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Rapid versus slow intensification of idealized tropical cyclones using soundings from reanalysis

Abstract

This study investigates the structural and thermodynamic differences between ensembles of rapidly (RI) and slowly (SI) intensifying tropical cyclones (TCs) using idealized simulations based on reanalysis-derived environmental soundings. Climatologically averaged wind and moisture profiles were applied to create more realistic TC environments than in previous idealized studies. RI storms generally exhibit smaller vertical tilt, greater symmetry, and weaker ventilation at onset compared to SI storms. In contrast, SI storms show stronger downdraft and radial ventilation, especially left and upshear of the shear vector. RI events contain more areas of intense reflectivity and strong updrafts, while SI events have more weak reflectivity and downdrafts. Although both storm types appear similar 24 hours before onset, a rapid vertical alignment and symmetrization of precipitation within the following 12 hours clearly distinguishes RI from SI. These results indicate that the time evolution of storm structure rather than a single environmental or structural state, provides a more reliable signal for predicting tropical cyclone intensification rates.

Keywords

Storm vertical tilt；Ventilation

Reference

Nebylitsa, S., Nolan, D. S., McNoldy, B. D., & Majumdar, S. J. (2025). Rapid versus slow intensification of idealized tropical cyclones using soundings from reanalysis. *Quarterly Journal of the Royal Meteorological Society*, 151:e5011. https://doi.org/10.1002/qj.5011