

REFLECTIONS

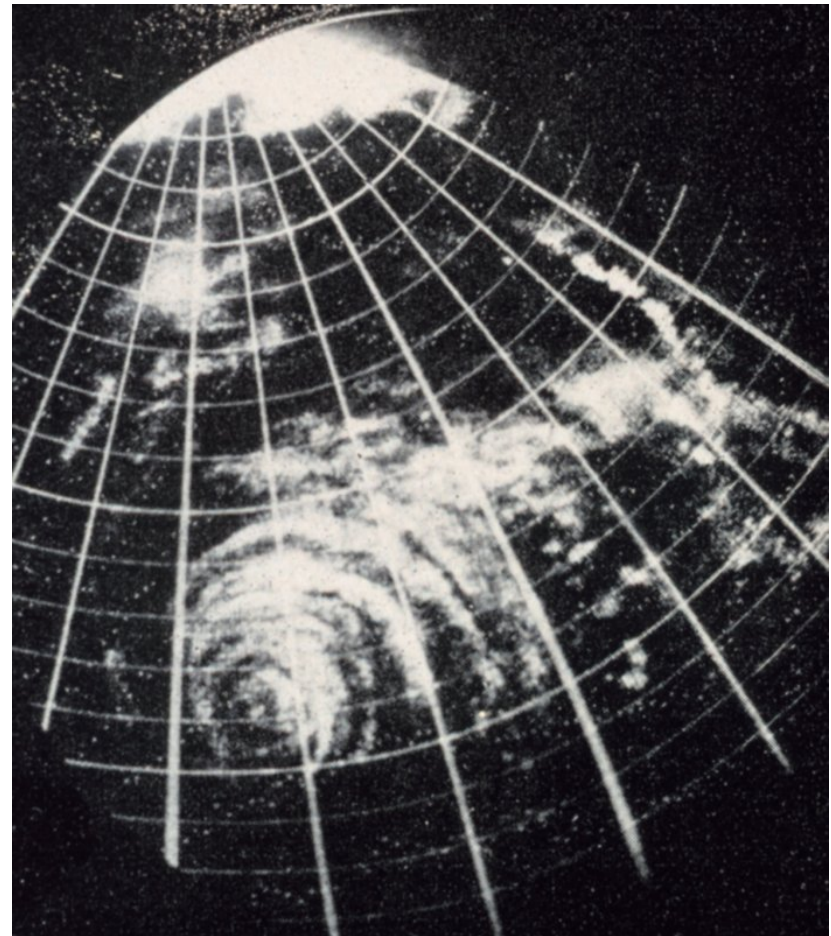
An aerial photograph of a hurricane's cloud deck, showing a dense layer of white and grey clouds with a dark, swirling center. The sky above the clouds is a deep blue.

Upon hurricane
research at HRD in
the past

Hugh Willoughby
Earth & Environment/FIU
07 November 2011

Scientific advances during WW II

- Aircraft reconnaissance begins after LCOL Duckworth's 1st flight into the "Surprise Hurricane" of July 1943
- NWS reports that aircraft reconnaissance reduced loss of life in the "Great Hurricane" of 1944
- Radar first used in Havana/Tampa Hurricane of 1944 (12-23 OCT)
 - First eye radiosonde ascent from Tampa
- Expanded upper-air observations worldwide
- Herbert Riehl's founding of US Tropical Meteorology at Univ. of Chicago
- Former military & naval meteorologists enter the field



PROJECT CIRRUS



- **Army, Navy, GE.**
- **Extensive AgI seeding to increase rainfall**
- **Exaggerated claims of success**
- **Seeded a hurricane off Georgia/Florida coast**
 - **13 October 1947**
 - **80 kg of solid CO₂**
 - **Some change in clouds on radar but no other documented changes**
 - **Reversed track to landfall in GA/SC**

Devastating 1954 & 1955 Seasons

- Hurricanes Carol, Edna, Hazel, Connie, Diane & Ione struck US
 - 400 dead
 - \$2B damage (adjusted to 2005)
- Congress starts National Hurricane Research Project





National Hurricane Research Project

- Study hurricane formation
- Study hurricane structure and dynamics
- Seek means for hurricane modification
- Seek means for improvement of forecasts

