

Assimilation of FORMOSAT-3/COSMIC electron density profiles into a coupled
Thermosphere/Ionosphere model using ensemble Kalman filtering

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This paper presents our effort to assimilate FORMOSAT-3/COSMIC (F3/C) GPS Occultation Experiment (GOX) observations into the National Center for Atmospheric Research (NCAR) Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) by means of ensemble Kalman filtering (EnKF). The F3/C electron density profiles (EDPs) uniformly distributed around the globe which provide an excellent opportunity to monitor the ionospheric electron density structure. The NCAR TIE-GCM simulates the Earth's thermosphere and ionosphere by using self-consistent solutions for the coupled nonlinear equations of hydrodynamics, neutral and ion chemistry, and electrodynamics. The F3/C EDP are combined with the TIE-GCM simulations by EnKF algorithms implemented in the NCAR Data Assimilation Research Testbed (DART) open-source community facility to compute the expected value of electron density, which is 'the best' estimate of the current ionospheric state. Assimilation analyses obtained with real F3/C electron density profiles are compared with independent ground-based observations as well as the F3/C profiles themselves. The comparison shows the improvement of the primary ionospheric parameters, such as NmF2 and hmF2. Nevertheless, some unrealistic signatures appearing in the results and high rejection rates of observations due to the applied outlier threshold and quality control are found in the assimilation experiments. This paper further discusses the limitations of the model and the impact of ensemble member creation approaches on the assimilation results, and proposes possible methods to avoid these problems for future work.