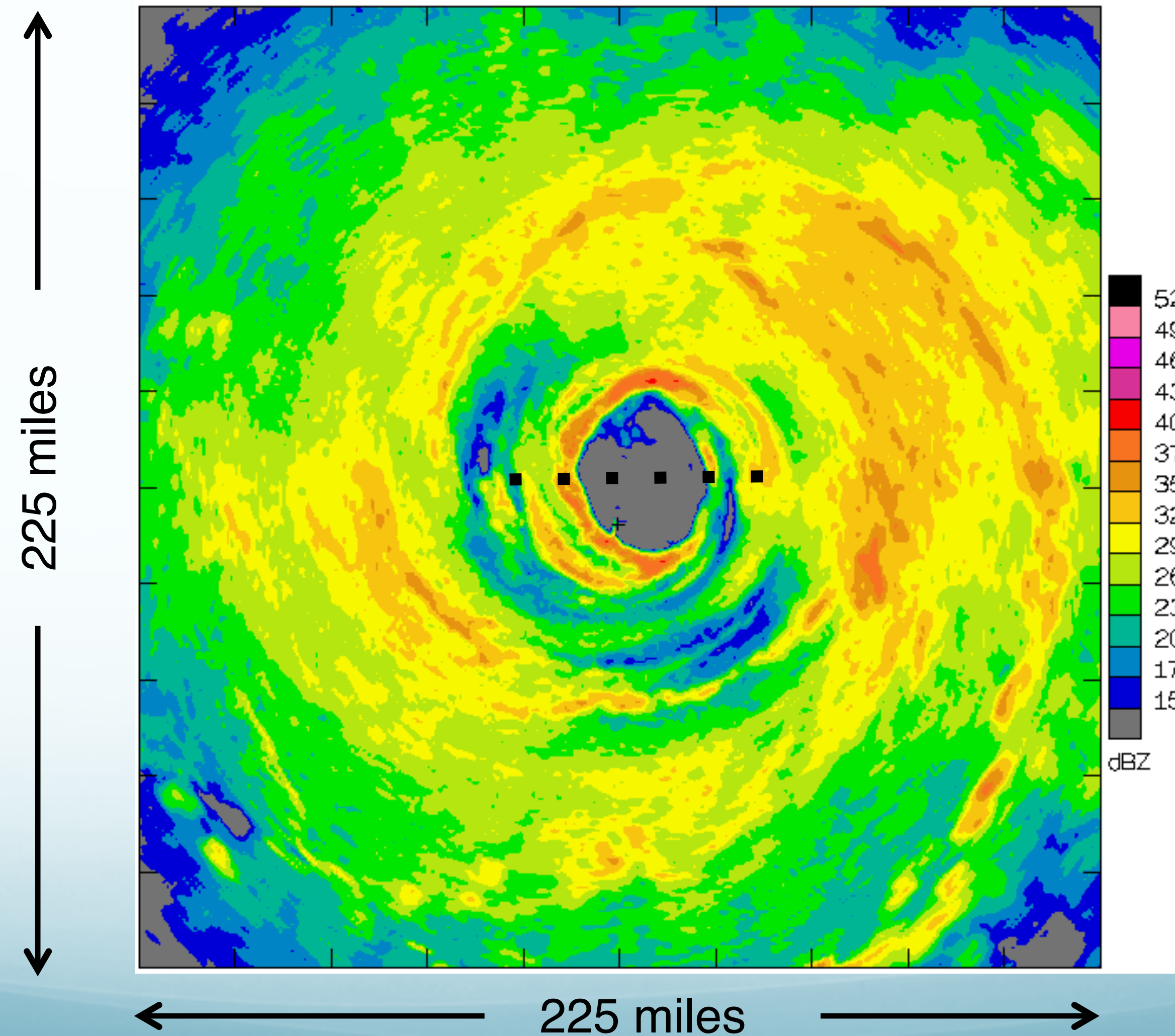
- Increased development on coasts is major factor
- Stronger hurricanes & higher sea level
 - Links to climate change were unclear until recently
- We'll discuss these more in coming weeks

