A study on the long-lived concentric eyewalls in tropical cyclones

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ABSTRACT

Concentrate eyewalls (CE) in tropical cyclones (TCs) in different basins were identified based on satellite imagery during 1997–2014. Their duration and structural parameters, including inner eyewall size, moat width, and outer eyewall width, were calculated. Differences in these parameters can best be distinguished by short-lived and long-lived CEs (i.e., CEs with durations shorter or longer than 20 h). A long-lived CE tends to have a larger size, mainly contributed by a larger moat and a larger outer eyewall width. The WNP has far more CEs than in ATL and in the eastern Pacific (EPAC) for all duration categories. Long-lived CEs cover about 20% of all CEs and are associated with higher sea surface temperature and weaker vertical wind shear. In the WNP, the TC tracks associated with long-lived CEs were with the less northward motion component.

A series of slab boundary layer (SBL) model experiments are conducted to explain why observed long-lived CEs often have a large moat size. The results highlight the importance of the variables of vortex intensity and the dimensionless moat to the inner eyewall pumping (IEP). A long-lived CE is with a large vortex intensity and dimensionless moat. The dimensionless moat is the moat size divided by the Rossby radius deformation which combines the effect of the moat size and the vortex pressure gradient force to accelerate the inflow and to enlarge the boundary layer IEP for inner eyewall convection maintenance. A phase diagram of IEP with vortex structure dimensionless moat and vortex intensity is constructed based on the scaling law for the aircraft and satellite observations. The eyewall replacement cycle may be viewed as the process to reduce the IEP from the decrease of the vortex intensity and the vortex size of the dimensionless moat. This leads to the ultimate disappearance of the inner eyewall.

REFERENCES

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Keywords: long-lived concentric eyewalls tropical cyclone; dimensionless moat; inner eyewall pumping