The Diurnal Cycle of Idealized Tropical Cyclones

Recent studies have shown that a tropical cyclone response to the diurnal cycle of radiation is apparent in both individual storms (Dunion et al., 2014) as well as within the tropical cyclone climatology. (Bowman and Fowler, 2015). While these studies suggest that an underlying, perhaps fundamental, mechanism within the storm may exist, the dynamics for this response are still unexplained. Given that previous studies on this subject were limited due to radiative parameterizations and boundary and initial conditions, a new study is conducted in an idealized model equipped with interactive radiation. This presentation will address the diurnal response of tropical cyclones using results from an axisymmetric simulation in radiative-convective equilibrium.

Fourier analysis reveals that a diurnal signal is present in the temperature, wind, and cloud ice fields. This signal is statistically different from random noise. Composite analysis of each hour of the day shows a coherent cycle in the storm intensity that lags the response in outflow temperature by a quarter of a day (six hours). Relative to the mean, the storm is seen to intensify in the early hours of the morning and weaken throughout the day. This is consistent with the observed precipitation maximum in convection over the open ocean as well as with previous studies. In addition, new convection forms in the eyewall in the late afternoon, consistent with recent observations of real storms. Examination of the radial-vertical wind suggests two distinct circulations: (1) a radiatively driven circulation in the outflow layer driven by absorption of radiation from the sun, (2) a convectively-driven circulation within the storm due to latent heating. These responses are coupled and are periodic with respect to the diurnal cycle.

Hypothesis tests of similar heating distributions will be presented using results from a Sawyer-Eliassen model solved on a balanced, mean vortex (see Pendergrass and Willoughby, 2009 and Willoughby, 2009). A possible explanation for the diurnal cycle of axisymmetric tropical cyclones will be introduced.

References


Bowman, K. P. and M. D. Fowler, 2015: The Diurnal Cycle of Precipitation in Tropical Cyclones. *J. Climate*, pre-release, doi: [http://dx.doi.org/10.1175/JCLI-D-14-00804.1](http://dx.doi.org/10.1175/JCLI-D-14-00804.1)
