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Characteristics of Large Scale Travelling Ionospheric Disturbances Exploiting Ground-Based Ionograms, GPS-TEC and 3D Electron Density Distribution Maps

Abstract:
The ionosphere is a region in the near-Earth space where a number of operations take place. These operations are important for the daily life and the safety of the citizens: telecommunication systems, navigation and surveillance systems, aircraft safety systems, all rely on signals propagating in the ionosphere and through the ionosphere. Therefore it is important to continuously monitor the state of the ionosphere and be able to predict irregularities and disturbances, that may affect the operation of these critical systems.

Large scale travelling ionospheric disturbances (LSTIDs) are associated with auroral and geomagnetic activity and propagate with wavelengths of 1000 - 3000 km, velocity of 300 – 1000 m/s and amplitude greater than 5-10 TECU. Current identification techniques of LSTIDs rely on the analysis of slant estimates of the Total Electron Content (sTEC) from the ground-based GNSS receiver network.

In this contribution we explore additional techniques for the identification and tracking of LSTIDs over Europe benefiting from the dense network of DPS4D ionosondes and of IGS receivers. This is a combined analysis based (a) on ionogram traces and their corresponding scaling parameters (foF2, hmF2, FF, HmF2), (b) on sTEC residuals calculated from the signals transmitted from GNSS satellites seen by receivers co-located with the ionosondes and (c) on the reconstructed Electron Density Distribution using the Topside Sounders Model Profiler (TaD) over the specific DPS4D ionosondes.

The results indicate that LSTID and their propagation over Europe can be captured by the ionograms and their corresponding scaled parameters, however a cadence of 5 min would improve the capacity of the TID identification system. Another very important result is that the TaD model is sensitive in LSTID propagation over a specific station and relevant electron density disturbances can be reproduced by the model predictions at heights between 200 and 400 km. Finally the analysis of 2 sec resolution sTEC residuals provide an additional indication of LSTID propagation over the area, although at the moment this can be only explored for post-processing purposes.