Assimilation of Tropical Cyclone Track and Structure Based on the Ensemble Kalman Filter (EnKF)

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A new vortex initialization method based on the ensemble Kalman filter (EnKF) has been proposed in this study. Three effective new observation operators related to the tropical cyclone (TC) track and structure, including center position, velocity of storm motion and surface axisymmetric wind structure, are used to construct a reasonable initial vortex in the high-resolution Weather Research and Forecasting (WRF) model. The first two observational parameters can be available from the best-track data of the operational forecast center, which are mainly based on the satellite analysis. The radial wind profile is constructed by fitting the combined information from both the best-track data and the dropwindsone data available from the aircraft surveillance observation, such as Dropwindsonde Observation for Typhoon Surveillance near the Taiwan Region (DOTSTAR) and T-PARC (THOREX-Pacific Asian Regional Campaign). By assimilating the above special parameters for TCs in a 24-h period, without employing any extra bogus scheme, a reasonable track and vortex structure is produced at the end of the assimilation period. The initialized vortex is consistent with the observations, with a typical vertical TC structure, despite that only the surface wind profile is assimilated. In addition, the subsequent numerical integration shows very minor adjustment during the early period, indicating that the initial condition from this method is dynamically well balanced. It is an important feature for the TC numerical integrations. Our results suggest that this new method provides an effective means of improving TC initialization and has good potential in both integrating special observations and conducting high-resolution numerical experiments to gain more physical insights into the dynamics of TC structure, and to improve the operational TC model forecast.