



## **Ionospheric observations over central part of India using comparative study of NavIC and GNSS**

Deepthi Ayyagari<sup>(1)</sup>, Sumanjit Chakraborty\*<sup>(1)</sup>, and Abhirup Datta<sup>(1)</sup>

(1) Centre of Astronomy, Indian Institute of Technology Indore Simrol Campus - 453552

This paper describes a comparative study of ionospheric observation over central part of India at Indore-Simrol using Indian Regional Navigation Satellite System (IRNSS) and Global Navigation Satellite System (GNSS). The IRNSS with an operational name of Navigation with Indian Constellation or NavIC, is an autonomous regional satellite navigation system. It covers India and a region extending upto 1,500 km and the system at present consists of a constellation of seven satellites. On the other hand, GNSS which comprises of GPS, GALILEO, GLONASS, etc is the standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage.

The ever-increasing exploitation of trans-ionospheric communications in satellite, aircraft, and surface transportation system navigations, require more precise estimation of the ionospheric delay error in the navigation signal due to free electrons and ions in the ionosphere and the electron density is retrievable from the refracted signals by modeling of the associated signal delays. The level of ionospheric activity measured using these signal delay is described in terms of electron density quantified by the number of electrons in a vertical column of cross-sectional area of  $1m^2$ , called as Total Electron Content (TEC).

The TEC is measured in TEC Units, where  $1 \text{ TECU} = 10^{16} \text{ electrons}/m^2$ . TEC is path dependent and by this notion it can be calculated by integrating along the path through the ionosphere, with the electron density as it is location dependent. The Vertical TEC (VTEC) is calculated by integration of the electron density on a perpendicular to the ground standing route whereas the Slant TEC (STEC) is obtained by integrating over any path. In the Indian low-latitude sector several isolated TEC measurements were made during the past three to four decades, using data from a number of low-medium earth orbiting, as well as geostationary satellite signals, the studies of which led to a broad understanding of the behaviour of the equatorial and low-latitude ionosphere.

This study presents VTEC measurements from IRNSS and GNSS observables over central part of Indian sub continent at Centre of Astronomy, IIT Indore for which selection of Ionospheric Pierce Point (IPP) latitude longitude and altitude remained an important aspect. To measure TEC along the line of sight, a simplified model which assumes the ionosphere to be a thin, uniform-density shell around the Earth, located near the mean altitude ( $h_f$ ) of maximum TEC approximately 350 km has been considered. A slant intersection with this shell model can be determined and a VTEC measurement can be determined. The intersection between line of sight and this shell is known to be the Ionospheric Pierce Point (IPP). At any point Azimuth ( $A_z$ ) and Elevation ( $E$ ) of the line-of-sight vector from user to satellite along with user's latitude-longitude is necessary to calculate the IPP locations. A diurnal variation of such TEC observations have been compared above the elevation angle of  $28^\circ$  as the minimum elevation angle for the IRNSS satellites is observed to be  $28^\circ$ . Such a comparative study using two constellations at two different altitudes would open up further studies of the ionosphere over the Indian subcontinent.

## References

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