Analyzing the transition from rainbands to a secondary eyewall using airborne radar observations of Hurricane Earl (2010)

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Airborne radar observations from the X-band NOAA P3 Tail Doppler radar were collected in the inner core of Hurricane Earl during a two-day period leading up to secondary eyewall formation (SEF). Dual-Doppler analyses were performed using the NOAA Hurricane Research Division (HRD) automated quality control and retrieval techniques to provide instantaneous three-dimensional reflectivity and wind fields. Although the underlying dynamical mechanisms for SEF remain uncertain, past studies indicate that a sufficient amount of rainbands must inhabit the storm’s inner core to spark the formation process. Prior to SEF, Earl exhibited an asymmetric rainband complex with convective and stratiform precipitation predominantly occurring in different regions of the storm. Relative to the environmental wind shear, the downshear-left (DL) quadrant of the storm had rainbands that were mostly stratiform precipitation. In this stratiform region was a mesoscale descending inflow jet similar to previous observations of Hurricane Rita leading up to its SEF (Didlake and Houze 2013). At the innermost point of the inflow jet, air abruptly plummeted from the middle levels into the boundary layer, which then connected to a local enhancement of the boundary layer radial inflow. A momentum budget analysis showed that this pattern was enhancing the local low-level tangential wind field, and contributed to the eventual development of the axisymmetric low-level jet of the secondary eyewall. This DL quadrant also developed the strongest overturning circulation associated with the developing secondary eyewall, which is a pattern consistent with past studies (Hence and Houze 2012, Didlake et al. 2017). These results emphasize the importance of rainband asymmetries, which must be thoroughly examined in order to fully understand the processes behind SEF.