NHRP, 1959

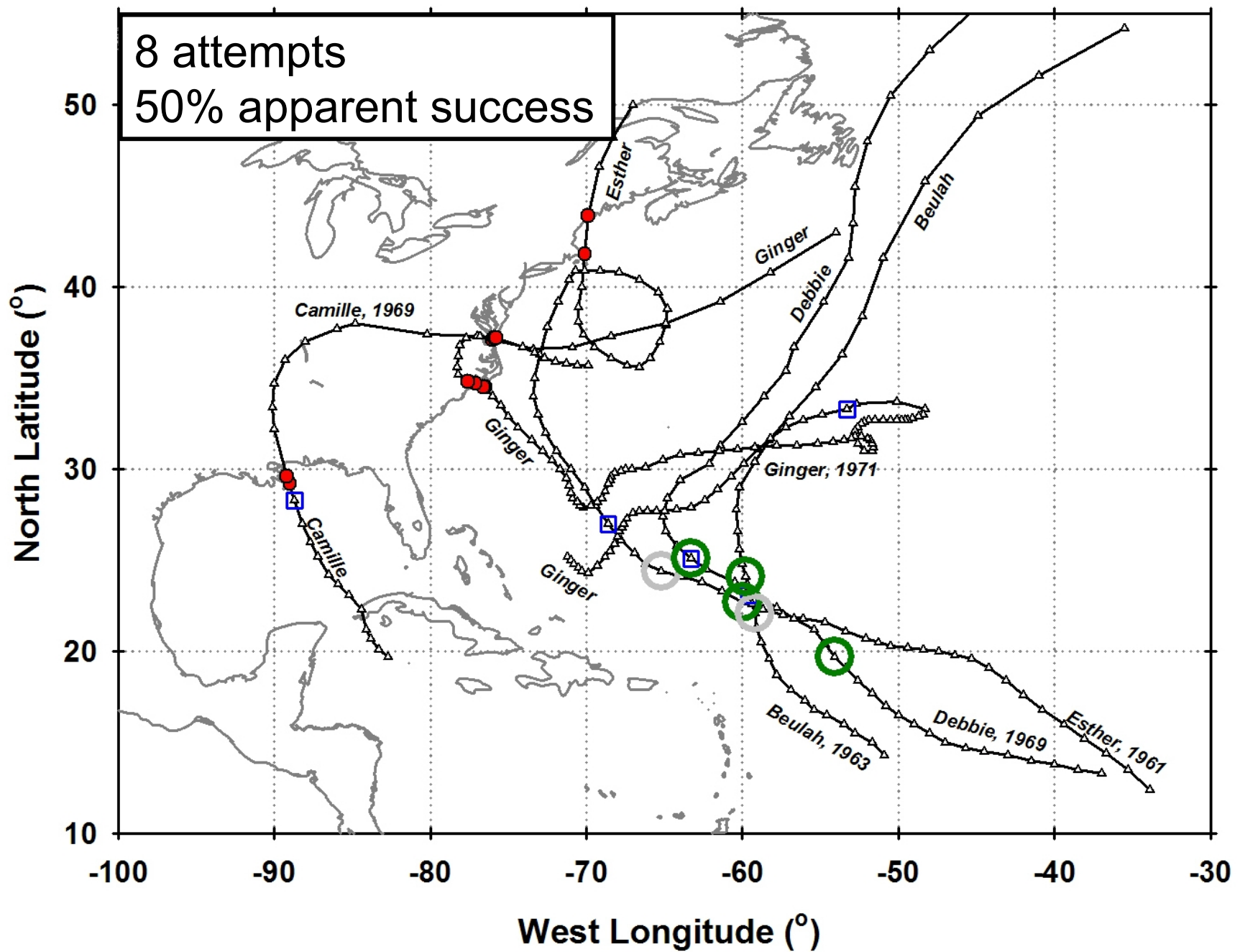
Hurricane Modification Strategy:

- Well thought-out, mainstream science
- Trigger symmetric instability, or
- Construct an outer eyewall, through cloud seeding with AgI
- Required abundant supercooled water
- Expanded eye should have weaker winds through partial conservation of angular momentum

