Analysis and Forecasting Analysis and forecast of typhoon Chanthu (2021) using an ensemble radar data assimilation system: Impact of model horizontal resolution and assimilation frequency on vortex spindown

林冠任[1] (Lin K.-J.) 楊舒芝[1] (Yang S.-C.)

[1]國立中央大學大氣科學系

Abstract

Typhoon Chanthu (2021) is a category 5-equivalent super typhoon with a very narrow eye when it is approaching Taiwan. During its northward movement offshore the east coast of Taiwan, it is well-observed by the coastal radar network. Therefore, this study assimilates the high-resolution radar observations using the WRF-local ensemble transform Kalman filter radar assimilation system (WLRAS) to investigate the analysis and prediction of super typhoon Chanthu. Results show that assimilating the radar data greatly improves the analysis of Chanthu. However, significant vortex spindown occurs when the deterministic forecast is initiated. Such results motivate this study to further investigate the causes of the significant vortex spindown. In particular, the impact of model horizontal resolution and assimilation frequency is examined.

The original WLRAS uses a triply nested domain with the finest horizontal resolution of 4 km, and the assimilation frequency is 15 minutes. Experimental results show that increasing the model horizontal resolution from 4 km to 1.33 km at the forecast stage can alleviate the spindown issue. Furthermore, the spindown is better resolved when the model resolution is increased earlier at the DA stage. Such results indicate that the high-resolution model is important not only for the forecast but also for the analysis performance. The positive impact of increasing model resolution is attributed to the better-resolved secondary circulation at the eyewall and the stronger warm core structure. Experimental results also show that using either 15-, 30-, and 60-minute assimilation intervals can establish good tangential wind structure within 3 hours, but only the 15-minute rapid update cycle is able to reconstruct the complete typhoon circulation and sustains typhoon intensity after a 12-hour forecast. It reveals that the rapid update cycle is critical for assimilating the dense radar data to obtain an accurate TC analysis and forecast.

Key words : radar data assimilation, tropical cyclone prediction, vortex spindown