Basic Hurricane Structure

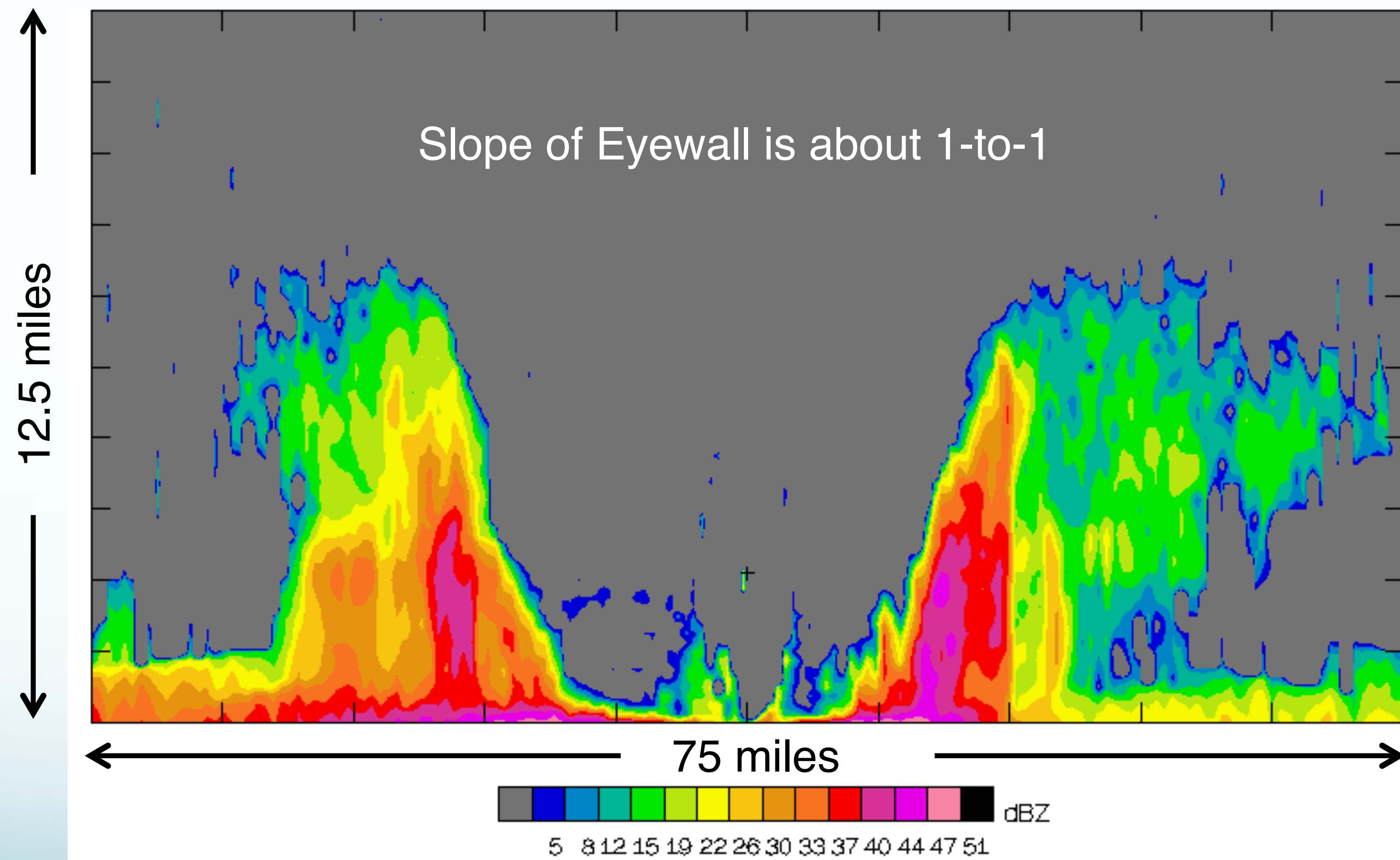


Floyd approaches
Florida

Radar Reflectivity: Floyd (1999)

