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Development of post-sunset ionospheric scintillation forecasting mechanism using poleward multistation GPS TEC gradient obtained from statistical TEC model in equatorial region

Dibyendu Sur (1,2) and Ashik Paul (1)

(1) UNIVERSITY OF CALCUTTA, INSTITUTE OF RADIO PHYSICS AND ELECTRONICS, KOLKATA, India (dibyendumalay@gmail.com), (2) NARULA INSTITUTE OF TECHNOLOGY, KOLKATA, INDIA (dibyendumalay@gmail.com)

The equatorial ionosphere is characterized by (i) large day-to-day variation of Total Electron Content (TEC) and high value of diurnal peak TEC, (ii) sharp latitudinal variation of TEC and (iii) post-sunset ionospheric scintillations. Transionospheric satellite signals always undergo through severe perturbation due to this scintillation. Fading of signal amplitude and loss of lock at the receiver end due to ionospheric scintillation is very common in the equatorial region. Any mechanism which can predict possible occurrence of post-sunset ionospheric scintillation can be very helpful to rectify this deterioration of signal. It has been well-established that maximum ionization is seen near $\pm 20^{\circ}$ latitude in equatorial region. This phenomenon is called Equatorial Ionization Anomaly (EIA). TEC gradient from either side of maximum ionization location (EIA crest) is very sharp in equatorial region. Recent studies also suggest a possible correlation between the intensities of poleward or equatorward gradients and possible occurrence of post-sunset ionospheric scintillation. Thus, forecasting of post-sunset scintillation is possible by measuring daytime TEC from multiple stations and computing TEC gradient from them. But this process requires multistation TEC receiver installations, proper maintenance and everyday data-recording. An alternate method of finding TEC from different stations is to predict them using an efficient and accurate TEC prediction model. Standard ionospheric models such as International Reference Ionosphere (IRI), Parameterized ionospheric Model (PIM), NeQuick are not efficient to predict TEC in low latitude regions. In this paper, development and validation of an alternate real-time GPS TEC data based statistical model has been reported. The model is designed using Artificial Neural Network (ANN). Training dataset of the model consists of GPS TEC data from a chain of stations positioned almost along 88°E longitude. The stations from where TEC data is used to train the model are (i) Calcutta (22.58°N, 88.38°E geographic, magnetic dip 32°), (ii) Baharampore (24.09°N, 88.25°E geographic, magnetic dip 35°), (iii) Farakka (24.79°N, 87.89°E geographic, magnetic dip 36°) and (iv) Siliguri (26.72°N, 88.39°E geographic; magnetic dip 40°). The stations cover a wide latitudinal swath of 22°-27°N. The training period covers the duration of January 2007 to April 2012. Correction between poleward TEC gradients computed from model predictions and possible occurrence of post-sunset scintillation ($S_4 \geq 0.4$) is established. Threshold poleward TEC gradients for occurrence of scintillation are suggested during different equinoctial periods of 2013. Forecasting accuracy of maximum 82% has been recorded during these periods of 2013.