Bob and Joanne Simpson



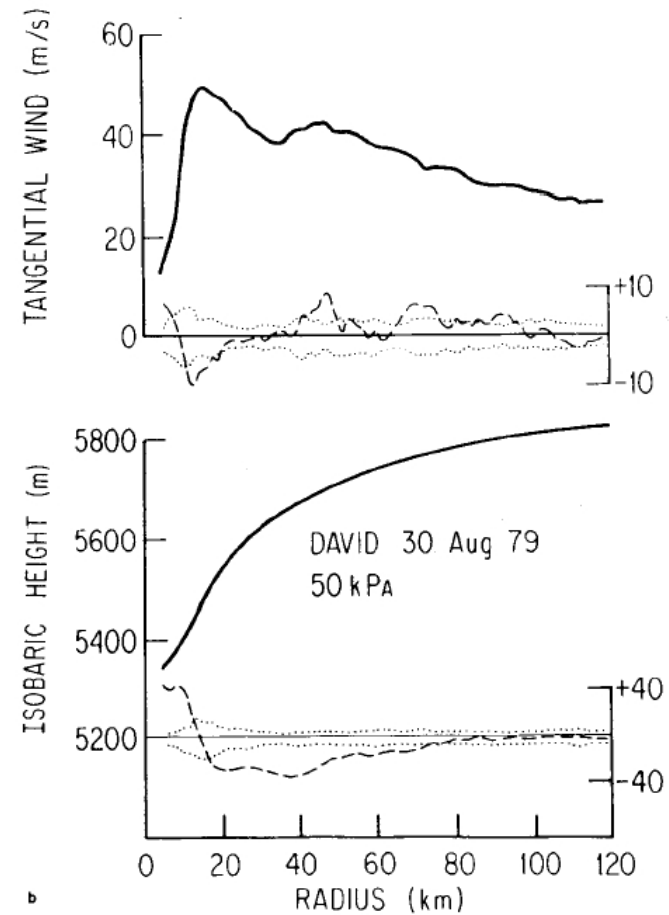
STORMFURY Hurricanes



NOAA WP-3Ds Acquired to replicate Debbie of 1969 seeding

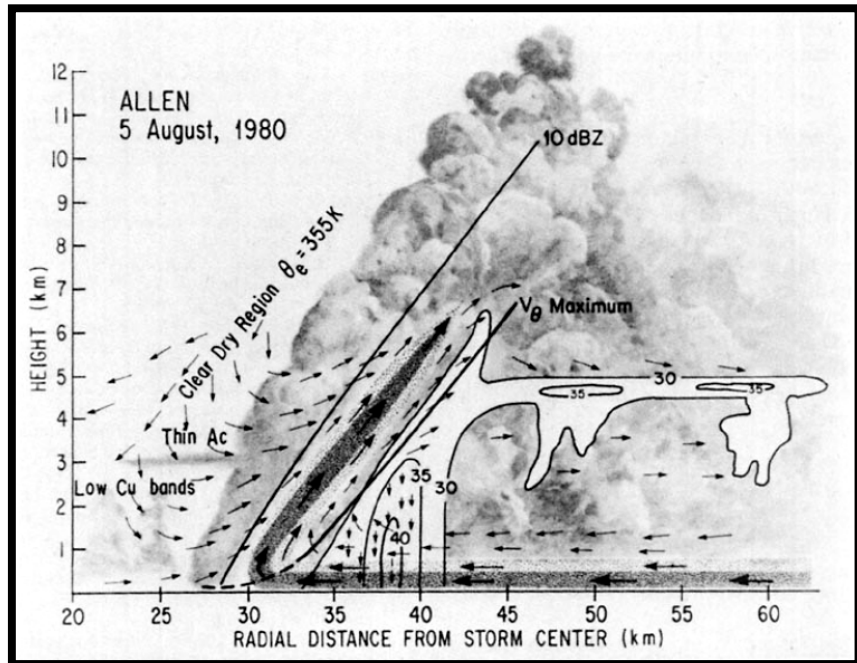


Concentric Eyewalls in Unmodified Hurricanes



New Understanding of Structure & Dynamics

- Most updrafts weaker than previously thought
- Inclined updrafts unloaded condensate
- Liquid water contents lower
- Observations of widespread radar brightband
- Widespread stratiform rain and mesoscale up- & downdrafts

