# An analysis of mid-latitude storm-time ionospheric peak parameters

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The solar wind effects on the Earth's environment are studied for their basic science value as well as for their crucial practical impact on human technological systems. Increased dissipation of solar wind energy in the near-Earth environment is a significant source of consequent perturbations in the upper atmosphere and ionosphere. Adverse stormy conditions can cause disruption of satellite operation, navigation, degradation of radio communications, leading to significant economic losses.

Current understanding of the response of the ionosphere to geomagnetic storms has been obtained through different observations, modelling and theoretical studies. As long as variations in the ionosphere are related in regular patterns, empirical models, such as the IRI model, sufficiently estimate corrections for the ionospheric effects on radio wave propagation. Recently the International Reference Ionosphere (IRI2001) model incorporated a geomagnetic activity dependence based on an empirical Storm-Time Ionospheric Correction Model (STORM), which is driven by an index derived from the previous thirty hours of geomagnetic activity. A number of scientific investigations have shown that neural networks can be useful as an alternative method to classical empirical models to predict main ionospheric parameters. In the present study we report the results of a comparative analysis of the observed ionospheric peak parameters with IRI-2001 and a neural network based global foF2 model during strong-to-severe ionospheric storms that occurred in the period 1995-2006 over the Southern and Northern Hemisphere middle latitudes. In our analysis we used data from a few ionospheric stations (e.g., Pruhonice, El Arenosillo, Athens), which were not included in the development or the previous validation of the models. Hourly values of the F2 layer critical frequency, foF2, and height of the F2 layer, hmF2, measured for 5-7 days during the main and recovery phases of each selected storm where compared with those generated by IRI-2001, and foF2 was also compared with the global foF2 model. To perform a detailed comparison between observed values, medians and model-generated values the correlation coefficient, the normalised root-mean-square error (NRMSE), and the percentage improvement are calculated. The comparative analysis illustrates that the improved IRI-2001 model with the activated STORM option provides better description of the ionisation distribution under geomagnetic storm conditions. The STORM model captures more effectively the negative phases of the summer ionospheric storms, nevertheless, electron density enhancement during winter storms and changeover of the different storm phases is reproduced with lower accuracy. The model corrections are less efficient for lower-middle latitudes and severe geomagnetic storms. As STORM model makes no storm-time corrections of hmF2, the correlation coefficient during storm main phase ranges between 0,3-0,7.  Results for the prediction of foF2 during storm-time periods by the global foF2 model were also generated.