Ph.D. Defense Announcement
Ellie Casas
Monday, April 18, at 1:00 p.m. MT

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Defense
ATS West Seminar Room (121 ATS West) or Teams

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Michael Bell (Adviser)
David Randall
Eric Maloney
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Investigation of Relationships Between Tropical Cyclone Structure and Intensity Change

Rapid intensification (RI) of a tropical cyclone (TC) remains one of the largest sources of intensity forecast error, due in part to internal dynamics that are complex and less well understood. Part of the difficulty in improving understanding of RI is due to complex interactions across a wide range of TC intensities, shapes, and sizes. In this doctoral study, I investigate these interactions by first simplifying the complexity by reducing the dimensionality of the intensity and structure parameter space to distill the key aspects of variability from observations, and then re-introducing physical complexity back into the experimental design through idealized modeling.

In Chapter 2, an Empirical Orthogonal Function (EOF) analysis is used to develop the intensity-size framework that lays the foundation for the rest of this doctoral study. In addition to commonly-used TC metrics, a new structural parameter is introduced that describes the decay of tangential wind outside the radius of maximum wind (RMW). The utility of this framework is demonstrated for describing key TC evolutionary features with observations of Hurricanes Rita (2005) and Charley (2004) and numerical simulations of Rita.

In Chapter 3, simplified TC analytic profiles are used to construct physically realistic wind fields that can explore the intensity-size phase space. Results suggest that while there are systematic differences between the details of the reconstructed wind fields using different methods, they all are representative of observed variability in TC structure despite being derived from a relatively small set of parameters derived from the EOFs.

In Chapter 4, these simplified TC wind profiles are used to investigate the tropical cyclone boundary layer (TCBL) response across our intensity-size phase space using both height-averaged (slab) and height-resolved TCBL numerical models. The results suggest that while there are some different dynamical ramifications of the specific analytic profiles used, the response depends more on the location in the intensity and size phase space than on the differences between analytic wind formulations. The results indicate that (1) strong, big TC profiles produce the strongest supergradient wind within the TCBL; (2) weak, big TCs have the largest RMW contraction as the TCBL adjusts; and (3) weak TCs regardless of size have TCBL responses that are less conducive for intensification.

Finally, in Chapter 5, full-physics, axisymmetric models are used to test whether the one-way TCBL responses found in Chapter4 are consistent with two-way TCBL interactions with influences from convection, and explore the dependencies of intensification rates on TC internal structure. The results suggest that small, strong TCs can achieve the highest rapid intensification rates. The findings

suggest that while intensification rates do not systematically vary with contraction rates of the RMW, both intensification and contraction rates do have some dependence on different aspects of TC intensity and size across the phase space. When visualized in the phase space, there is a relatively smooth transition between an "initially large mode'" and "initially small mode" of RI. The findings of this doctoral study provide new insights into the role of TC intensity and size in the RI process.

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