Detecting the Ionospheric Trough Using EDAM

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The ionosphere is a variable layer of charged particles in the earth's atmosphere which sits at an altitude of 90km to 1000km. High latitude (>60°) regions of the ionosphere are notoriously difficult to model. Reasons for this include, but are not limited to; converging longitudinal and magnetic field lines and the auroral oval. There are many distinguishing features of this region of the ionosphere, one of which is the mid-latitude ionospheric trough, first described in 1965 as the F-layer ionospheric trough (Muldrew, 1965). Although named the mid-latitude trough this phenomenon is often seen at high latitudes, representing itself as a region of depleted electron density extending longitudinally, (~30°), but is narrow in latitude, (~10°). This daily feature can be used to determine the performance of different ionospheric models in the high latitude region.

The Electron Density Assimilative Model (EDAM) is an ionospheric model, which uses various data sources including GPS and ionosondes to create a full 3D grid of global electron densities every 15 minutes. EDAM uses the International Reference Ionosphere – 2007 (IRI2007) as the background model to assimilate data into, by means of a Gauss Markov Kalman filter. This work validated both EDAM and IRI2007 using foF2 and TEC, where foF2 is the highest frequency reflected off the F2 layer and TEC is the total electron content along a path.

To calculate foF2, EDAM was run for the first week in January 2003, assimilating GPS data from European stations for a select high-latitude region; 50° to 86° latitude and -8° to 28° longitude. The GPS data assimilated into EDAM shows a trough-like feature in foF2 as a reduction in foF2. The same location in IRI2007 does not show any trough-like features.

For the TEC validations EDAM was run for September 2002 assimilating GPS stations in Europe and was compared against values measured at the GPS station HERS, which was not included in the assimilation. Due to unknown differential code biases (DCBs) in the GPS transmitters and receivers it was not possible to use TEC directly, therefore differential slant TEC (dSTEC) measurements were analysed. These are defined as the difference along a satellite path at the point of closest approach subtracted from each point along the satellite arc. This increases the accuracy to less than 0.1TECu (1TECu=$10^{16}e^{-}m^{-3}$), as the DCBs have been effectively removed. Comparisons of dSTEC show EDAM improves on IRI2007 in bringing the electron density grids in the high latitude ionosphere closer towards the truth data.

References

Muldrew, D. B. (1965). F-Layer ionoization Troughs Deduced from Alouette Data. *Journal of Geophysical Research*, 2635-2650.