

# Tropical Cyclone Structure and Intensity Change

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CMMAP Colloquium  
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# My Research

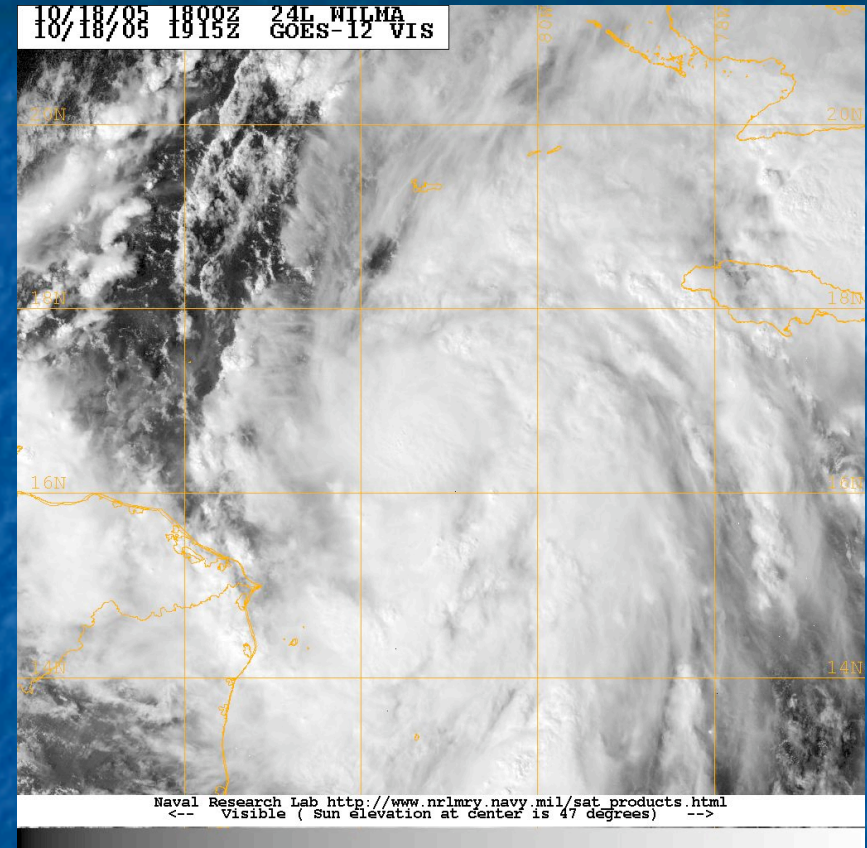
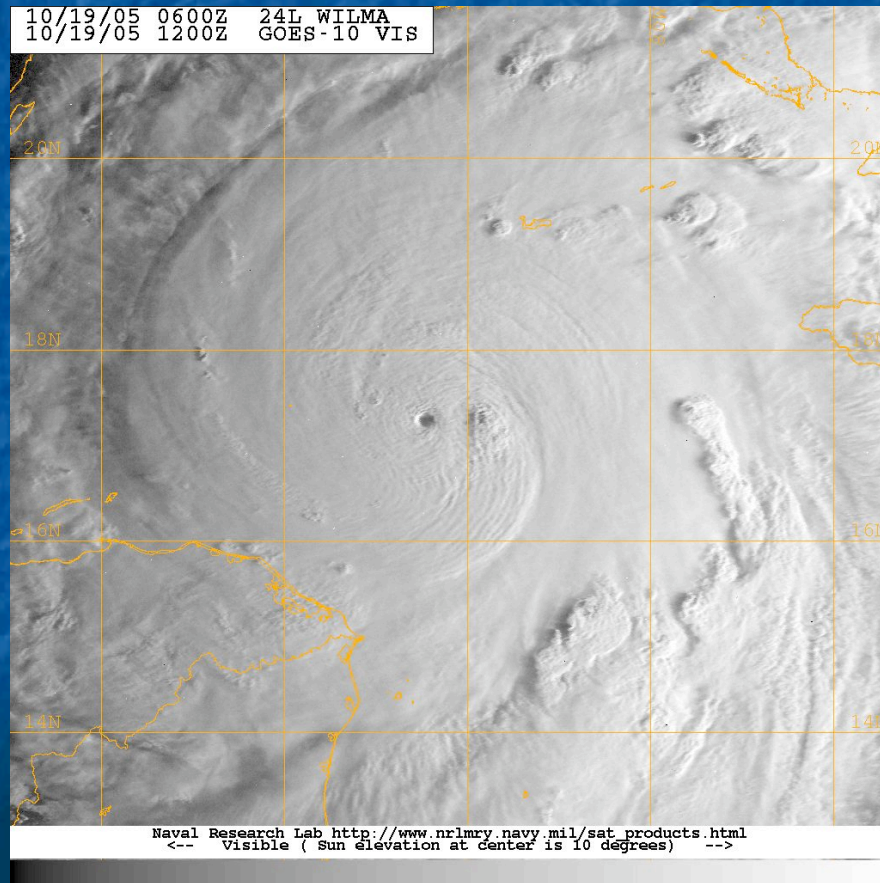
- Where are my interests?
  - Hurricane modeling
  - Representation of hurricanes in mesoscale and global models
- Finishing PhD – should defend Fall 2009
- Current research focus
  - Observations and theoretical model representations of hurricane structure
  - Influence of structure on intensity change

# Motivation

- Tropical cyclone forecasting
  - Track
  - Intensity
    - Rapid intensification
  - Structure
    - Eye size, concentric eyewalls, annular hurricanes

