Advanced Study of Vortex Relocation Scheme for Tropical Cyclone Initialization in WRF Model

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This paper introduces a relocation scheme for tropical cyclone (TC) initialization in the WRF model and demonstrates its application to 70 forecasts of typhoons Sinlaku, Jangmi (2008) and Linfa (2009). An efficient and dynamically-consistent TC vortex relocation scheme for the WRF has been developed to improve the first guess of the TC analysis, and hence improves the tropical cyclone initialization. The vortex relocation scheme moves the TC circulation to its observed location, and adds the relocated TC circulation back to the environmental flow to obtain the updated first guess with a correct TC position. Analysis of these typhoon cases indicates that the relocation procedure moves the typhoon circulation to the observed typhoon position without generating discontinuities or sharp gradients in the first guess. Numerical experiments with and without the vortex relocation procedure for typhoons Sinlaku, Jangmi and Linfa forecasts show that about 67% of the first guess fields need a vortex relocation to correct typhoon position errors. As the vortex relocation effectively removes the typhoon position errors in the analysis, the simulated typhoon tracks are considerably improved for all forecast times, especially in the early periods as large adjustments appeared without the vortex relocation. The result suggests that the main difficulty of objective analysis methods, like 3DVAR, in TC analysis comes from poor first guess fields with incorrect TC positions rather than not enough model resolution or observations. Therefore, by eliminating the typhoon position error in the first guess that avoids a distorted initial typhoon circulation, the vortex relocation scheme is able to improve the WRF-ARW typhoon initialization and forecasts particularly when using data assimilation update cycling.

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