Multiscale Analysis of Tropical Storm Hot Tower and Warm Core Interactions Using Field Campaign Observations

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Hot Towers

- Role in intensification of storms
- Vertical structure of HT and how they differ from ordinary deep tropical convection
- Impact on warm core structure

Multiscale Studies of Hot Towers

Understanding of the role of hot towers in TC intensification requires knowledge of multiple scales from large scale environment down to small scale microphysics.

Examine hot towers with observational perspective from larger scale (satellite) down to convective scale (aircraft remote sensing and in situ).

Previous Hot Tower / Warm Core Studies From NASA Hurricane FC

- Document vertical structure of HT (Bonnie - 1998, Chantal - 2001, Emily - 2005, Dennis - 2005
- Examined possible roles of HTs in intensification and organization of warm core (Bonnie, Dennis)
- Examined why TC did not intensify with presence of strong HT (Chantal)
- Characteristics of HT vertical motion & reflectivities

Proposal Objectives

- Completion of major case studies Hurricane Bonnie (1998), Hurricane Emily (2005)
- Analysis of additional tropical cyclone (TC) convective burst cases from data sets collected during recent NASA campaigns [Dennis (2005), Gert (2005), and Helene (2006)].
- Diagnostic studies of HT/convective burst heating (Owen Kelley) & warming rates due to subsidence in eye.
- Diagnosing internal characteristics of TC hot towers using high-resolution single (EDOP) and dual-wavelength (EDOP and CRS) airborne radar observations.
- Mesoscale environment in which HT & bursts develop.

Hurricane Bonnie (1998)

