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Multiscale Structures in Tropical Cyclone Boundary Layers

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We present recent advances in the development of the resonant triad interaction model of large scale roll vortices in the tropical cyclone boundary layer. The relatively shallow, high shear and strong surface buoyancy flux conditions that characterize the tropical cyclone boundary layer make it an ideal environment for the formation of mixed shear/convection roll vortices. The most commonly documented rolls tend to align close to the mean wind direction and have aspect ratios (wavelength/depth) of near 2.5 to 4. Some observations suggest much smaller scale rolls are nearly ubiquitous in the near surface layer. Recent analyses of synthetic aperture radar images of the sea surface under tropical cyclones find nearly ubiquitous signatures of very large aspect ratio rolls, with wavelengths of order 10 km or greater. These rolls apparently extend from the surface into the lower troposphere. Our studies hypothesize that nonlinear triad wave-wave interactions are a likely candidate to explain the formation and persistence of these large aspect ratio modes, the variability in detectability of "standard roll vortices and a possible reason why such large scale rolls are not formed in mesoscale numerical models.