# Eye Size – Very Small Eyes

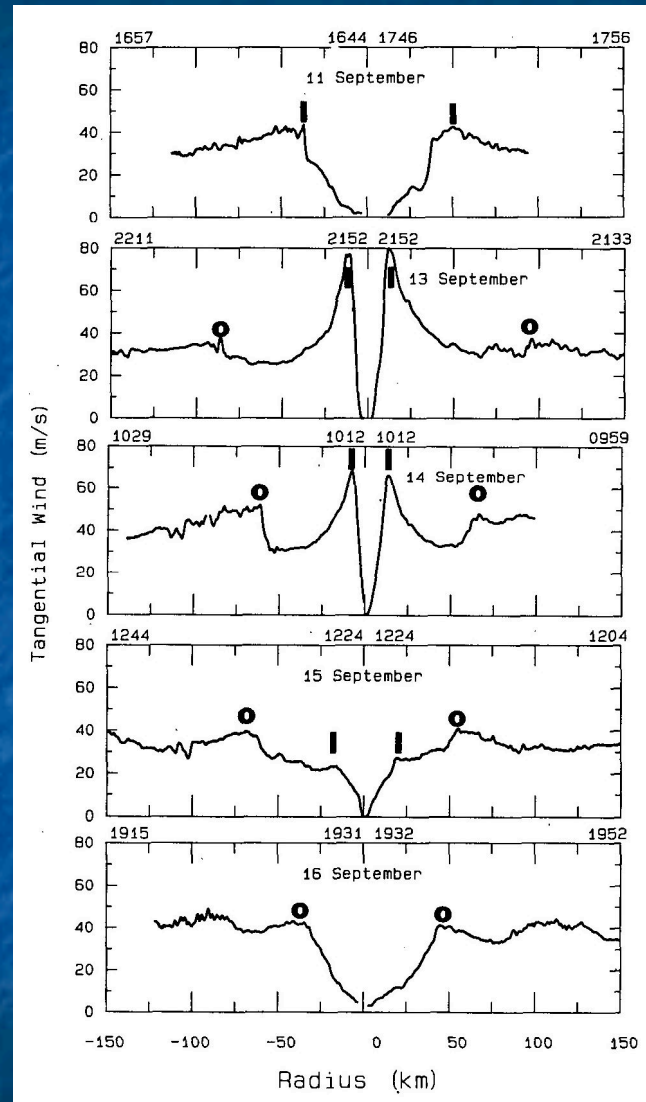
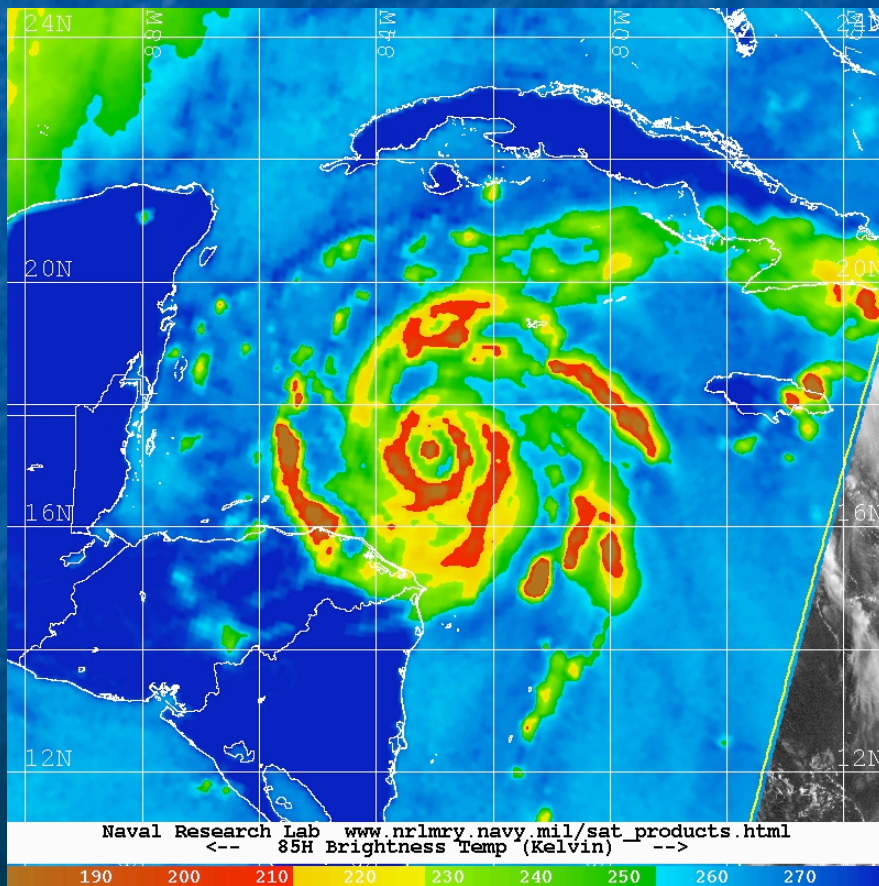
- Very small eyes often appear coincident with rapid intensification.



- Understanding and predicting pinhole eyes could improve estimates of current intensity, forecasts of rapid intensification, and hurricane size estimates.

# Concentric Eyewalls

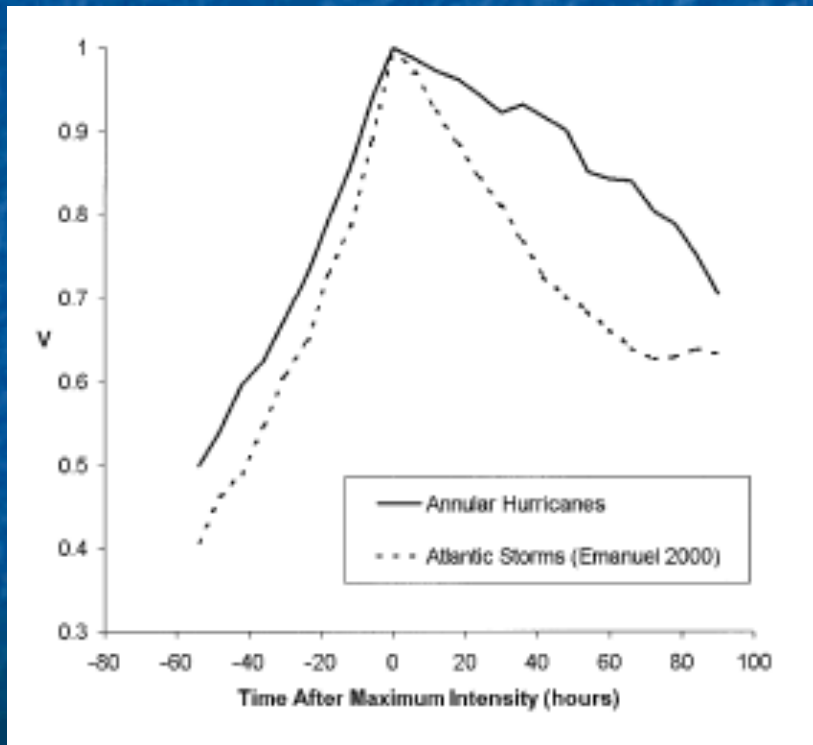
- Concentric eyewall cycle:
  - Ring of convection develops outside of current eyewall, forming outer eyewall
  - Outer eyewall cuts off inner eyewall from source of energy, destroying inner eyewall
  - Outer eyewall replaces inner eyewall and contracts



