Structural Changes Preceding Rapid Intensification in Tropical Cyclones as shown in a Large Ensemble of Idealized Simulations

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Structural changes that precede rapid intensification (RI) of tropical cyclones (TCs) are examined in a full physics model by conducting a large ensemble (270) of simulations.

The processes leading to RI in a representative case with moderate shear are consistent with previous studies for weakly sheared cases. The most distinct changes are that the vortex tilt and the vortex size begin to decrease more rapidly 6 h before the onset of RI.

A vorticity budget analysis for the upper layer around the low--level center reveals that the vertical vorticity is increased by vertical advection, stretching, and tilting terms before RI, whereas the horizontal advection is small. Thus, the upright vortex structure is not achieved through a vortex alignment process, but rather is built upward by deep convection.

The ensemble simulations are generated by changing the intensity and size of the initial vortex, the magnitude of vertical wind shear, and the translation speed. The ensemble members that show RI are consistent with the control case and many previous studies:

before the onset of RI, the intensity gradually increases, the radius of maximum tangential velocity (RMW) decreases, the flow structure becomes more symmetric, the vortex tilt decreases, and the radius of maximum convergence approaches the radius of maximum winds.

A dimensionless parameter representing a tendency for the formation of the vertically upright structure is considered.

The product of this parameter and the local Rossby number is significantly larger for TCs that exhibit RI in the next 24 hours.

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