Polarimetric Radar Observations of Size Sorting in the Asymmetric Eyewall of Hurricane Matthew (2016)

*Chelsey N. Laurencin[1], Anthony C. Didlake, Jr.[1]

1. The Pennsylvania State University

Using polarimetric and Doppler radar observations of Hurricane Matthew (2016) captured by WSR-88D and the NASA High Altitude Wind and Rain Profiler (HIWRAP) radars, this study examines the microphysics and kinematic processes in the observed asymmetric eyewall structures. The data were analyzed in the context of deep-layer environmental wind shear, a typical governing factor on inner core asymmetries. In the single eyewall case, warm-rain size sorting of raindrops was observed, marked by a differential reflectivity (Z_{DR}) column in the downshear-right quadrant and a specific differential phase (K_{DP}) column in the downshear-left, both overlapping the maximum reflectivity. Because Z_{DR} columns can be used as a proxy for the location of strongest updrafts, the observed size sorting signature indicated that the largest raindrops fell out of the updraft faster than the smaller, abundant drops that were advected further downstream by the primary circulation. The shear-relative location of this feature was a quadrant upwind of those documented in past literature, which could be due to land interaction with the eyewall convection. Still, the observed asymmetries in the tangential and vertical velocity aligned with the size sorting signature, and a simple trajectory calculation for falling raindrops within this kinematic field yielded results consistent with the shear-relative locations of the observed K_{DP} and Z_{DR} columns. In the concentric eyewall case, size sorting was initially solely observed in the left-of-shear quadrants of the inner eyewall, which, despite being in a decaying stage, had deeper and stronger polarimetric enhancements than the outer eyewall. The outer eyewall maximum reflectivity, originally in the left-of-shear half, gradually shifted upwind in a similar manner to that of previous studies. Simultaneously, the decaying inner eyewall merged with the outer eyewall, boosting the outer eyewall convection and completing an eyewall replacement cycle. The outer eyewall subsequently developed a size sorting signature within its downshear quadrants, indicating that a persistent, concentrated updraft formed, likely in response to the increasing wind shear.

Keywords: Size sorting, Tropical Cyclones, Polarimetric radar, Kinematics, Convection