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Concentric Eyewalls and Tropical Cyclone Vortex-scale Structure Characteristics

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More than half of major tropical cyclones (TCs) form concentric eyewalls (CEs) at least once in their life cycle. CE formation and the ensuing eyewall replacement can result in a rapid change in TC intensity and wind field structure. Over the past decade, the dynamics of secondary eyewall formation (SEF) have been the subject of intense research. The separation distance between the inner and outer eyewalls, however, can vary dramatically from case to case. The mechanisms determining the radial location where the secondary eyewall forms are much less understood.

This study investigates the relationship between secondary eyewall size and the TC vortex-scale structural features prior to the formation of CE, utilizing satellite data, high-resolution reanalysis data and best-track dataset. The results show that there is a significant positive correlation between the secondary eyewall size and the strength of outer-core circulation and TC size. The stronger the outer-core circulation is and the larger the TC size is, the larger the secondary eyewall size is. The correlation between secondary eyewall size and the mid-level outer TC circulation features appears two days before CE formation, suggesting that stratiform processes occurring in the middle tropospheric levels playing important roles prior to SEF.

Furthermore, the differences in vortex-scale structure between the major TCs that do not form obvious CE structure and the TCs that form CE structure are compared and analyzed. The strength of outer-core circulation in TCs without obvious CE structure is much weaker and the corresponding TC size is smaller. The results of this study demonstrate that TC needs to reach certain size as well as a certain intensity to form CE structure. Intense TCs with too small size are not prone to form obvious CE structure.