Improving Analysis and Prediction of Tropical Cyclones by Assimilating Radar and GNSS-R Wind Observations: Observing System Simulation Experiments

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This study investigates the impact of assimilating ground-based radar reflectivity and wind data on tropical cyclone (TC) intensity prediction. The effect on a high-impact TC in the Western-North Pacific region that penetrated the Bashi channel is examined. A multiscale correction based on successive covariance localization (SCL) method is adopted to improve the analysis and forecast performance. In addition, GNSS-R wind speed retrieval is assimilated jointly to complement the TC boundary layer where radar data is limited. Model experiments are conducted and evaluated using the observing system simulation experiments (OSSEs) framework.

Results show that assimilating the radar data reduces the wind speed analysis error within the TC circulation by 18 %. The TC intensity forecast is improved for a lead time longer than two days, and the error of TC's peak intensity is reduced by 5 hPa. Applying the SCL method further reduces the wind speed analysis error by 29 %, and the forecast TC's peak intensity is improved by 13 hPa. The additional assimilation of the GNSS-R wind speed observation is beneficial in the rapid update assimilation framework. The TC analysis at the lower atmosphere is improved by 11 %, and 6 hPa in TC intensity prediction. However, the effect of GNSS-R is restricted due to the sampling error introduced by the SCL method in areas where the amount of radar data is limited. Sensitivity experiments with different GNSS-R data arrangements show that better GNSS-R wind coverage and additional wind direction information can further improve the TC analysis.

Keywords:Radar data assimilation, GNSS-R wind, Tropical cyclone prediction