Effects of Doppler Wind Lidar on the Heavy Rainfall Event in Taipei City: A Case Study

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On June 4, 2020, a short-term heavy rainfall event occurred in Taipei City, and more than 200 mm of rainfall fell in the Xinyi District of Taipei City in 2 hours. On that day, the weather system near Taiwan had fronts in the north of Taiwan and outer seas and mild typhoons in the waters southwest of Taiwan. Analyzing the overall environmental field is conducive to the development of the convective system. However, the numerical model operated by the Central Weather Bureau in Taiwan does not catch the small and medium severe rainfall system that occurred that day. The forecast cannot accurately hit the location of the convective system and the accumulated rainfall it brings.

This research applies advanced data assimilation methods (e.g., hybrid DA, 3DVar) to develop a high-resolution data assimilation forecasting system (UCD-WRF-GSI) in a small area (e.g., Northern Taiwan) through the assimilation of Songshan Airport Doppler lidar data. The three-dimensional wind field data obtained from the observation can effectively reconstruct the short-term heavy rainfall case. The results show that the cause of this case is the interaction of the atmosphere at different spatial scales, such as the northeasterly wind brought by the front, the southerly wind brought by the typhoon, and the local land-sea circulation. Taking the Xinyi District of Taipei City as an example, the UCD-WRF-GSI forecast results increased the cumulative rainfall by 30 mm compared with the original forecast, effectively improving the accuracy of cumulative rainfall forecast in this area by 15%. In other words, the numerical assimilation method proposed in this study can provide more realistic forecast results for the location and rainfall intensity of short-term heavy rainfall events.

Keywords:extreme precipitation, data assimilation, Doppler wind lidar