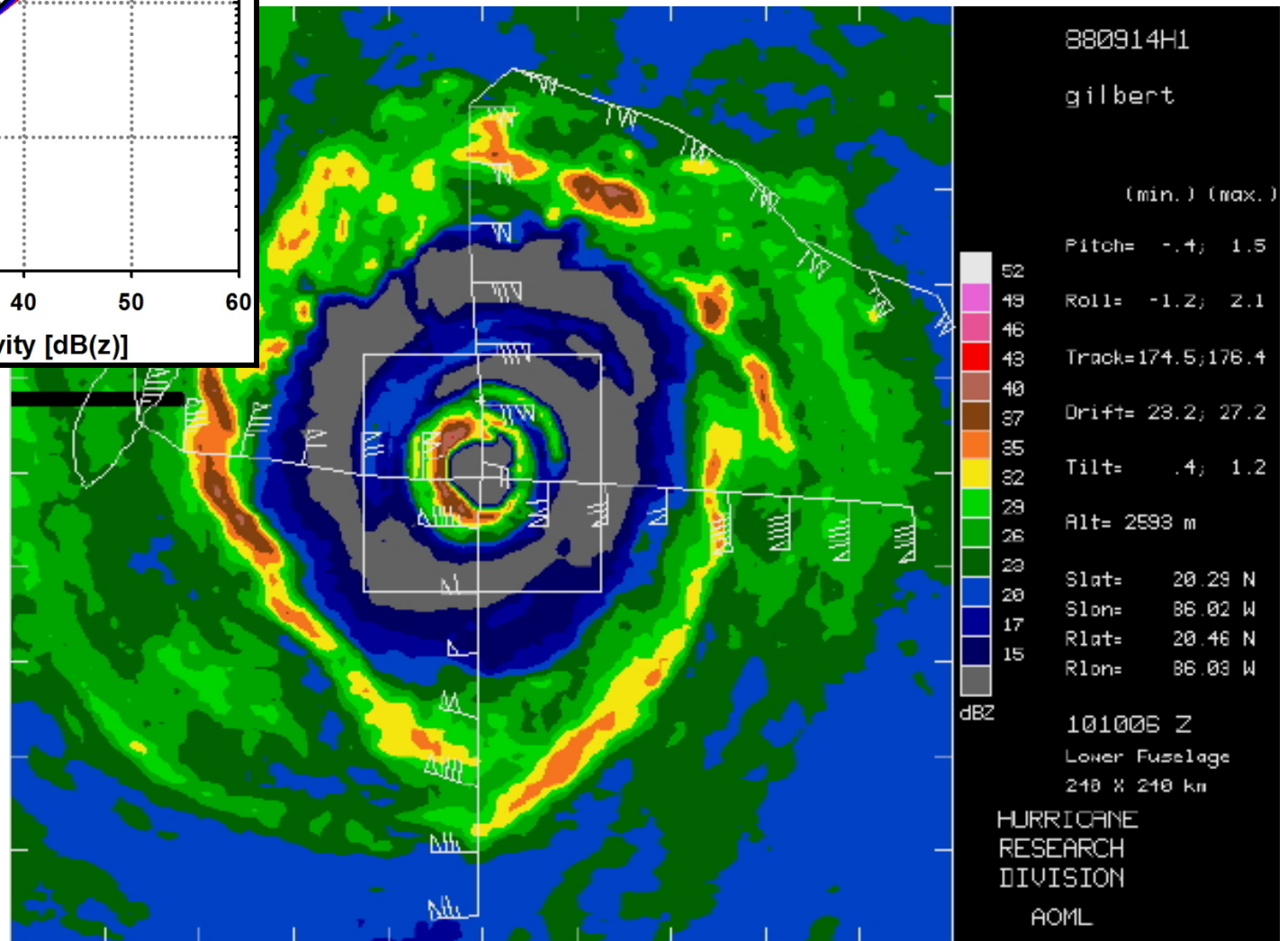
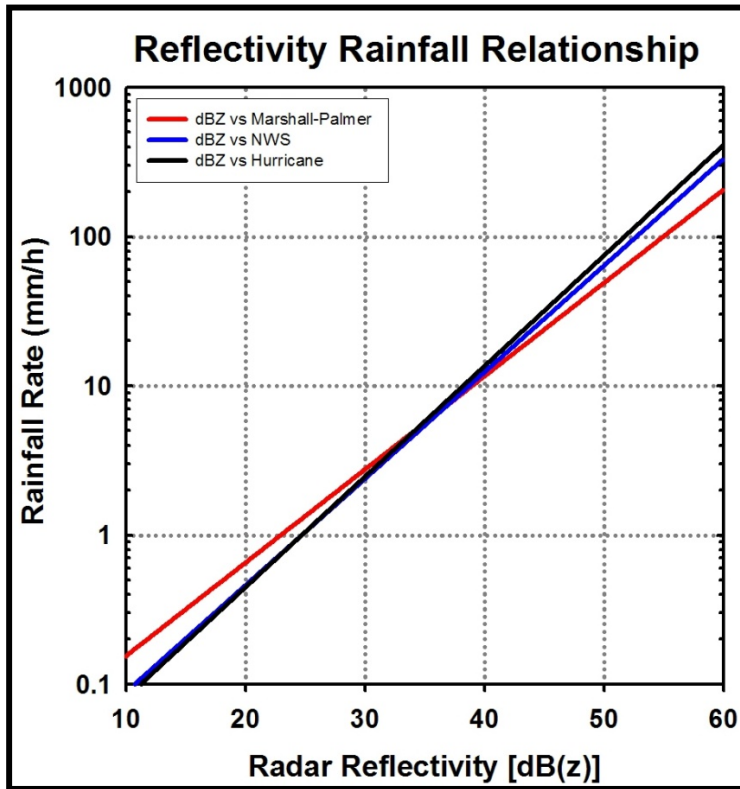


Jorgensen 1984b

STORMFURY Abandoned Because

- Limited supercooled water
- Eye expansion happens in unmodified hurricanes
- Political difficulty with finding experimental subjects