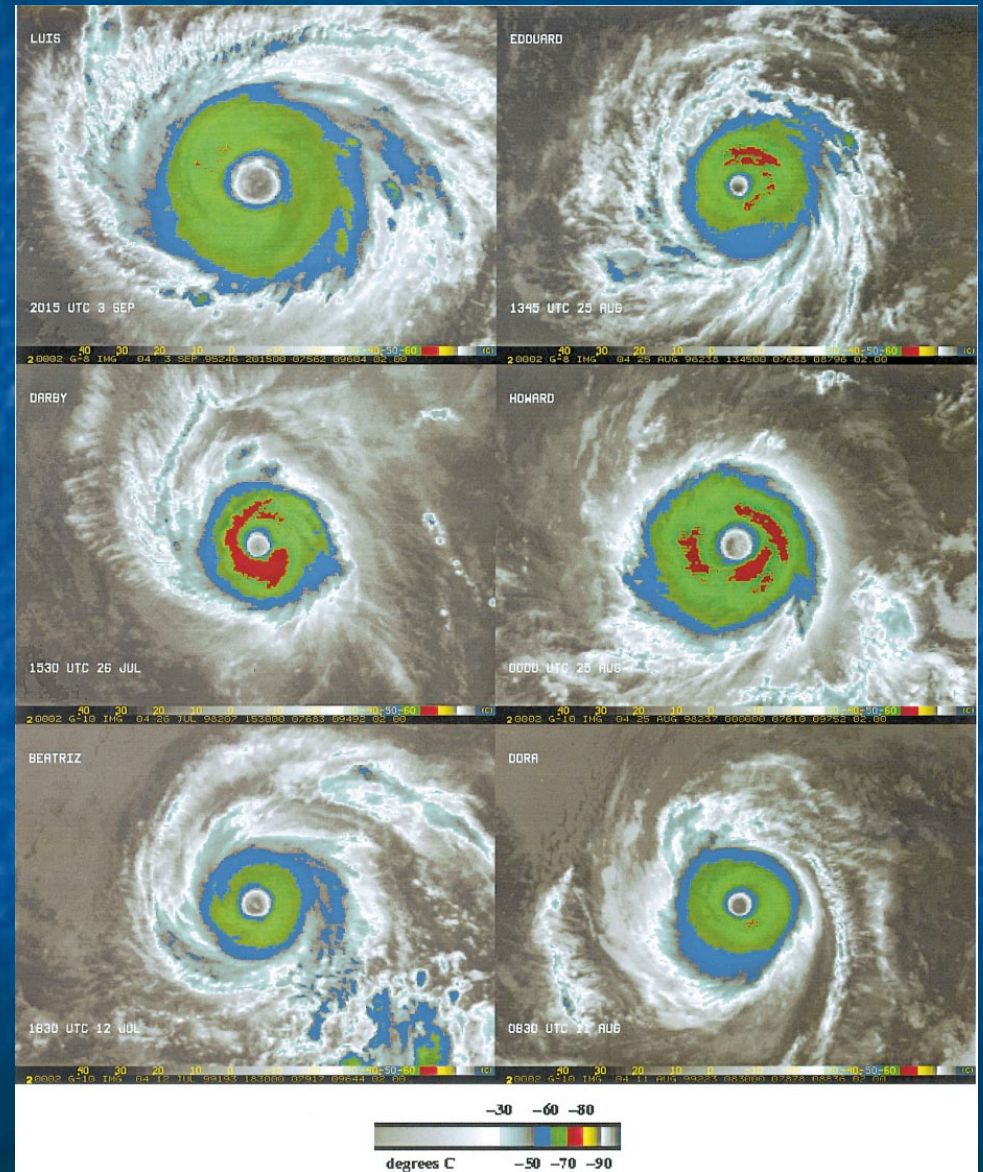
Black and Willoughby 1992  
Hurricane Gilbert (1988)

# Annular Hurricanes

- Symmetric tropical cyclones
  - Large circular eye
  - Lack of spiral bands
- Reach higher % of their maximum potential intensity and maintain intensity longer than average



