# Observation System Simulation Experiments Using JPL-USC GAIM with COSMIC and Ground-Based GPS Observations

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The University of Southern California (USC) and the Jet Propulsion Laboratory (JPL) have jointly developed a real-time Global Assimilative Ionospheric Model (GAIM) to monitor space weather, study storm effects, and provide ionospheric calibration for NASA flight projects. JPL-USC GAIM is a physics-based 4D (time as the 4$^{th}$ dimension) data assimilation model that uses both 4DVAR and Kalman filter techniques to solve for the ion & electron density state and key drivers such as equatorial electrodynamics, neutral winds, and production terms. Daily (post-processed) GAIM runs can accept as input ground GPS total electron content (TEC) data from 1000+ sites, occultation links from CHAMP, SAC-C, and the COSMIC constellation, UV limb and nadir scans from the TIMED and DMSP satellites, and in situ data from a variety of satellites. GAIM is also capable of ingesting multiple data sources in real time, updates the 3D electron density grid every 5 minutes, and solves for improved drivers every 1-2 hours. The entire assimilative modeling can be accomplished on a single dual-processor Unix workstation since our forward physics model and the adjoint model were expressly designed for data assimilation and computational efficiency.

In this presentation, we will discuss the impact of the GPS observation system on assimilative ionospheric modeling through observation system simulation experiments (OSSE’s). The observation system includes the transmitting satellites and space-borne as well as ground-based tracking receivers. In our OSSE’s, either physics-based or empirical models are used to compute electron density and line-of-sight TEC along radio observation links at each epoch. The simulated observations are then ingested into GAIM with an initial state and model drivers that are intentionally perturbed from the conditions that are used to simulate the data. The Kalman filter and 4DVAR processes are then applied to improving ionospheric state modeling and estimating perturbed drivers, respectively. We will also compare the effectiveness of the current COSMIC constellation with a proposed COSMIC follow-on mission with augmented coverage.