High-order azimuthal wavenumber asymmetries in rapidly intensifying Hurricane Michael (2018)

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Hurricane Michael (2018) was the first Category 5 hurricane to make landfall in the United States since Hurricane Andrew (1992). Michael underwent rapid intensification during its approach to Florida, and the coastal Next Generation Weather Radar (NEXRAD) observations showed evidence of azimuthal asymmetries from wavenumber 1 - 6 with evolving polygonal shapes evident in the radar reflectivity. While polygonal eyewall structures have been previously observed in radar and satellite imagery, the corresponding evolution of wind asymmetries are very difficult to quantitatively measure due to both spatial and temporal sampling limitations. A single-Doppler wind retrieval with the Generalized Velocity Track Display (GVTD) technique is used to analyze the axisymmetric and asymmetric kinematic evolution at 5-minute intervals. The analysis shows quantitative evidence of growing high-order wavenumber structures in the tangential wind field that suggest the presence of rapidly-evolving vortex Rossby waves (VRWs). A spectral time decomposition of the GVTD winds indicates that the azimuthal propagation speeds of different VRWs are roughly consistent with linear wave theory on an amplifying mean radial vorticity gradient. While both the reflectivity and wind field show evidence of high-order structure, they do not propagate together, suggesting that divergence asymmetries are not fully coupled to the vorticity asymmetries. The results highlight that the GVTD technique can be used to investigate TC internal vortex dynamics with high temporal and spatial resolution. The implications of the results for improved understanding of rapid intensification will be discussed.

Keywords: Tropical Cyclone, Vortex Rossby Wave, GVTD technique