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Prediction of Ionospheric irregularities with GPS-derived S4 index variations observed at Agra during the ascending phase of the solar cycle 24: Preliminary Results

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In the recent scenario, satellite-based communications are the priority of each country in the world due to their wide range of applications. So an efficient navigation system is required for the recording of accurate data but ionospheric irregularities (scintillations) play a very important role in satellite communication. Satellites provide false data due to these irregularities which may be very unsafe for a country. To overcome this problem, the study and prediction of these irregularities are very important, especially at low latitudes due to the existence of irregularities such as equatorial ionization anomaly (EIA), Spread-F, etc. The GPS-derived scintillation data may be analyzed by using well-established statistical techniques and modern tools like artificial neural networks (ANN) based techniques, etc.

In the present study, the GPS-derived scintillation data of the S_4 index observed at Agra station, India (Geo. Lat. 27.2ºN, Geo. Long. 78ºE) have been analyzed initially during the ascending phase of solar cycle 24 for the year 2011. Firstly, S_4 index data have been processed by using statistical techniques and, then ANN-based technique for the prediction purpose. The S_4 index data have been analyzed diurnally and also in different seasons such as winter (January, February, November, December), summer (May, June, July, August), and equinox (March, April, September, October). The impact of solar activity and magnetic storms have also been examined. The solar activity parameter i.e. solar flux F10.7 cm and magnetic storm parameter i.e. ∑Kp are also examined to show their impact on the S_4 index data recorded at Agra station. Further, our results are compared with GPS-TEC data recorded at Agra and finally, the ANN technique is used to predict the S_4 index variation. The preliminary results are as follows.

The diurnal S_4 index variations lie between 0.06 and 0.12 and its maximum value was recorded in the month of September (≈0.12). The seasonal minimum and maximum values of the S_4 index are recorded in winter (≈0.07) in the equinox (0.078), respectively. The correlation between the S_4 index and GPS-TEC is calculated and its value ≈0.68). Further, the correlation coefficients between S_4 and F10.7 and S_4 and F10.7 are calculated which are not significant. Finally, the results are processed by using the ANN-based NARX time series model and the results are highly significant i.e. predicted values are well matched with the observed values. More studies on the same line may be very useful for our navigation system.