Assessment of the impact of FORMOSAT-7/COSMIC-2 GNSS RO observations on mid- and low-latitude ionosphere specification and forecasting using Observing System Simulation Experiments

Chih-Ting Hsu*[(1),(2)], Tomoko Matsuo[(2)], Xinan Yue[(3)], Tzu-Wei Fang[(4)], Timothy Fuller-Rowell[(4)], Kyo Ide[(5)], and Jann-Yenq Liu[(1)]

(1) Institute of Space Science, National Central University, Taoyuan, Taiwan
(2) Aerospace Engineering Sciences, University of Colorado at Boulder, CO, USA
(3)Chinese Academy of Sciences, Beijing, China
(4) Space Weather Prediction Center, National Oceanic and Atmospheric Administration, Boulder, CO, USA
(5) Department of Atmospheric and Oceanic Science, University of Maryland, MD, USA

The Formosa Satellite-7/Constellation Observing System for Meteorology, Ionosphere and Climate-2 (FORMOSAT-7/COSMIC-2) GNSS RO payload can provide global observations of slant total electron content (sTEC) with unprecedentedly high spatial temporal resolution and have a great potential to improve the ionospheric numerical weather prediction. By using observing system simulation experiments, we can quantitatively assess the impact of FORMOSAT-7/COSMIC-2 GNSS RO data on ionospheric specification and forecast. For this purpose, a coupled model of the Global Ionosphere Plasmasphere and the Thermosphere Ionosphere Electrodynamics General Circulation Model is incorporated into the NOAA Community Gridpoint Statistical Interpolation system (GSI) Ensemble Square Root Filter (EnSRF). EnSRF is an ensemble-based data assimilation scheme that can optimally combine observations with a model using second-order statistics (i.e., the sample mean and covariance information) obtained from a Monte-Carlo approach. It is critical for EnSRF to minimize the detrimental effects of sampling errors on the estimation of the correlation between observations and model states.

This study demonstrates how an EnSRF technique designed specifically for the FORMOSAT-7/COSMIC-2 sTEC observations can enhance the impacts of FORMOSAT-7/COSMIC-2 GNSS RO data on ionospheric specification. Specifically, the impact of the ensemble size and covariance localization is being examined by comparing the results of observing system simulation experiments. Our findings are: (1) sTEC data assimilation with EnSRF can improve the global ionospheric specification and forecasting. (2) The ensemble size larger than 70 is recommended for sTEC data assimilation with EnSRF. (3) The covariance tapering using the Gaspari-Cohn function (the compactly supported 5th-order piecewise rational function) with a length scale of 5000km to localize the impact of observations in the horizontal direction can improve the sTEC data assimilation quality.