Knaff et al. 2003

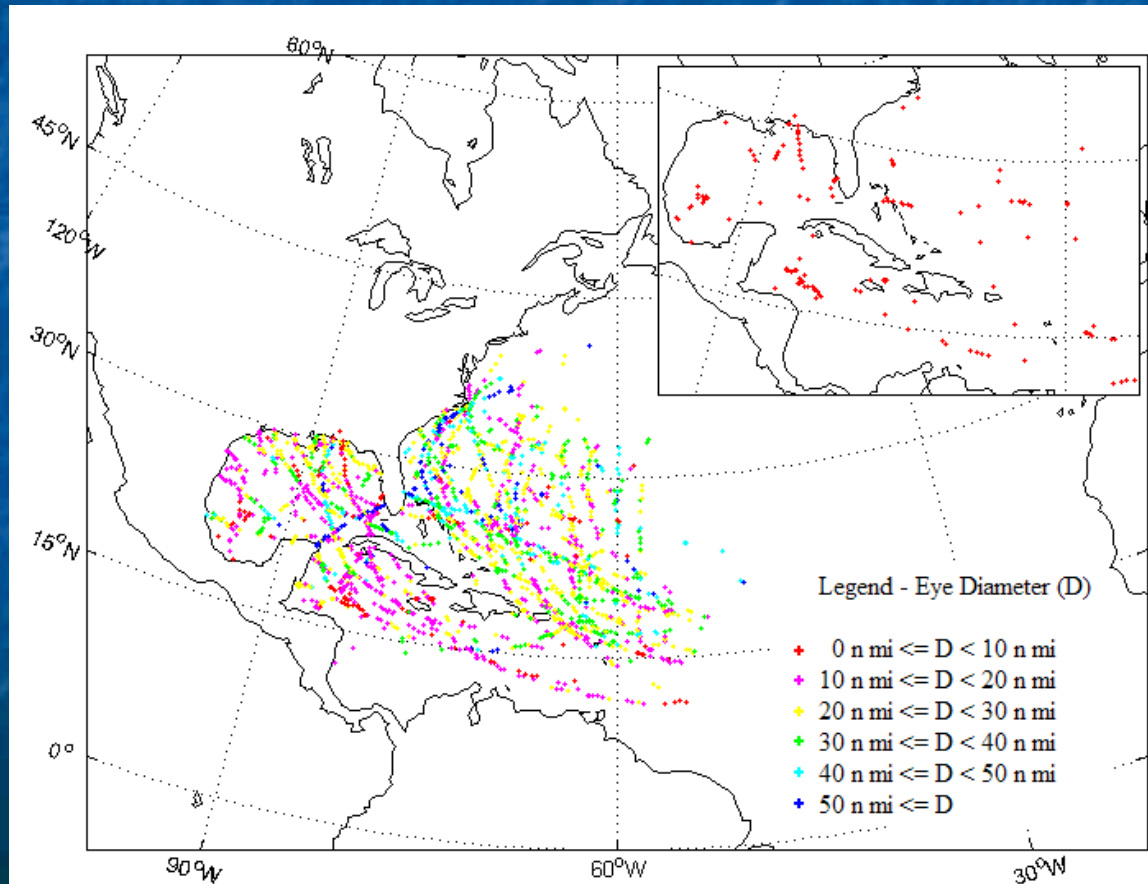


# My Research

- Three thematically-related projects
  - Climatology of observed eye size in Atlantic hurricanes, comparison with overall structure and intensity change
  - Examination of annular hurricanes with theoretical model using various vorticity edge gradients
  - Examination of the efficiency of diabatic heating in producing rapid intensification for a range of vorticity profiles

# Climatology of Eye Size

- Preliminary results: small eyes and rapid intensification
  - All but 5 (33 of 38) TCs with small eyes met RI threshold (25kt/24hr, Kaplan and DeMaria 2006); increase to 30kt/24hr still includes 28 of 38
  - Of those, 23 (19) had small eye estimates within the 12 hrs before to end of RI period
- Over half of TCs with pinhole eyes reached major hurricane strength
- One third of TCs with no pinhole eye estimates reached major hurricane strength

