

Global cloud-permitting simulations of Typhoon Fengshen (2008)

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Large-scale fields and inner-core processes relevant to the formation and intensification of Typhoon Fengshen (2008) were examined by simulations using Nonhydrostatic Icosahedral Atmospheric Model (NICAM; Satoh et al. 2014) with a cloud-permitting (3.5-km mesh) resolution (Nasuno et al. 2016). Fengshen was formed in mid-June during the onset of the WNP monsoon and the active phase of a boreal summer intraseasonal oscillation (BSISO) event. The TC genesis was preceded by the formation of a lower tropospheric large-scale gyre associated with enhanced equatorial westerlies and a middle tropospheric wave trough intruding above the gyre.

To understand the impact of atmospheric conditions and the convective effects on the TC environment and precursor disturbance, five simulations were performed by varying the initial data (interpolated using ECMWF YOTC or NCEP FNL analysis) and cloud microphysics settings.

In three simulations initialized using the ECMWF YOTC, a middle tropospheric trough developed within a few days following a large-scale latent heat release, which enabled the successive occurrence of deep convective events within the 50-km radius of the incipient disturbance and subsequent TC formation. In the run with weaker latent heating in the lower troposphere, the trough was weak and TC formation was significantly delayed.

In the run initialized using the NCEP FNL, where the latent heat release averaged over the entire simulation was the same as its ECMWF YOTC counterpart, neither the trough nor a TC developed, lacking the collocation between the latent heat release and large-scale gyre in the early period. Under the vertical wind shear increasing poleward, it was critical for the incipient vortex to experience upward penetration before it moved farther northward.

These results indicate that the superposition of large-scale disturbances in the lower and middle troposphere and their linkage through convective enhancement played an important role in the genesis of Fengshen by preconditioning the establishment of a deep upright inner core. Another implication is that the modeled TC genesis is sensitive to difference in initial environment under a strong vertical shear like in this case.

References:

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Keywords: Tropical cyclogenesis, global nonhydrostatic model, cloud-permitting simulation