ニューラルネットワークを用いた日本上空のTEC標準モデル

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Regional reference total electron content model over Japan based on neural network mapping technique

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One of the important effects of the ionosphere on radio waves is a propagation delay in the ionosphere depending on the frequency and total electron content (TEC) integrated along the propagation path. There have been several attempts to model this effect through theoretical and empirical approaches. A large effort is the continuous development and improvement of the International Reference Ionosphere (IRI), which describes the density at various heights for given geophysical conditions based on the observations for a long term. Total electron content can be derived by integrating the height profile of the electron density. In the topside ionosphere and plasmasphere, however, scarce data of electron density are available, nevertheless the contribution of the plasmaspheric electron density to TEC can not be neglected. On one hand, direct measurements of TEC using radio waves transmitted from the Global Positioning System (GPS) satellites increased in this decade. Thus GPS-based TEC data are now available to construct an empirical model of TEC.

The total electron content derived from GPS Earth Observation Network (GEONET), which consists of more than 1000 GPS receivers over Japan, was used to construct a regional reference model. The data cover almost the whole solar activity period from April 1997 to June 2007. Firstly, TECs were determined for 32 grid points separated by 2 degrees and expanding from 27 to 45 N in latitude and 127 to 145 E in longitude at each quarter hour. Secondly, the latitude-local mean time variation averaged over 3 days was represented by the surface harmonic functional expansion with both degree and order of 7. Finally, the coefficients of the surface harmonic function were modeled by using a neural network technique for input parameters of season (day of the year) and solar activity (F10.7 index and sunspot number). Thus, two-dimensional TEC maps (latitude vs. local mean time) can be obtained for any given set of solar activity and day of the year (or season).