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JPL/USC GAIM: Using COSMIC occultations to estimate ionospheric state and drivers in near real-time

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0.1 We are in the midst of a revolution in ionospheric remote sensing driven by the illuminating powers of ground and space-based GPS receivers, new UV remote sensing satellites, and the advent of data assimilation techniques for space weather. In particular, the COSMIC 6-satellite constellation provides unprecedented global coverage of GPS occultations ($\sim$5000 per day), each of which yields electron density information with unprecedented $\sim$1 km vertical resolution. Calibrated measurements of ionospheric delay (total electron content or TEC) suitable for input into assimilation models are available in near real-time (NRT) from COSMIC with a latency of 15 to 120 minutes. Similarly, NRT TEC data are available from two worldwide NRT networks of ground GPS receivers ($\sim$75 5-minute sites and $\sim$125 more hourly sites, operated by JPL and others). The combined NRT ground and space-based GPS datasets provide a new opportunity to more accurately specify the 3D ionospheric density with a short time lag.

0.2 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 DoD customers and NASA flight projects. JPL/USC GAIM is a physics-based 3D 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 (delayed) GAIM runs can accept as input ground GPS TEC data from 1000+ sites, occultation links from the COSMIC constellation, UV limb and nadir scans from the TIMED & DMSP satellites, and in situ data from a variety of satellites (DMSP & C/NOFS). RTGAIM ingests multiple data sources in real time, updates the 3D electron density grid every 5 minutes, and solves for improved drivers every 1-2 hours. In the presentation, we will discuss the expected impact of COSMIC occultation data, describe recent improvements to the adjoint model and estimation of drivers, and present early validation results for NRT ingest of COSMIC data into RTGAIM.