Aircraft Radar in Gilbert

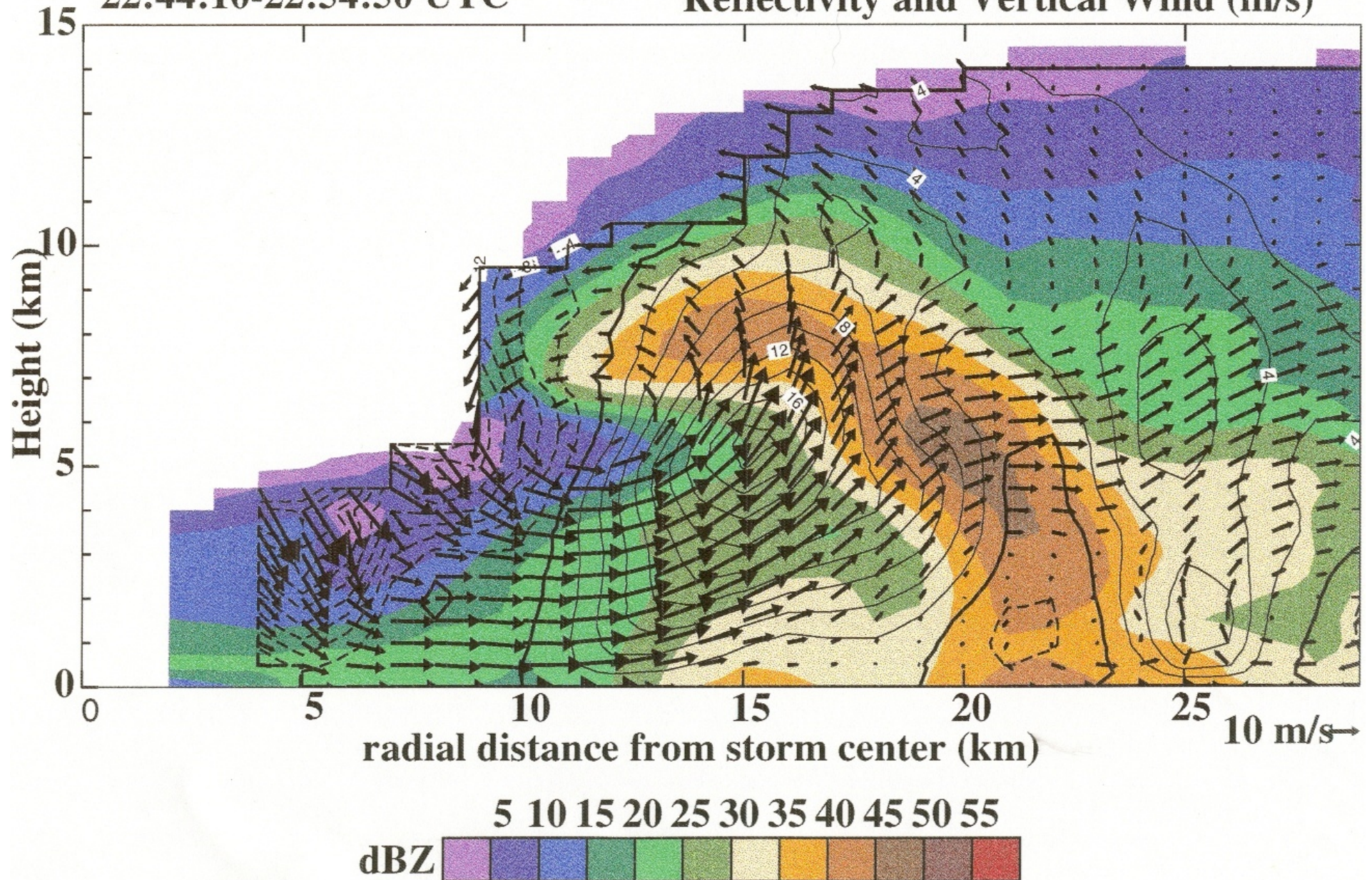


Olivia September 25, 1994

Radial Cross-section along