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ORIGINAL ARTICLE

GPS-TEC variations during low solar activity period (2007–2009) at Indian low latitude stations

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Abstract The paper is based on the ionospheric variations in terms of vertical total electron content (VTEC) for the low solar activity period from May 2007 to April 2009 based on the analysis of dual frequency signals from the Global Positioning System (GPS) satellites recorded at ground stations Varanasi (Geographic latitude 25°16′ N, Longitude 82°59′ E), situated near the equatorial ionization anomaly crest and other two International GNSS Service (IGS) stations Hyderabad (Geographic latitude 17°20′ N, longitude 78°30′ E) and Bangalore (Geographic latitude 12°58′ N, longitude 77°33′ E) in India. We describe the diurnal and seasonal variations of total electron content (TEC), and the effects of a space weather related event i.e. a geomagnetic storm on TEC. The mean diurnal variation during different seasons is brought out. It is found that TEC at all the three stations is maximum during equinoctial months (March, April, September and October), and minimum during the winter months (November, December, January and February), while obtaining intermediate values during summer months (May, June, July and August). TEC shows a semi-annual variation. TEC variation during geomagnetic quiet as well as disturbed days of each month and hence for each season from May 2007 to April 2008 at Varanasi is examined and is found to be more during disturbed period compared to that in the quiet period. Monthly, seasonal and annual variability of GPS-TEC has been compared with those derived from International Reference Ionosphere (IRI)-2007 with three different options of topside electron density, NeQuick, IRI01-corr and IRI 2001. A good agreement is found between the GPS-TEC and IRI model TEC at all the three stations.

Keywords GPS · Ionospheric total electron contents · Geomagnetic storm · IRI model

1 Introduction

The measurement of Total Electron Content (TEC) of the ionosphere has become important in recent years, in view of the increasing demand on the transionospheric communication systems used in the navigation of space-borne vehicles, such as satellites, aircrafts, as well as surface transportation systems. The value of TEC is used for making appropriate range corrections, as well as accounting for errors introduced in the range delays owing to the effects of space weather-related events, such as geomagnetic storms and scintillations due to ionospheric irregularities (Rama Rao et al. 2006). It was observed that during the strong scintillation, deep amplitude fades or large phase fluctuations may cause signal disruptions in the receiver-satellite link. A decrease in the number of GPS signals locked by a user's receiver can result in poor navigation accuracy. The ionospheric effects on satellite communication, satellite tracking and navigational control application are directly proportional to the TEC. Now it is well accepted that a GPS-based navigation system provides accurate, continuous and all-weather three-dimensional location of a user. As such, the dependence on this navigation system has increased drastically in recent years. When the GPS signals propagate through the ionosphere, the carrier experiences a phase advance and the code experiences a group delay due to the

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