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Identification of travelling ionospheric disturbances in the ionosphere using GPS with independent verification

The MIDAS (multi-instrument-data-analysis-system) and IDA (ionospheric-data-assimilation) algorithms are two mathematically different approaches to assimilating multiple ionospheric data sources into a coherent picture of the 3D time dependent ionospheric electron density. Currently, the vast majority of available observations of the ionosphere come from global positioning satellite systems such as GPS. However, the long integration paths through the ionosphere, the movement of the satellites and the use of simplistic filtering techniques brings into question the reliable identification of fast moving structures such as medium-scale TIDs.

This paper takes a comprehensive approach to determining the capability and limitations of using GPS signals for studying TIDs. In the first instance, a computer simulation of a TID-rich ionosphere is generated and used to formulate a set of fictitious satellite-to-ground observations using a realistic geometry of actual GPS observations for a given day over Europe. The data are then used to show the strengths, limitations, blurring and artifacts associated with simplistic time-series filtering techniques. As a second stage, geostationary satellite observational geometry is investigated and the improvements in determining TID parameters are evaluated. In the final step, actual data taken through a TID rich ionosphere are analyzed to investigate the applicability of the study to real-world observations.

The results show promise for the identification of some TIDs using GPS and show the key importance of backing up the observations with computer modeling to test the techniques being used. The implications for the resolution of ionospheric data assimilation algorithms and in particular the use of different observations to infer the presence of TIDs are discussed.