azimuth 24 from storm center

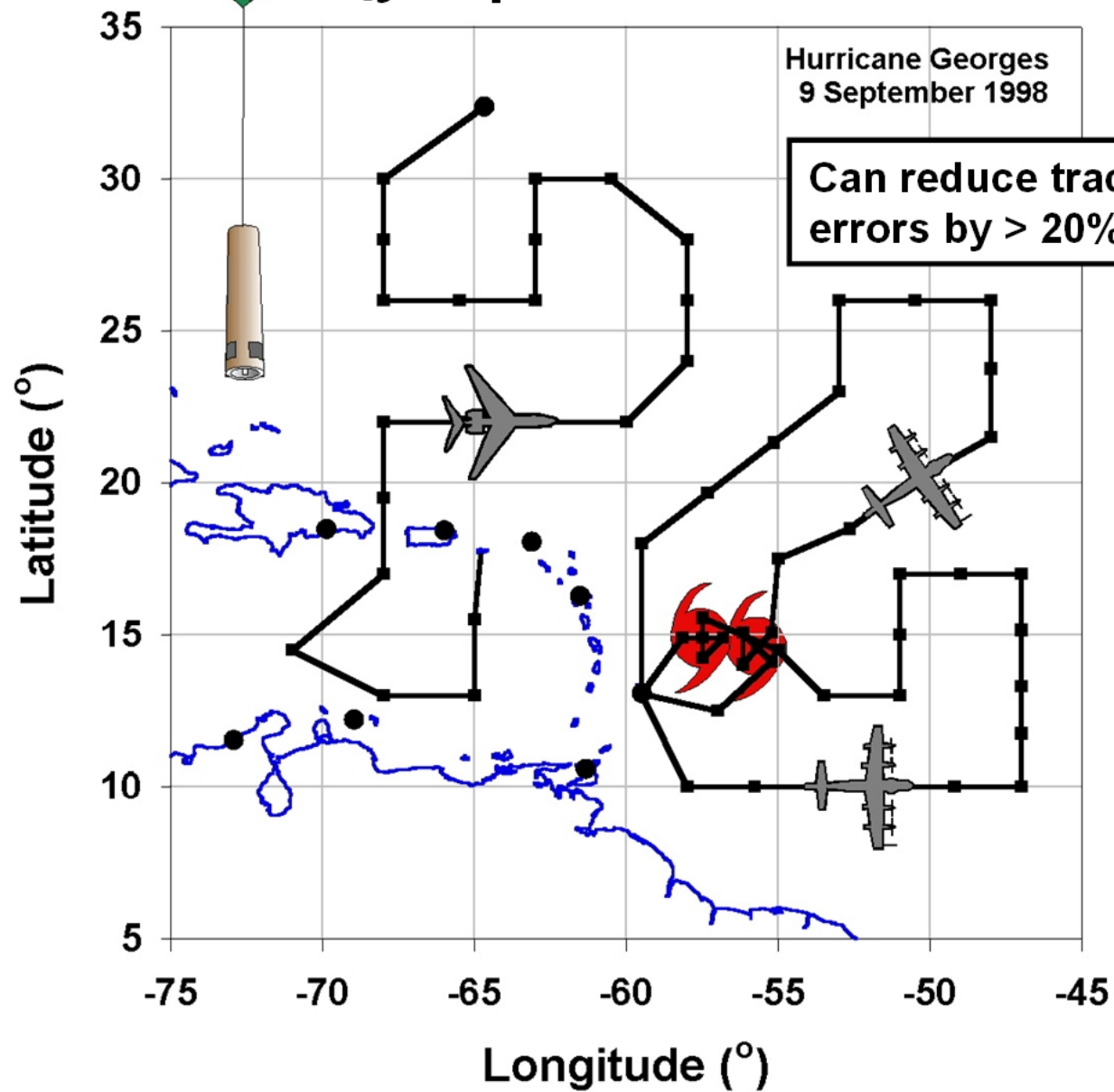
22:44:10-22:54:50 UTC

Reflectivity and Vertical Wind (m/s)

