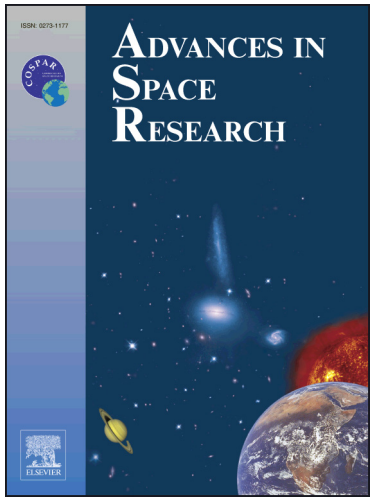

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Abstract— Global Positioning System (GPS) is a remote sensing tool of space weather and ionospheric variations. However, the interplanetary space-dependent drifts in the ionospheric irregularities cause predominant ranging errors in the GPS signals. The dynamic variability of the low-latitude ionosphere is an imperative threat to the satellite-based radio communication and navigation ranging systems. The study of temporal and spatial variations in the ionosphere has triggered new investigations in modelling, nowcasting and forecasting the ionospheric variations. Hence, in this paper, the dynamism in the day-to-day, month-to-month and seasonal variability of the ionospheric Total Electron Content (TEC) has been explored during the solar maximum period, January-December 2013, of the 24th solar cycle. The spatial and temporal variations of the ionosphere are analysed using the TEC values derived from three Indian low-latitude GPS stations, namely, Bengaluru, Guntur and Hyderabad, separated by 13-18 degrees in latitude and 77-81 degrees in longitude. The observed regional GPS-TEC variations are compared with the predicted TEC values of the International Reference Ionosphere (IRI-2012 and 2007) models. Ionospheric parameters such as Vertical TEC (VTEC), relative TEC deviation index and monthly variations in the grand-mean of ionosphere TEC and TEC intensity, along with the upper and lower quartiles, are adopted to investigate the ionosphere TEC variability during quiet and disturbed days. The maximum ionospheric TEC variability is found during March and September equinoxes, followed by December solstice while the minimum variablitity is observed during June solstice. IRI models are in reasonable agreement with GPS TEC but are overestimating during dawn hours (01:00-06:00 LT) as compared to the dusk hours. Higher percentage deviations are observed during equinoctial months than summer over EIA stations, Guntur and Hyderabad. GPS TEC variations are overestimated during dawn hours for all the seasons over Bengaluru. It has also been observed that positive storm effect (enhancement of TEC) is observed during the main phase of the March storm, 2013 (March 16-18, 2013) while both positive and negative storm effects (depletion of TEC) are registered during the main phase of the June storm, 2013 (June 28-30, 2013) at Bengaluru and Guntur, respectively. IRI-2012 model has slightly large discrepancies with the GPS-VTEC compared with the IRI-2007 model during the June storm, 2013 over Guntur station. This analysis highlights the importance of upgrading the IRI models due to their discrepancies during quiet and disturbed states of the ionosphere and developing an early warning forecast system to alert about ionosphere variability.

Keywords— GNSS, GPS, Ionosphere, TEC, Ionosphere Variability, IRI Model.

1. INTRODUCTION

The Global Navigation Satellite Systems (GNSS) such as Global Positioning System (GPS), Galileo, GLONASS, BeiDou, and Indian Regional Navigation Satellite System (IRNSS) have been used for providing position, velocity and time information in all weather conditions. The ionosphere, occupying an altitude of 50-1000 km, is one such dominant layer of atmosphere challenging the Communication, Navigation and Surveillance (CNS) applications. The interplanetary space conditions, such as solar activity, geomagnetic activity, meteorological influences and coupling of thermosphere and magnetosphere contribute to the complexity of the ionosphere.

The physical and chemical parameters of the ionosphere such as temperature, composition, and number of ions and electrons change with respect to geographic location, time of the day, day of the season,