Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PEM025-14 Room: Function Room A Time: May 27 15:45-16:00

Improvement of empirical total electron content model based on artificial neural network

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In the previous study, an artificial neural network (ANN) total electron content (TEC) model was constructed by using the 10.7-cm solar radio flux (F10.7) and the international sunspot number (SSN) as proxies of solar activity changes. The model was improved by applying several new proxies of solar activity based on direct measurements of solar irradiances. TEC database was constructed from a dense GPS receiver network over Japan for the period from April 1997 to March 2008 that covered a whole 11-year solar activity period. In the present study, the ANN training for predicting TEC as a target parameter was done by including new solar proxies, 26-34 nm integrated irradiance by the SOHO/SEM instrument and Mg II cwr (the core-to-wing ratio of Mg II 280 nm line), as well as the traditional indices F10.7 and SSN. The data gaps of SOHO/SEM observations were filled by the outputs of an empirical solar irradiance model, SOLAR2000. Root mean square errors (RMSEs) of TEC after the training was completed using a variety of combinations of the solar proxies were compared. When a single daily proxy was used, SOHO/SEM yielded the smallest RMSE or it was the best proxy for predicting ionospheric TEC. However, when mean values for 7-day, and 27-day periods were concurrently used, Mg II cwr also yielded a good result as well as SOHO/SEM. Combinations of different types of proxies further improved the ANN training achievement. The best result was obtained when the 10.7-cm solar radio flux, Mg II cwr index, and SOHO/SEM 26-34 nm irradiance were used (all include daily, 7-day, 27-day means). The results of ANN training achievement for a variety of input patterns were interpreted based on the behavior of solar irradiance changes at various wavelengths and in different solar atmospheric regions, i.e., photosphere, chromosphere, transition region, and corona.

Keywords: total electron content, artificial neural network, solar activity, F10.7 index