USC/JPL GAIM: A REAL-TIME GLOBAL IONOSPHERIC DATA ASSIMILATION MODEL

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Abstract:

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. The University of Southern Califronia (USC) and the Jet Propulsion Laboratory (JPL) have jointly developed a Global Assimilative Ionospheric Model (GAIM) to monitor space weather, study storm effects, and provide ionospheric calibration for DoD customers and NASA flight projects. 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. GAIM accepts as input ground GPS TEC data from 900+ sites, occultation links from CHAMP, SAC-C, IOX, and the coming COSMIC constellation, UV limb and nadir scans from the TIMED and DMSP satellites, and in situ data from a variety of satellites (C/NOFS & DMSP). GAIM can ingest multiple data sources in real time, updates the 3D electron density grid every 5 minutes, and solves for improved drivers every 1-2 hours.GAIM density retrievals have been validated by comparisons to vertical TEC measurements from TOPEX & JASON, slant TEC measurements from independent GPS sites, density profiles from ionosondes & incoherent scatter radars, and alternative tomographic retrievals. Daily USC/JPL GAIM runs have been operational since March 2003 using 100-200 ground GPS sites as input and TOPEX/JASON and ionosondes for daily validation. A prototype real-time GAIM system has been running since May 2004. RT GAIM ingests TEC data from 77+ streaming GPS sites every 5 minutes, adds more TEC for better global coverage every hour from hourly GPS sites, and updates the ionospheric state every 5 minutes using the Kalman filter. We plan to add TEC links from COSMIC occultations and UV radiance data from the DMSP satellites, when they become available, to the daily and RT GAIM runs. Our presentation will include results from numerous validation case studies and one year of JASON validation statistics. Customers are currently evaluating the accuracy of USC/JPL GAIM "nowcasts" for ray tracing applications and trans-ionospheric path delay calibration.