Precipitation Structure Upshear and Its Role in Tropical Cyclone Intensification

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It has long been known that tropical cyclone (TC) structure and intensity change are highly sensitive to the environmental vertical wind shear. High vertical wind shear (considered to exceed 20-25 kt between 850 and 200 hPa) is generally detrimental to intensification. However, there is a range of moderate shear values, between 10 and 20 kt, where the response of the TC is uncertain, and it is in this range of shear values where significant forecast uncertainty lies. Whether or not a TC intensifies in this shear environment is dependent on characteristics of the environment as well as the TC vortex.

One aspect of the vortex structure that has received considerable attention recently is the precipitation structure, and how that structure varies as a function of the vertical shear. Recent aircraft, satellite, and modeling-based studies have identified different modes of precipitation, e.g., deep convection vs. shallow convection and stratiform precipitation, as having differing importance in indicating TC intensification is either about to start or has already begun. In general, intensification has been associated with a higher distribution of deep convection inside the local radius of maximum wind and a greater azimuthal coverage of precipitation of all types.

This study will present results from recent and ongoing case study and composite analyses of airborne Doppler radar data of the structure of precipitation on the upshear side of TCs and its relationship with TC intensification. Intensifying TCs have more deep convection upshear, with stronger updrafts that peak at a higher altitude with higher echo tops, than non-intensifying TCs. Shallow to moderate convection and stratiform precipitation on the upshear side, possibly associated with moistening of the midlevels, are also seen prior to and during intensification. These results suggest a complex interplay between precipitation structure and TC intensification, with processes that provide a more favorable local environment for the maintenance of convection upshear being an important player. Such a relationship suggests that knowledge of the structure of the precipitation on the upshear side of the TC can provide an indication of the potential for intensification.