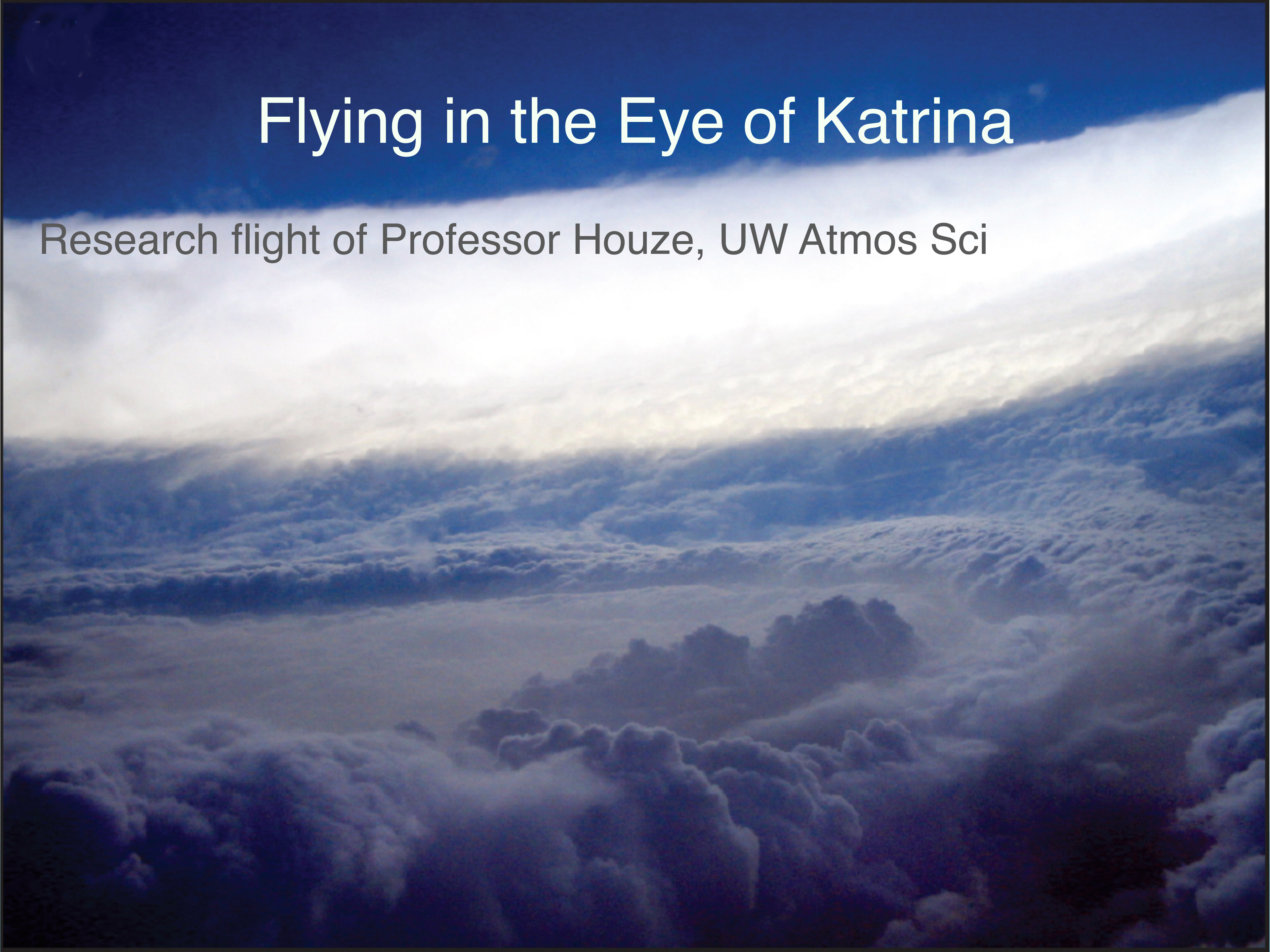


Cross-section approximately along black dotted line on previous slide. Aircraft at “+”.



Flying in the Eye of Katrina

Research flight of Professor Houze, UW Atmos Sci





Eye of Katrina from UW Research Flight
Photo by Dr. Deanna Hence