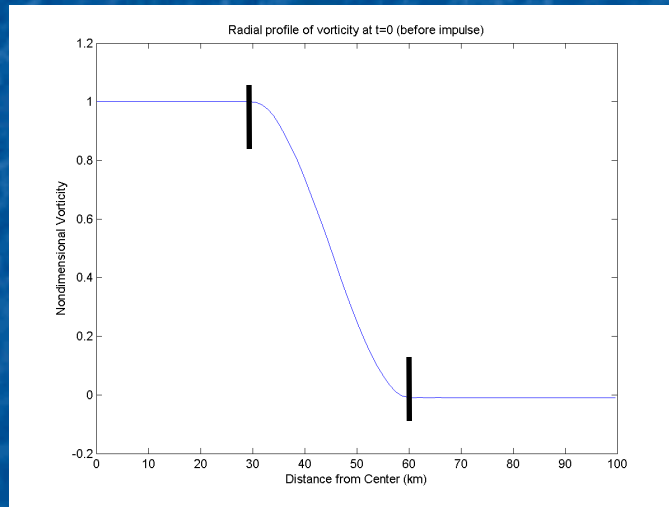




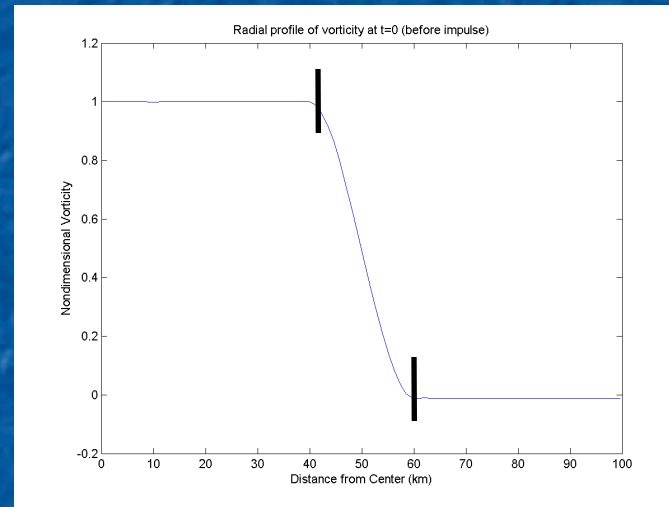
# Vorticity Edge Gradients

## ■ Initial Vorticity Profiles

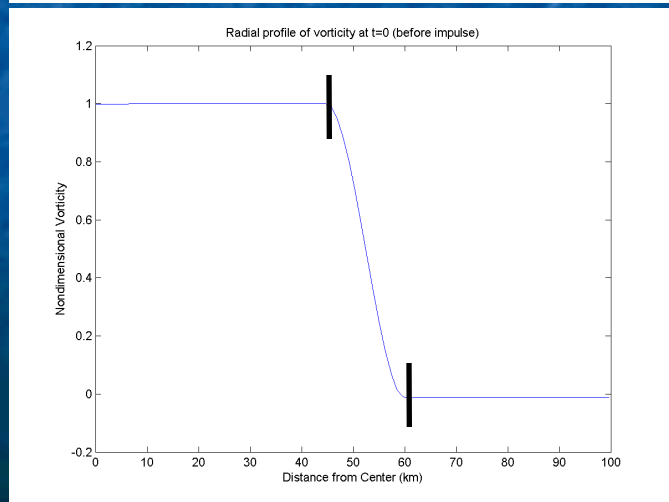
$$R_i = 0.5R_0$$



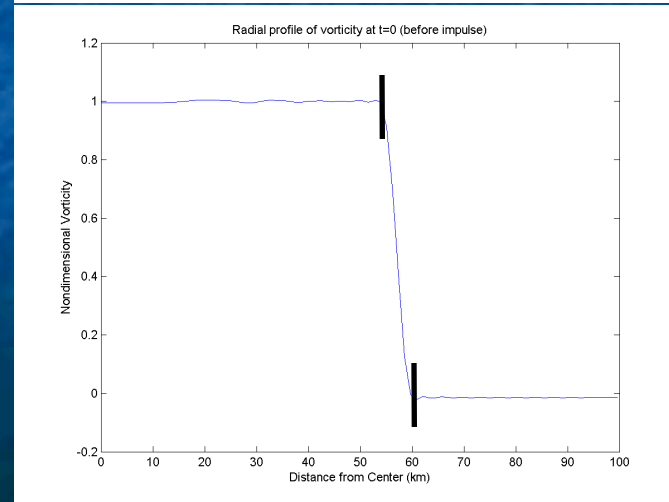
$$R_i = 0.67R_0$$



$$R_i = 0.75R_0$$



$$R_i = 0.9R_0$$

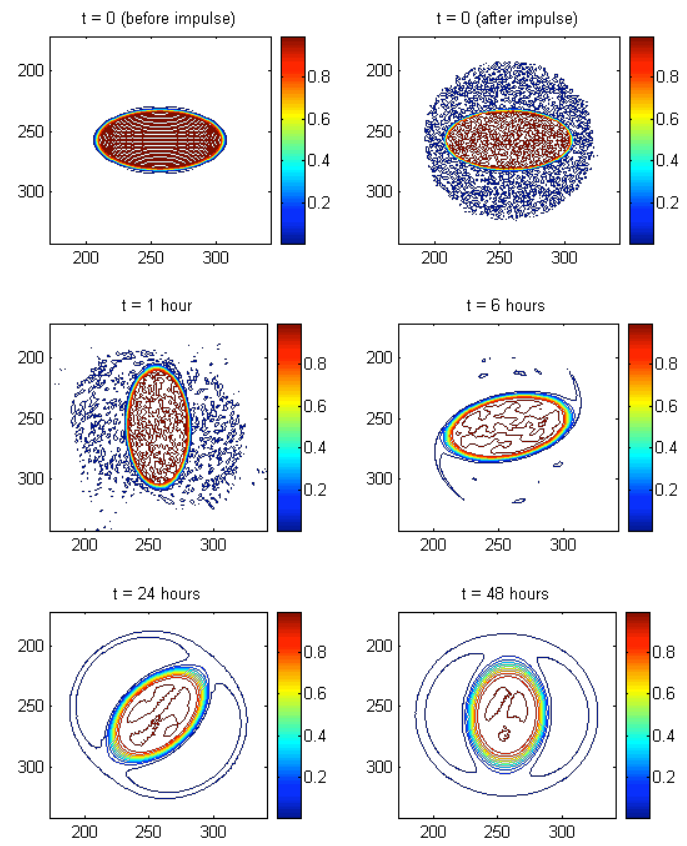
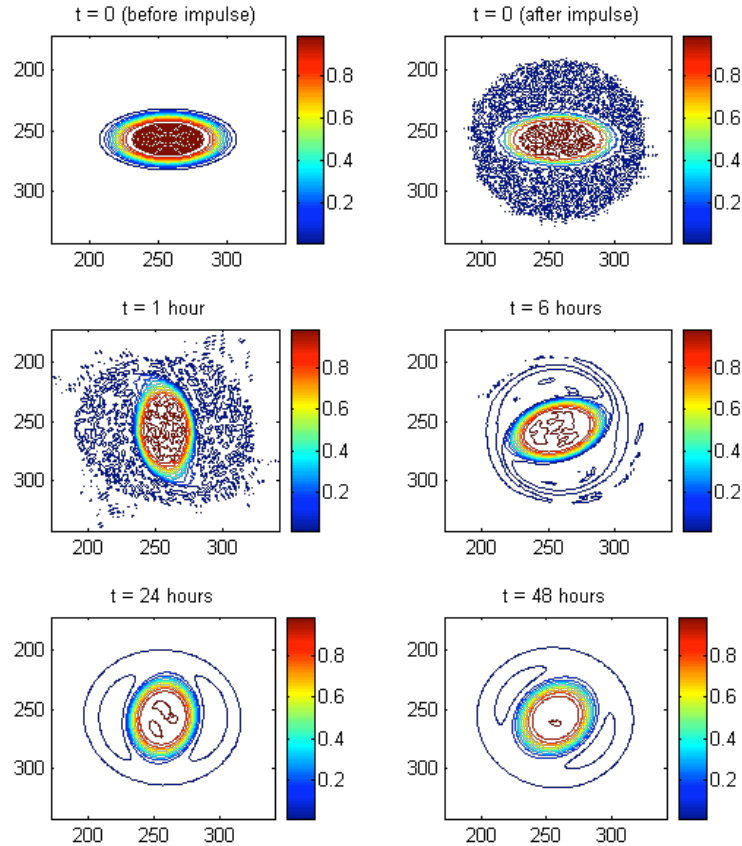


# Vorticity Edge Gradients

## ■ Preliminary Results

$$R_i = 0.5R_o$$

$$R_i = 0.9R_o$$



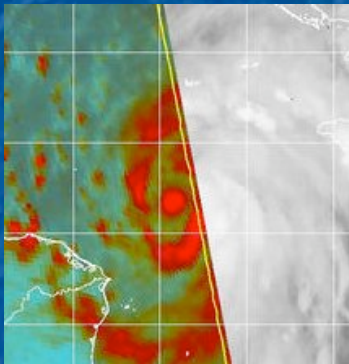
Questions?

