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Effect of Unidirectional Vertical Wind Shear on Tropical Cyclone Intensity Change—Lower-Layer Shear Versus Upper-Layer Shear

Abstract

In this study, a quadruply nested, nonhydrostatic tropical cyclone (TC) model is employed to investigate how the structure and intensity of a mature TC respond differently to imposed lower-layer and upper-layer unidirectional vertical wind shears (VWSs). Results indicate that TC intensity initially decreases shortly after the VWS is imposed in both cases, but the subsequent evolutions differ markedly. Under upper-layer shear, the TC weakens more rapidly and for a longer period, associated with stronger storm-relative asymmetric flow in the middle-upper troposphere and greater vertical vortex tilt, which enhance ventilation of the warm core and lead to more substantial weakening. In contrast, under lower-layer shear, the TC weakens only initially and then exhibits a quasi-periodic intensity oscillation with a period of approximately 24 hr, closely linked to the boundary-layer thermodynamic "discharge/recharge" mechanism associated with shear-induced outer spiral rainband activity. For the upper-layer shear case, although outer rainbands also develop quasi-periodically, the boundary-layer inflow is too weak to advect low equivalent potential temperature air into the inner core, which remains in the outer region, and thus no significant intensity oscillation occurs.

Keyword

Vertical Wind Shear (VWS)

Reference

Fu, H., Wang, Y.-Q., Riemer, M., & Li, Q.-Q. (2019). Effect of unidirectional vertical wind shear on tropical cyclone intensity change—Lower-layer shear versus upper-layer shear. *Journal of Geophysical Research: Atmospheres, 124*(12), 6265–6282. https://doi.org/10.1029/2019JD030586