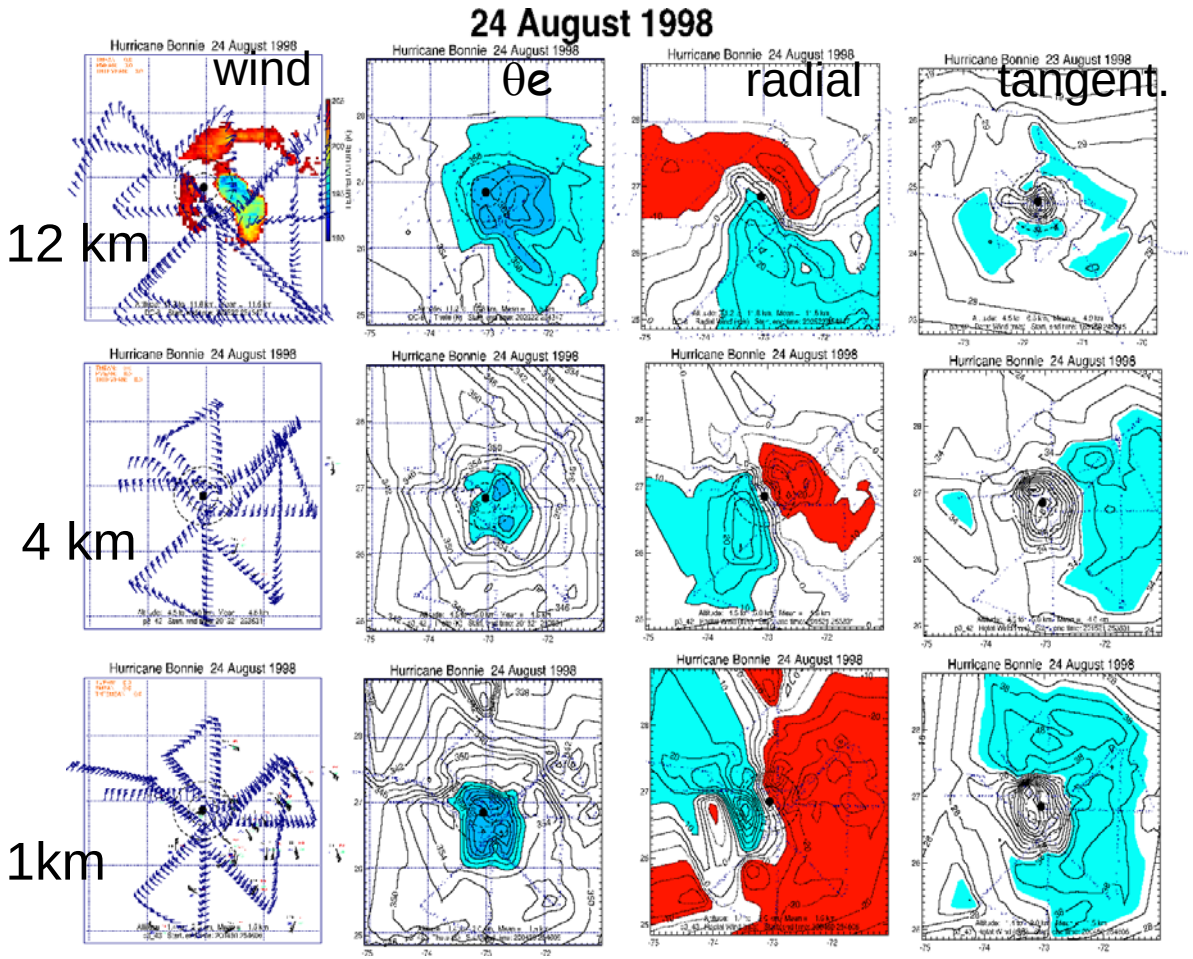


Figure 1. Structure of Hurricane Bonnie derived from dropsonde and aircraft flight level data. Top to bottom: 12 km, 4 km, and 1 km levels; Left to right: wind vectors, q_e, radial, and tangential winds.

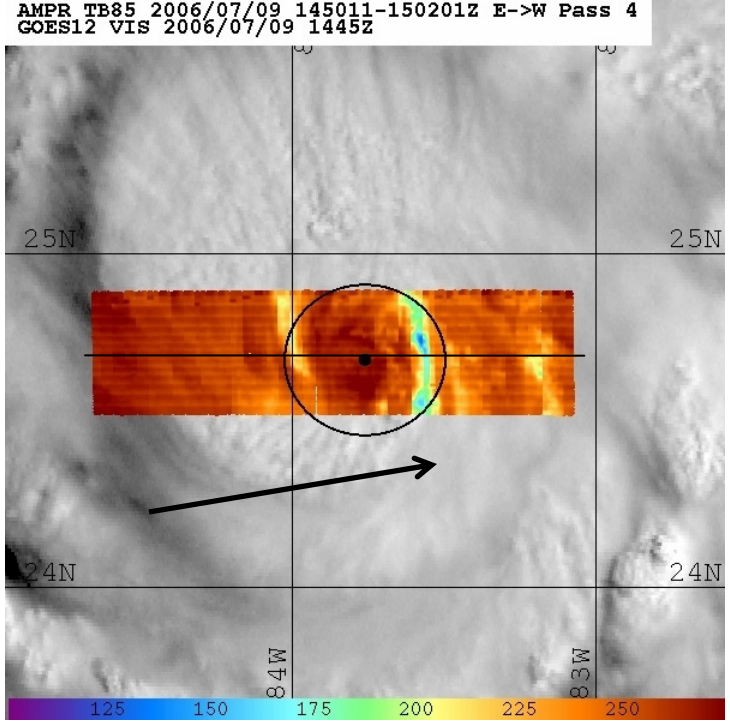
- Compositing of DC-8 and P3 flight level and drop-sonde measurements to obtain warm core & velocity structure
- 3 flight days, 2 had hot towers

