Geophysical Research Abstracts
Vol. 18, EGU2016-2708, 2016
EGU General Assembly 2016

Prediction of foF2 during geomagnetic storms – a global perspective

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Geomagnetic storms cause complex and difficult to predict changes in ionospheric electron density. The severity of density perturbations depends on various parameters including solar cycle phase, season, local time of storm onset, the intensity and duration of the storm, and the geomagnetic coordinates of the station. Superposed Epoch Analysis (SEA) was used to examine a 50-year period (years 1964–2014, solar cycles 20–24) of foF2 observations recorded using a world-wide database of over 160 ionosondes. The analysis was used to identify reoccurring patterns in the evolution of foF2 for various geomagnetic storm parameters. A total of 1356 storms were identified in the 50-year period using a Dst-index based temporal filter, namely Dst ≤ -30 nT for at least 5 consecutive hours. Before the SEA, diurnal and seasonal effects were accounted for by subtracting monthly median quiet-time values of foF2. The SEA identified and ranked the effects of various parameters on foF2. The analysis showed that storm-time foF2 perturbations are regulated mostly strongly by storm intensity and duration, geomagnetic latitude, season, phase of the solar cycle, and local time of storm onset. Solar cycle number and geomagnetic longitude had the least influence on foF2 perturbations. The most regularly observed storm feature was an increase in electron density (positive storm effect) at low magnetic latitudes during the post storm onset hours. Decreases in electron densities (negative storm effects) occurred at mid and high magnetic latitude regions, but with the depth of density decrease exhibiting a strong dependency on storm intensity, season and phase of solar cycle. This analysis forms the basis of empirical model which can be used to help predict storm-time variations of foF2.