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Travelling Ionospheric Disturbances nowcasting HF-based methodology and its validation with GNSS-TEC analysis techniques

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Travelling Ionospheric Disturbances (TIDs) constitute a specific type of space weather phenomenon that can be solar-driven and/or be driven by other processes acting below the ionosphere. Independent of their source, the effects imposed by TIDs at the ionospheric altitudes are very important. Considering also the high occurrence frequency of TIDs (almost daily), and the variety of their characteristics regarding their velocity, propagation direction and amplitude, their identification and tracking is very complicated and has not been achieved in operational service mode.

Towards this direction, we have developed a new technique for the real-time identification of TIDs, which is based on the analysis of oblique Digisonde-to-Digisonde (D2D) "skymap" observations for the direct specification of the TID wave parameters. The D2D method transmits fixed-frequency HF signals from one Digisonde to a remote Digisonde that measures angle-of-arrival, Doppler frequency, and time-of-flight of ionospherically reflected high-frequency (HF) radio pulses from which the TID parameters are calculated for the mid-point between the two Digisondes. The D2D technique has been tested and implemented for the first time in the framework of the Net-TIDE research project (NATO SPS) with data streaming from the network of European Digisonde DPS4D observatories (http://tid.space.noa.gr).

The results of the D2D technique are validated in the framework of the new TechTIDE EC H2020 project "Warning and mitigation technologies for Travelling Ionospheric Disturbances Effects" (http://tech-tide.eu). In this contribution we are focusing on a period of moderate auroral activity occurred on 21 April 2017. The D2D results indicate large scale TID (LSTID) activity for 8 hours over France and Germany with the propagation direction to be predominantly southward with azimuth angles varying between 120º and 240º. For the assessment of the D2D results with independent measurements we first analysed the electron isodensity contours derived from the vertical ionogram soundings. These time series of data reveal electron density fluctuations with height with a periodicity indicative of the passage of LSTIDs over the Digisondes. In addition, we analysed the temporal and spatial gradients of European TEC maps and we got a good evidence of LSTID activity at the locations of DPS4Ds with comparable amplitude. More tests were performed with the GNSS TEC de-trending methodologies confirming the validity of the D2D results.