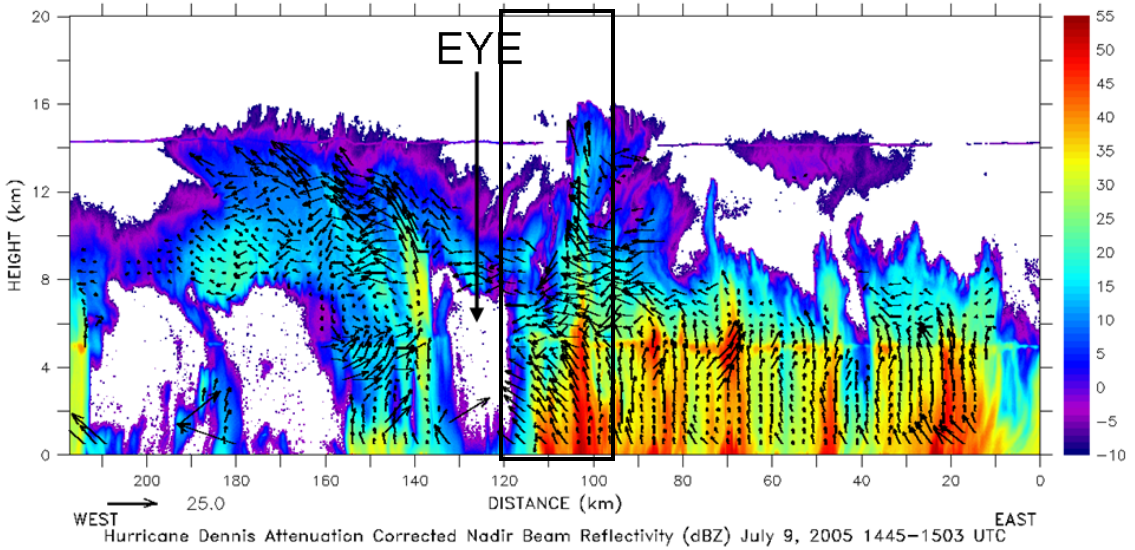
Warm Core Aspects to Evaluate

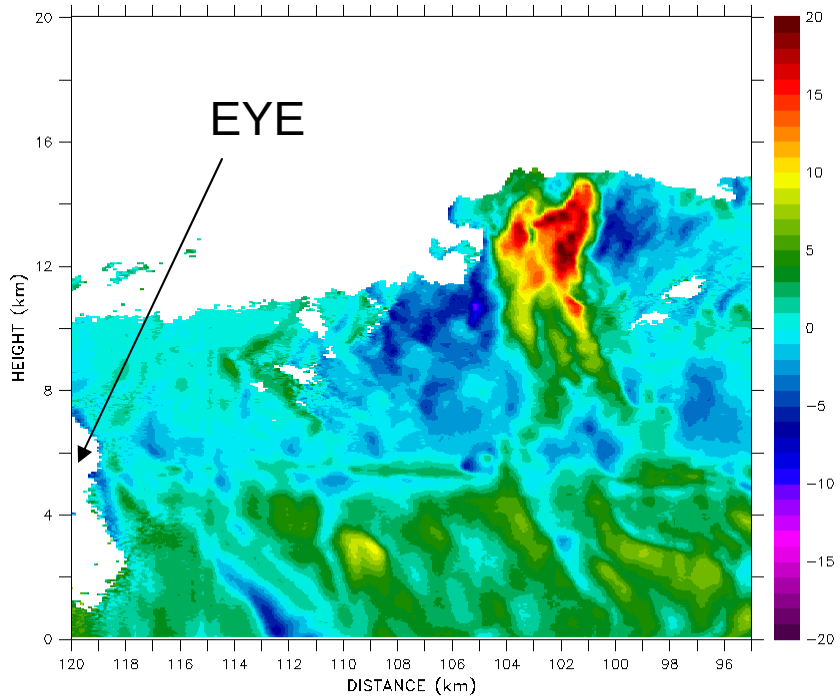
- Does it evolve top-down or bottom-up?
- Is it symmetric?
- How does insitu and dropsonde evaluations of WC compare with satellite measured estimates (AMSU retrieval)?
- How does MSLP respond to the observed warming?

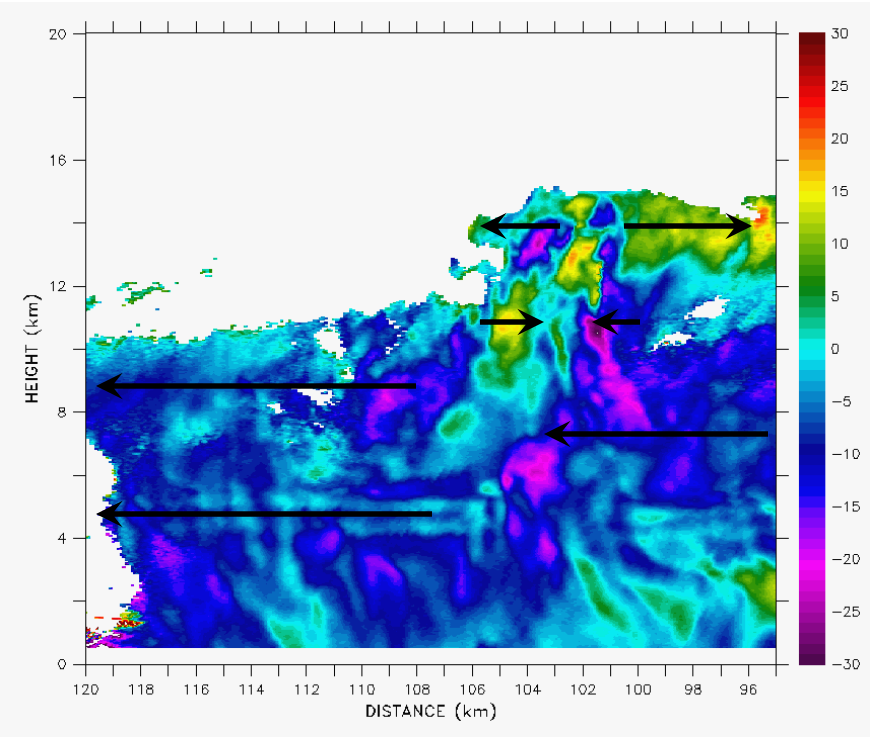
Hurricane Dennis (2005)

