UNIVERSITY of HAWAI'I MĀNOA

Department of Atmospheric Sciences Ph.D. Dissertation Announcement

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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

Ph.D. Dissertation Title:

Radar-derived Thermodynamic Structure of a Major Hurricane in Vertical Wind Shear

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Abstract:

Investigating the physical mechanisms that determine the location and timing of eyewall convection is critical to understand intensity changes in tropical cyclones. Observations within the eyewall are essential to identify these physical mechanisms, but high resolution measurements of both kinematic and thermodynamic quantities in the eyewall are limited. Direct thermodynamic observations in particular are limited spatially to aircraft tracks and dropsonde paths. This study presents a thermodynamic retrieval tailored specifically toward rapidly rotating vortices, which provides an unprecedented view of the three-dimensional temperature and pressure structure of the inner core region of tropical cyclones using airborne Doppler radar data. The retrieval is applied to observations in Hurricane Rita collected on 23 September 2005 during the RAINEX field campaign. The retrieved pressure and temperature fields along with the wind and precipitation structure of Hurricane Rita emphasize the impact of vertical wind shear on the azimuthal location of convection in the eyewall and show the dynamic and thermodynamic processes that act to balance the vortex tilt. Analysis of the contributions of the retrieved pressure and temperature fields to different azimuthal wavenumbers suggests the interpretation of eyewall convection within a three-level framework of balanced, quasibalanced, and unbalanced motions. The axisymmetric, wavenumber-0 structure is determined by both gradient wind and hydrostatic balance, resulting in a pressure drop and temperature increase toward the center. The wavenumber-1 structure, and perhaps in part the wavenumber-2 structure, is determined by the interaction of the storm with environmental vertical wind shear, resulting in a quasi-balance between shear and shear-induced kinematic and thermodynamic anomalies. The higher-order wavenumbers are connected to unbalanced motions and convective cells within the eyewall.