Improving Operational Numerical Prediction of Afternoon Thunderstorms over Taiwan through Surface Data Assimilation

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Taiwan, a subtropical island with steep mountains, is influenced by diverse weather systems, including typhoons, monsoons, frontal, and convective systems. Of these, the prediction of deep, moist convection here is particularly challenging due to complex topography and apparent landsea contrast. This study explored the benefits of assimilating surface observations on prediction of afternoon thunderstorms using a 2-km resolution WRF and WRFDA model system with rapid update cycles. Consecutive afternoon thunderstorm events during 30 June to 08 July 2017 are selected. Five experiments, consisting of 240 continuous cycles are designed to evaluate the data assimilation strategy and observation impact. Statistical results show that assimilating surface observations systematically improves the accuracy of wind and temperature prediction near the surface. Also, assimilating surface observations alone in one-hour intervals improves model quantitative precipitation forecast (QPF) skill, extending the forecast lead time in the morning. Furthermore, radar data assimilation can benefit by the additional assimilation of surface observations, particularly for improving the model QPF skill for large rainfall thresholds. An afternoon thunderstorm event that occurred on 06 July 2017 is further examined. By assimilating surface and radar observations, the model is able to capture the timing and location of the convection. Consequently, the accuracy of the predicted cold pool and outflow boundary is improved, when compared to the surface observations.