# Hurricane Wilma (2005)

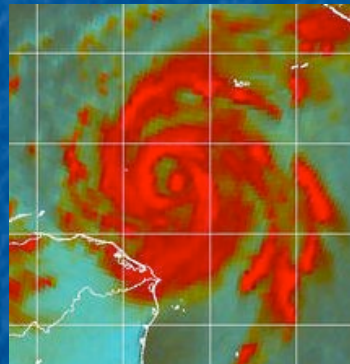
- Rapid intensification
  - 95 kts in 24 hrs
  - Record deepening rates (6, 12, and 24 hrs)
  - Category 5 with record low pressure: 882 mb
- Pinhole eye
  - 2 n mi eye diameter
- Concentric eyewalls
  - Concentric eyewall cycle after rapid intensification and pinhole eye

# Concentric Eyewall Cycle

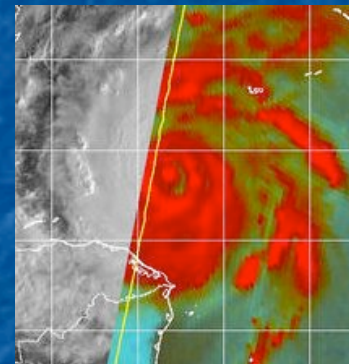
Hurricane Wilma (2005)



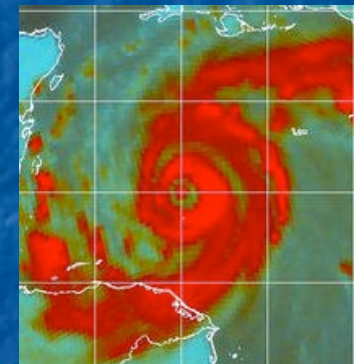
**10/19 0014 UTC**  
**130 kts/946 hPa**



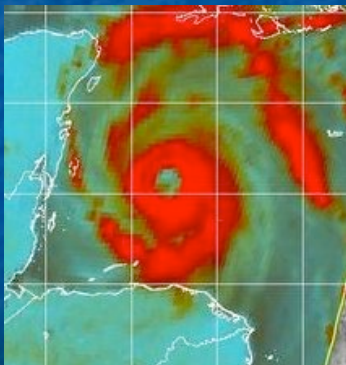
**10/19 1214 UTC**  
**160 kts/882 hPa**



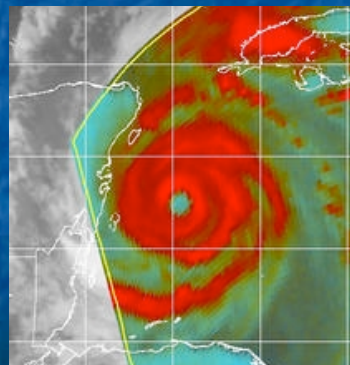
**10/19 1358 UTC**  
**157 kts/885 hPa**



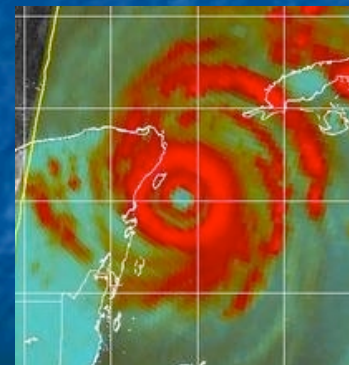
**10/20 0000 UTC**  
**135 kts/892 hPa**



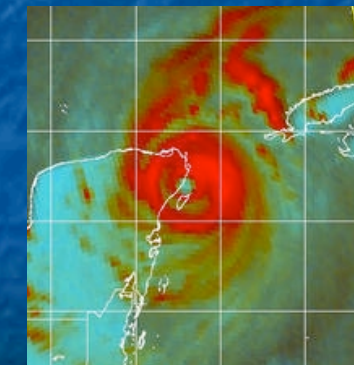
**10/20 1234 UTC**  
**130 kts/910 hPa**



