The estimation and sensitivity of GNSS-RO bending angle observation errors in the GSI hybrid data assimilation system

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Abstract

The Central Weather Bureau (CWB)'s Global Forecast System (CWBGFS) has used the Gridpoint Statistical Interpolation (GSI) data assimilation package developed by the National Centers for Environmental Prediction (NCEP) for its operational data assimilation. In GSI, the "bending angle" of the GNSS radio occultation (GNSS-RO) data is assimilated using the built-in default observation error settings, which is a family of empirical piecewise quadratic equations with respect to the observation height that were determined by NCEP with their Global Forecast System (GFS) model some years ago. Since CWB has used these default observation error settings for our own CWBGFS model, and NCEP has also upgraded their model to the finite-volume cubed-sphere dynamical core (FV3)-based FV3GFS system, it is important to investigate whether these settings are still suitable when coupled with different numerical models. In this study, two methods, the Desroziers et al. (2005) method and the total variance method, are used to estimate the optimal bending angle observation errors. The diagnosed observation errors are roughly two times as large as the default values consistently in both the FV3GFS and CWBGFS systems. Accordingly, a one-month assimilation experiment using the newly estimated bending angle observation errors is conducted with the CWBGFS, and a positive impact on forecast skills is therefore obtained, confirming that the default observation error values in GSI are certainly not optimal. This work is part of the joint effort between CWB and NCEP on the assimilation of the new FORMOSAT-7/COSMIC-2 GNSS-RO data, aiming to achieve optimal use of the data in the numerical weather prediction.