Steve Guimond, Gerry Heymsfield & Joe Turk

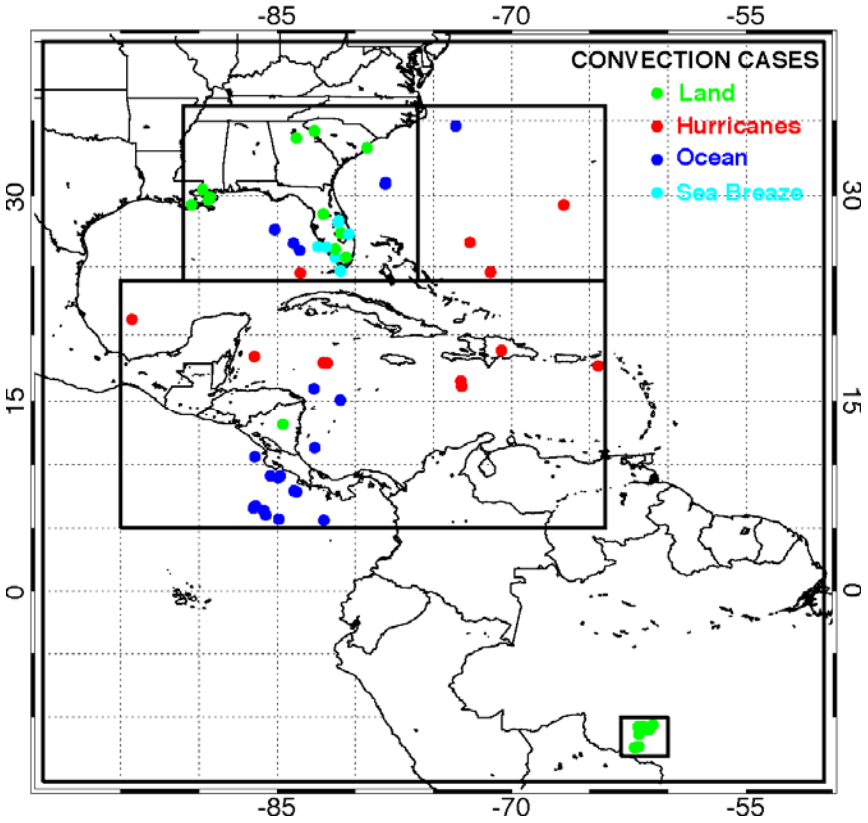






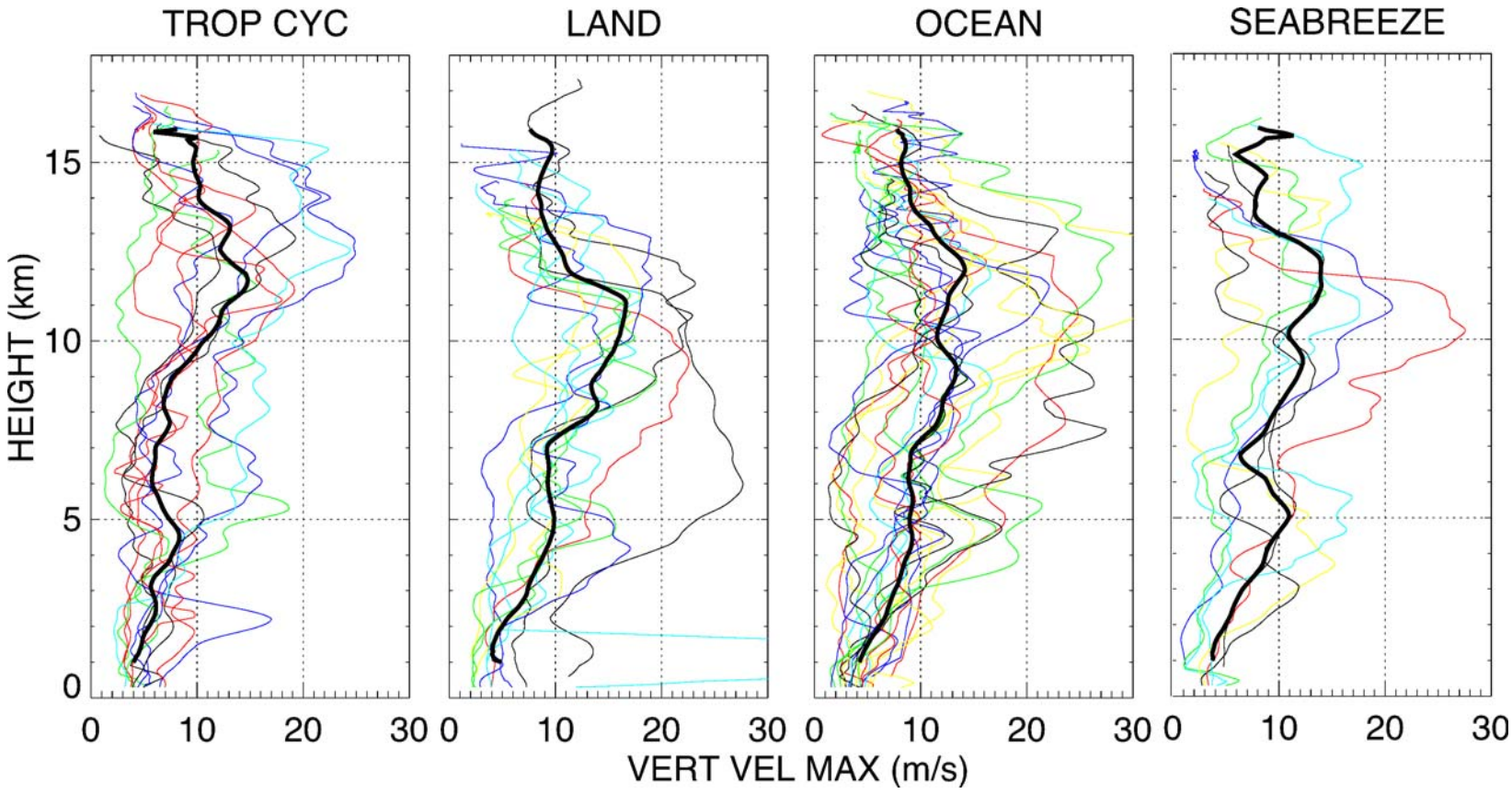


Hot Tower Vertical Structure Statistics From EDOP



Paper submitted to JAS special issue

Comparison of Maximum Updraft Properties in Different Regions



TRMM Studies of HT
(O. Kelley, E. Zipser, J. Stout, and M. Summers)

- The Tallest Oceanic Convection Usually Forms Outside of Tropical Cyclones
- In 10 years of TRMM data, almost 200 convective cells far from continents lift precipitation-size ice up to 17 km above ocean surface
- Despite their extreme height, these convective cells over ocean appear to have modest updrafts relative to the rapid updrafts of equally tall continental cells.
- Very few of these 17 km tall ocean cells form within tropical cyclones. Instead, most of them form within tropical depressions or mesoscale convective systems.
- The TRMM satellite radar is useful for conducting this kind of broad survey over the ocean, where there are few ground radar and only occasional research aircraft flights.

Future Work

- Continue on HT / warm core interactions in Bonnie, Emily HT characterization from aircraft observations (Heymsfield, Halverson)
- Satellite convective burst/ HT studies (Halverson, Kelley)
- Dual-wavelength characterization of HT (Tian, Heymsfield)
- Characterizing hot tower heating and its impact on TC dynamics (Guimond)

Vertical Structure of HT

EDOP-derived