**10/20 2347 UTC**  
**130 kts/923 hPa**



**10/21 1219 UTC**  
**125 kts/929 hPa**

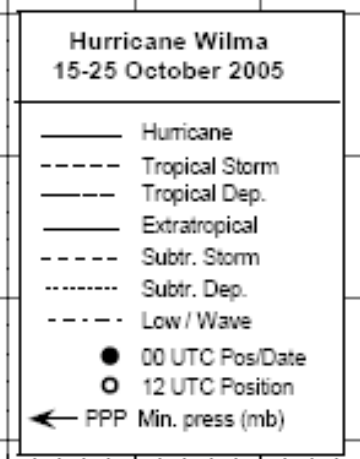
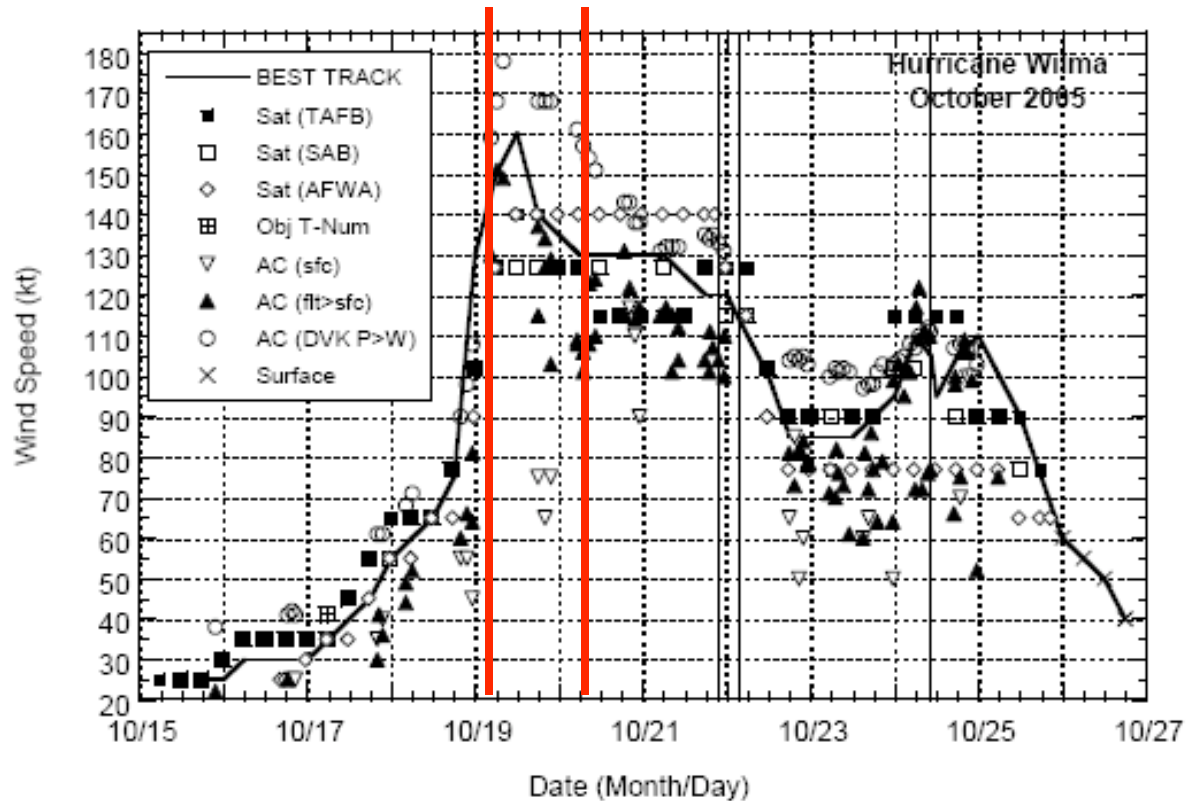
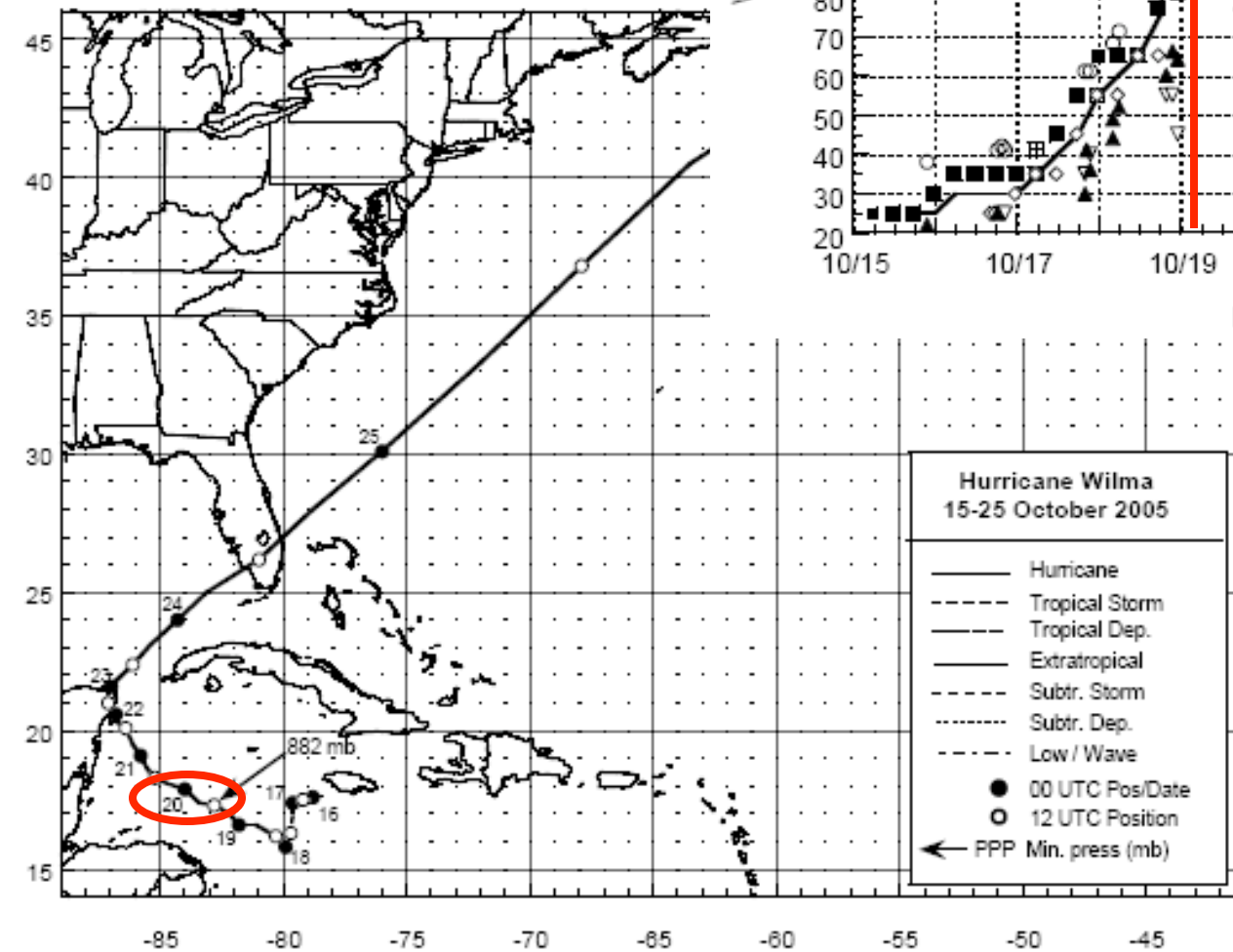