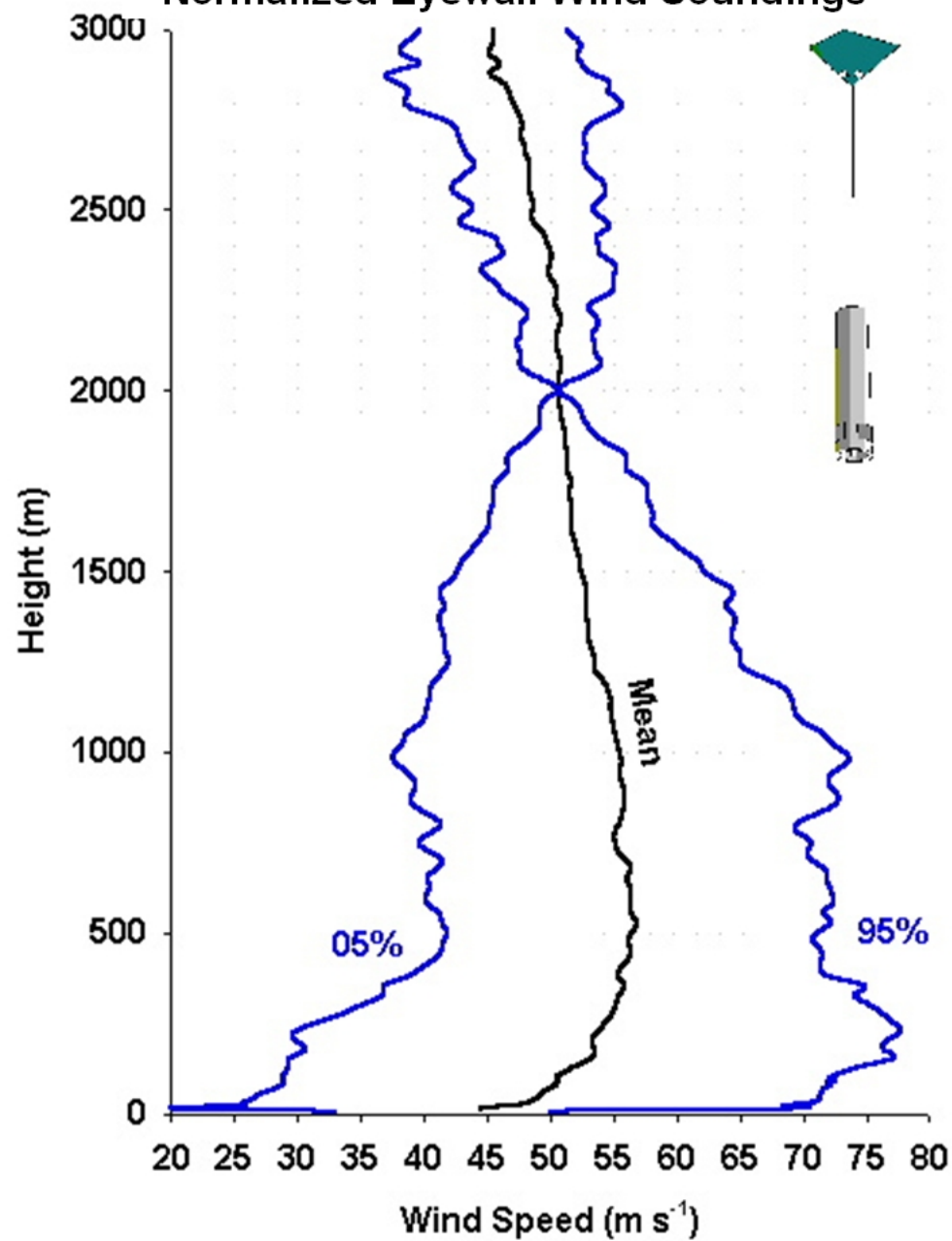




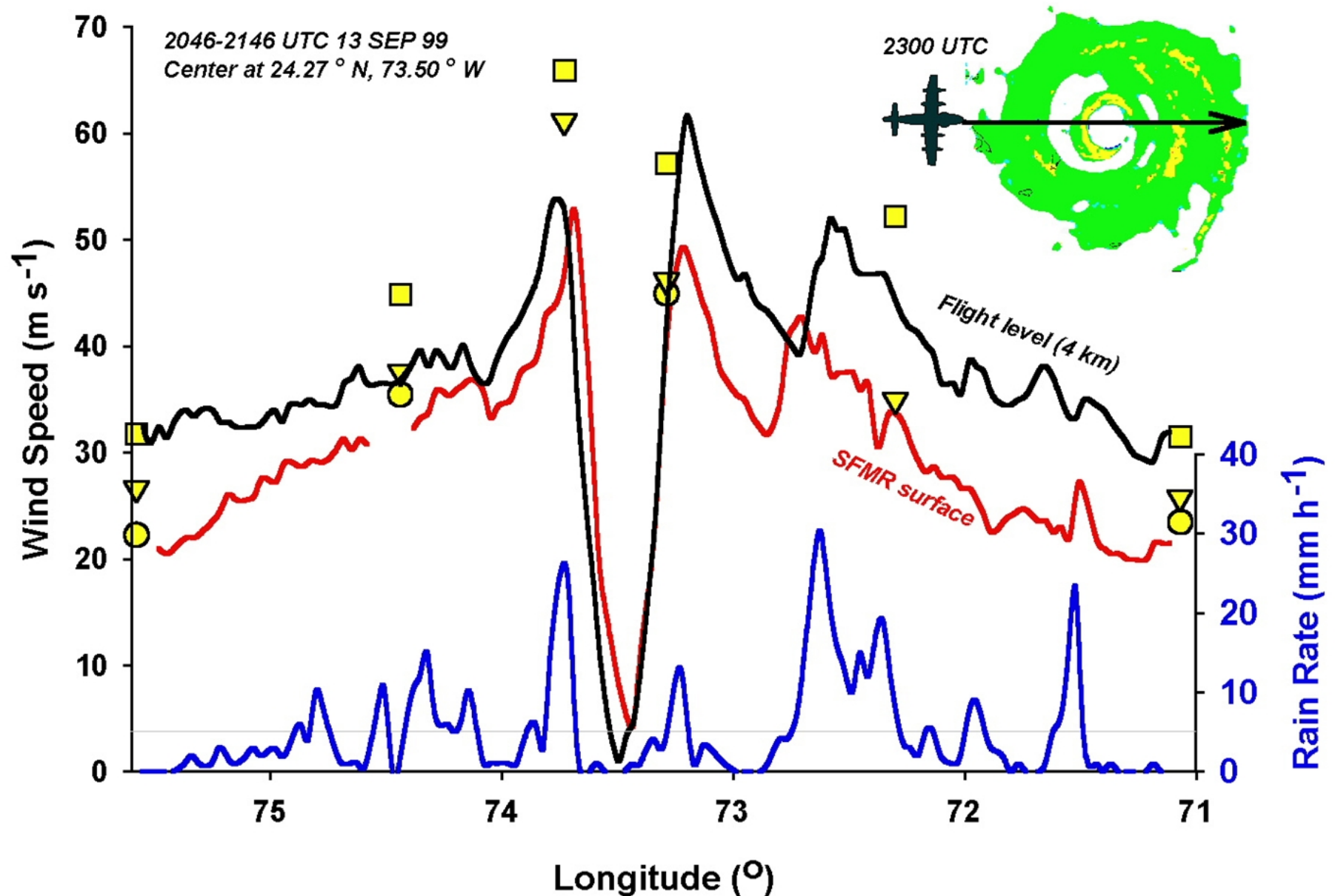
Synoptic Surveillance



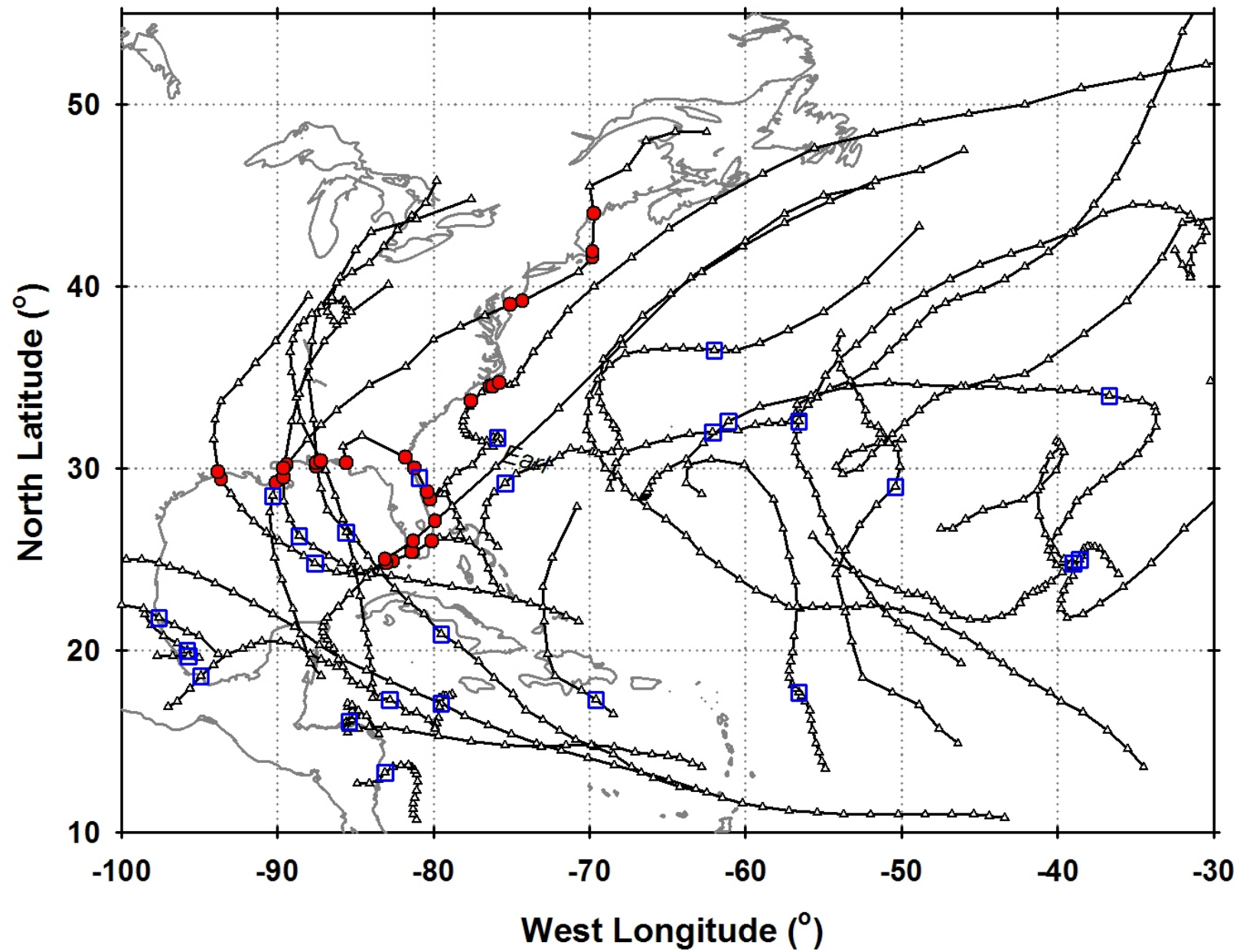
Normalized Eyewall Wind Soundings



Scatterometer and Radiometer Data in Floyd



2005 Hurricane Season



**Thank you for your attention.
Questions?**

