PhD Defense Announcement
Benjamin Trabing
October 28, 2020 at 3:30 p.m.

Benjamin Trabing
PhD Defense

Wednesday, October 28, 2020
3:30 p.m.

Defense
Virtual through Teams

Post Defense Meeting
Virtual

Committee:
Michael Bell (Adviser)
Christine Chiu
Susan van den Heever
John Knaff (CIRA)
Bret Windom (Mechanical Engineering)

ON INTENSITY CHANGE AND THE EFFECTS OF SHORTWAVE RADIATION ON TROPICAL CYCLONE RAINBANDS

In this dissertation, the effects of shortwave radiation and the diurnal cycle of radiation on tropical cyclone rainbands are explored. In order to improve short term forecasts of tropical cyclone intensity and size, a better understanding of the processes that affect the inner rainbands of tropical cyclones is warranted. In Part I, the distribution of intensity forecast errors from the National Hurricane Center (NHC) are characterized in the Atlantic and East Pacific basins. Analysis of the forecast error distributions and the relationship between the thermodynamic environments in which those errors occur leads to the conclusion that improvements need to be made to our understanding and prediction of inner-core processes, particularly to predict rapid changes in intensification and weakening.

The effect of shortwave radiation on tropical cyclone rainbands during an eyewall replacement cycle (ERC) is examined in Part II. In the idealized experiments we vary the amount of incoming solar radiation to change the magnitude of the response and assess the sensitivity of the timing of the ERC. Shortwave radiation has a delaying effect on the ERC primarily through its modifications of the distribution of convective and stratiform heating profiles in the rainbands. Shortwave radiation reduces the amount and strength of convective heating profiles by stabilizing the thermodynamic profiles and reducing convective available potential energy. The idealized modeling study shows that the coupled interactions between the shortwave radiation and the cloud microphysics is at the crux of the experiment and requires further verification by observations.

Part III explores the diurnal cycle of convection in the rainbands of Typhoon Kong-rey (2018) using a suite of novel observations from the Propagation of Intraseasonal Tropical Oscillations (PISTON) field campaign. Convection in the rainbands of Typhoon Kong-rey had a more pronounced diurnal cycle compared to the rest of PISTON where shortwave heating in the upper-levels increased the static stability during the day. Pronounced diurnal oscillations in the brightness temperatures, which are out of phase with those documented in Dunion et al. (2014), are found to be coupled with outflow jets below the tropopause and radially outward propagating convective rainbands approximately ~6 hours later.

In Part IV an attempt is made to simulate the diurnal variations in the rainbands of Typhoon Kong-rey that were observed during PISTON. Four experiments are conducted using commonly used shortwave radiation and cloud

microphysics schemes to determine the extent to which previous and future studies can reproduce diurnal variability. Of the four experiments, only one realistically simulated Typhoon Kong-rey's rapid intensification and none of the experiments reproduce the diurnal oscillations in the infrared brightness temperatures. The interactions between the shortwave radiation and cloud microphysics schemes cause variations in the distribution of convective and stratiform precipitation in the inner-rainbands and the extent of upper-level clouds that can largely explain the differences in the intensity. Sensitivity tests suggest that more work on documenting radiation-microphysics interactions is needed to improve model forecasts of inner-rainband structure.