**10/22 0220 UTC**  
**117 kts/932 hPa**

Courtesy of Chris Rozoff

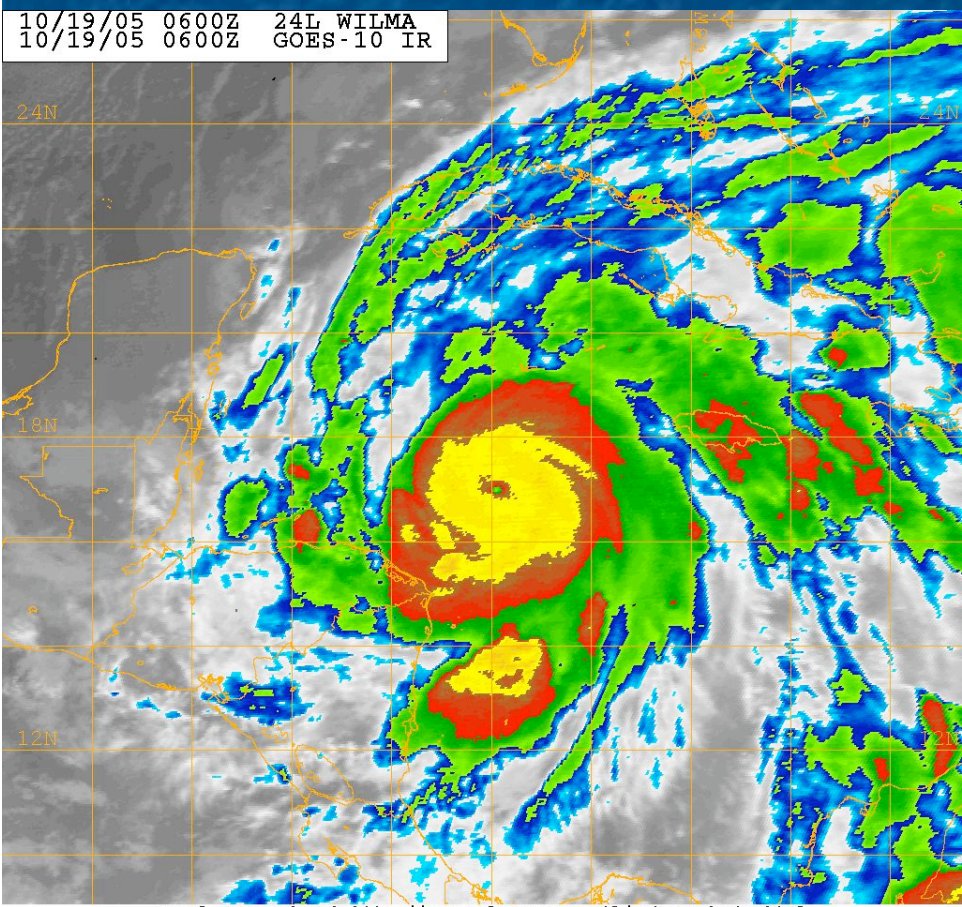
SSM 85 GHz Composites

# Hurricane Wilma 2005

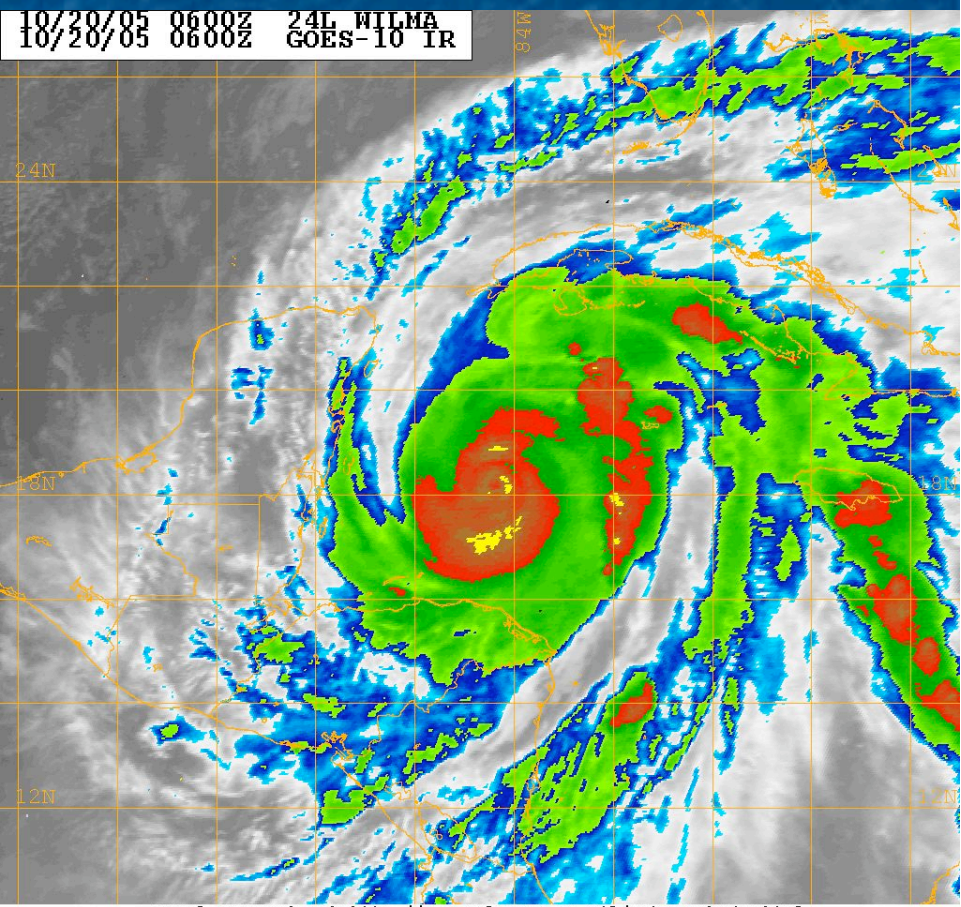


# Hurricane Wilma 2005

10/19/05 0600Z 24L WILMA  
10/19/05 0600Z GOES-10 IR



10/20/05 0600Z 24L WILMA  
10/20/05 0600Z GOES-10 IR



Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
IR Temperature (Celsius)

Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
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