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Forecast of tropical cyclones near landfall through assimilation of GVTD-retrieved winds from single-Doppler radar using 3DVAR and EnKF

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The generalized velocity track display (GVTD) technique was developed to estimate the primary circulations of landfalling tropical cyclones (TCs) from single-Doppler radar data recently. This study explores the assimilation of GVTD-retrieved winds into a TC prediction model, and examines its impact relative to that of directly assimilated radial velocity data. Super Typhoon Saomai (2006) and Meranti (2010) are chosen as the test cases, and data from the coastal operational radar at Wenzhou and XiaMen, China are used. The 3DVAR and EnKF within the Advanced Regional Prediction System (ARPS) are used to assimilate either the radial velocity data directly or the GVTD-retrieved winds, at 30-min intervals for 2 hours.

The results from both 3DVAR and EnKF demostrate that the assimilation of the GVTD-retrieved winds results in much improved structure and intensity analyses of Saomai and Meranti compared to those in the Japan Meteorological Agency mesoscale reanalysis as well as that assimilating radial velocity (Vr) data directly. The experiments that assimilating the retrieved circulations using 3DVAR and EnKF produce the similar analyses and forecasts in this study, although the EnKF is theoretically more advanced than 3DVAR.The ability of the GVTD method in providing complete vortex circulation is the primary reason for its superior performance over direct assimilation of Vr data; for the latter, the azimuthal data coverage is often incomplete, and the cross-beam wind component is missing. With the improved initial conditions, the subsequent 12-h forecasts of typhoon intensity, track and precipitation are also improved. Subjective and quantitative evaluations of the precipitation and circulation patterns show consistent results. The assimilation of axis-symmetric wind components is primarily responsible for the improvement, while the asymmetric wind component has small impact. Furthermore, an attempt to assimilate additional radar reflectivity data is also made; it results in slight improvement to the intensity and precipitation forecast.