

Evaluating the Impact of Assimilating GNSS RO Refractivity Data Using a Nonlocal Observation Operator with CWA's regional NWP system

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Abstract

The Global Navigation Satellite System (GNSS) radio occultation (RO) data from FORMOSAT-7/COSMIC-2 have been operationally assimilated in a regional numerical weather prediction (NWP) system called CWA-WRF in the Central Weather Administration (CWA) since 2021. Currently, the RO refractivity data is assimilated in the CWA-WRF via a local observation operator that assumes the RO retrieved refractivity is representative of a local point. The local operator calculates RO refractivity without considering the effects of horizontal inhomogeneity around the RO measurements, which can be significant over regions with large horizontal moisture or temperature gradients. To improve the accuracy of the assimilation, a nonlocal observation operator that calculates the integrated amount of the model refractivity along the ray paths centered at the perigee points can be used. In this study, we conduct a comparative experiment to evaluate the impacts of assimilating RO refractivity with the nonlocal observation operator available in recent versions of WRF on the CWA-WRF forecast. Preliminary results show that the model analysis and forecast error reductions are statistically significant up to 5 days long, and the typhoon track errors are also reduced. However, the nonlocal observation operator requires excessive computational resources, which makes it challenging to be used in operational forecasting. With the encouraging results, we will continue to investigate using the nonlocal refractivity operator to assimilate RO data operationally in the CWA-WRF.

Key words: FORMOSAT-7, radio occultation, data assimilation, nonlocal observation operator