Improvement of Rainfall Ensemble Forecast of Typhoon Morakot (2009) from Assimilation of GPS RO Refractivity Data

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Abstract

A product from GPS radio occultation (RO) remote-sensing technique is the atmospheric refractivity profiles. The COSMIC constellation provides approximately 1,500 GPS RO refractivity profiles per day, uniformly distributed around the globe. Atmospheric refractivity is related to meteorological information on atmospheric density, temperature, and humidity. Through the multi-variable correlation in ensemble-based data assimilation system as well as the intrinsic adjustment in model evolution, the assimilation of RO refractivity data can improve the analysis of large-scale circulations as well. For typhoon forecast RO refractivity data is particularly important, as it provides valuable weather information over data sparse ocean.

However, the assimilation of RO refractivity, which is a non-traditional atmospheric measurement, into regional numerical weather prediction model is challenging. Many practical aspects of assimilation and data handling can influence the outcome of the assimilation. For example, the thinning of GPS RO refractivity profile, the quality control, and the specification of observational errors. Detailed design and configuration of ensemble system can also influence the results. For example, the localization radius and inflation factor for the ensemble data assimilation. Moreover, there are complicated interactions among these issues.

In this study, we developed simple but effective treatments for data thinning, data quality control and observation error specification in the ensemble-based data assimilation system WRF/DART. Intensive tests are performed for the track and rainfall forecast of Typhoon Morakot (2009). A new rainfall ensemble forecast verification technique is used to demonstrate the skill gained from the assimilation of RO refractivity data.

Key words: radio occultation (RO), refractivity, data assimilation, rainfall ensemble forecast, Typhoon Morakot (2009), WRF/DART