URSI AP-RASC, Sydney, Australia, 17-22 August 2025

Proposal of a new methodology for IGS ionospheric products combination

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Accurate knowledge of free electron distribution in Earth's ionosphere is critical for mitigating ionospheric delay in satellite-based navigation and for monitoring space weather. Many global ionospheric maps (GIMs), such as those produced by the International GNSS Service (IGS), rely on ground-based GNSS measurements. However, independent validation of GIM quality remains challenging, particularly over oceanic regions where external data are scarce. While satellite altimetry can provide Vertical Total Electron Content (VTEC) estimates over oceans, additional data sources are needed to comprehensively assess and refine existing GIM products.

In this study, we propose a new, flexible methodology for combination of IGS ionospheric products and explore the potential of the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) system for ionospheric analysis. DORIS offers precise dual-frequency observations that can be used to quantify differences in Slant Total Electron Content (dSTEC). Building upon methods initially developed for GNSS data, we extend the dSTEC concept to DORIS, demonstrating that modern receivers enable direct calculation of DORIS-based dSTEC. Our results reveal a strong correlation—reaching about 0.8 over a three-month period—between dSTEC metrics derived from DORIS and those from GNSS, underscoring the consistency of the two techniques.

We further show that DORIS dSTEC can serve not only for unbiased GIM quality assessment but also for weighting individual GIMs in the IGS combination process. When compared against Jason-3 altimeter-derived VTEC, the resulting combined GIMs from both DORIS and GNSS data exhibit standard deviations on the order of 4.70–4.80 TECu. Notably, the DORIS-based combination slightly outperforms the GNSS-based approach. These findings highlight DORIS as a robust, complementary resource for validating and merging ionospheric maps, with the methodology already prepared for a routine generation of the new IGS combined ionospheric products.