Modelling TEC changes over Southern Africa using the neural network method

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Abstract

This paper describes the application of neural network (NN) technique to predict total electron content (TEC) variations over Southern Africa using the dual frequency Global Positioning System (GPS) receiver network during the solar cycle 23. The general known parameters which influence TEC changes such as magnetic activity, solar activity, diurnal variarion, seasonal variation and the geographical position of the receiver were used as inputs to the NN. Data from 10 GPS receiver stations was used in NN training and validating processes while the remaining stations provided the dataset that was used to test the overall performance of the NN model. The predicted NN TEC was compared with TEC values from the International Reference Ionosphere (IRI) with the corresponding GPS TEC derived using the Adjusted Spheric Harmonic Analysis (ASHA) algorithm. Preliminary results indicate that the NN model predicts GPS TEC with an average root mean square error (RMSE) of $\sim$ 4 TECU compared with 12 TECU RMSE for the IRI during Autumn equinox month, while the average RMSE for NN and IRI models for the winter equinox month are $\sim$ 2 TECU and 5 TECU respectively. In solstice months, the NN and the IRI models have a RMSE difference of $\sim$ 1 TECU near low solar activity periods. Further analysis was undertaken by verifying GPS TEC with ionosonde data from the available three ionosonde stations within South Africa. An attempt to quantify solar wind effects using the Advanced Composition Explorer (ACE) data is also presented by considering solar wind velocity and the z-component of interplanetary magnetic field (IMF, Bz) as independent inputs to the NN.

key words: GPS TEC variability, solar activity, Ionosphere, IRI model