Tropical Cyclone Structure and Evolution

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Background and Interests

- B.S. in Mathematics and Physics at Morehouse College in 2006
  - Research interests in numerical PDEs, fluid dynamics, and gravitational wave physics
- M.S. in Physics at University of Texas at Brownsville in 2008
  - Research interests in population synthesis, gravitational wave phenomenology, and density estimation
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Tropical Cyclone Evolution

- The role of internal dynamics in intensity changes of hurricanes
  - What factors determine the maximum potential intensity that a tropical cyclone can achieve given the thermodynamic state of the atmosphere and the ocean?
  - What factors prevent the tropical cyclones from reaching its maximum potential intensity?
  - What factors govern the internal dynamics of a tropical cyclone?

Maximum Potential Intensity (MPI)

- Three major theories in formulating the MPI:
  - Tropical cyclones behave as a Carnot heat engine in which energy is added at the warm ocean surface and lost in the cool outflow area (Emmanuel, 1991).
  - The MPI of a tropical cyclone is related to the maximum temperature anomalies in the cyclone eye due to subsidence warming (Holland, 1997).
  - The MPI of a tropical cyclone is due to the presence of high-entropy air in the low-level eye, leading to a modified Carnot cycle (Persing and Montgomery, 2003).

Vortex Rossby Waves and Tropical Cyclone Structure

- Vortex Rossby waves (VRWs) play important roles in tropical cyclone structure and intensity changes
  - Radially outward-propagating VRWs may be responsible for initiating spiral rainbands and can intensify of the mean vortex (Montgomery and Kallenbach, 1997)
  - VRWs with low azimuthal wave numbers dominate the asymmetric structure in the eyewall and play an important role in mixing angular momentum and potential vorticity between the eye and the eyewall (Wang, 2001).

Eyewall Processes and Tropical Cyclone Structure

- The cyclone eyewall can be highly asymmetric and is usually characterized by polygonal structure and VRWs.
  - The polygonal eyewall structure is due to the internal gravity wave interference patterns due to superposition of wavenumbers (Lewis and Hawkins, 1982).
  - Elliptic eyewall could result from the azimuthally propagating wavenumber-2 VRWs around the eyewall (Kuo et al, 1999).
- The eyewall replacement cycle is believed to be responsible for large fluctuations in intensity (Willoughby et al, 1982; Wang 2002).

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