Artificial neural network based prediction of Large Scale Travelling Ionospheric Disturbances

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Keywords *LSTIDs, Ionosphere, Artificial Neural Networks*

Abstract

Geomagnetic storms and their associated effects have been investigated for decades not only to better understand the phenomena, but also to measure their impact on different technologies. Such storms are closely related to ionosphere and thermosphere perturbations, such as positive or negative deviations of electron densities from quiet conditions, changes in the thermosphere circulation and high-latitude irregularities. One frequently observed phenomenon observed during geomagnetic storms are large scale atmospheric gravity waves that are generated due to heating at high-latitudes. Their signatures in the ionosphere electron density are called Large Scale Travelling Ionospheric Disturbances (LSTIDs). Such disturbances propagate equatorward with wavelengths greater than 1000 km, periods between 30 min and 3 h, and horizontal velocities ranging from 400 to 1000 m/s. Although different studies have investigated the occurrence of LSTIDs and attempted to monitor and track them, an operational model for predicting such phenomena in the range of minutes to hours ahead has not yet been developed. In this investigation we propose the usage of an artificial neural network (ANN) to perform short-term predictions of LSTIDs occurrence. Our approach consists of using a multi-layer perceptron ANN to predict a GNSS based TID index (TIDx), which can serve as a proxy for LSTIDs activity. Since the generation of LSTIDs is related to solar wind conditions, we use solar wind information at Lagrangian point L1 as input information to predict TIDx in the European sector. Our results show that such approach has a good potential for LSTIDs prediction activities at mid-latitudes.