Ionospheric studies using Indian regional navigation satellite NavIC: Opportunities and challenges

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Indian regional satellite system (NavIC) provides an opportunity to monitor the ionosphere over low latitude regions similar to GPS system. However, the advantage of NavIC over GPS is that continuous monitoring of TEC can be done using the 3 geostationary satellites which GPS can't. Moreover, combination of GPS and NavIC will increase number of raypath through the ionosphere. It is, however, important to know the suitability of NavIC for such ionospheric studies. NavIC constellation is very different from GPS. In GPS, the satellite altitudes are around 20,200 km, whereas the NavIC is consist of 3 geostationary and 4 geoshyncronous satellites at 36,000 km. This leads to interesting question to be asked: whether NavIC observations can indicate the extra ionization due to this height difference? and is this extra ionization is significant? An effort has been made to compare the performance of TEC estimated by GPS with that of NavIC receiver under varied geomagnetic conditions to answer these questions.

For this purpose dual frequency GPS and NavIC data are measured at IIT Indore, a location in central India. (22.7196 N, 75.8577 E). The Indian Regional Navigation Satellite System (IRNSS), with an operational name of NavIC (Navigation for Indian Constellation) is an autonomous regional satellite navigation system that is designed to provide accurate real-time positioning and timing services over India and surrounding region. The data has been measured for 13 months during September 2017-September 2018.

The comparison has been done instant by instant for each NavIC satellite with all the GPS satellites available in the neighborhood. All GPS Ionospheric pierce points (IPP) in a 1 degree grid surrounding the NavIC IPP location are considered for this purpose. The IPP location is estimated assuming the thin ionospheric shell height at 350 km. The correlation analysis indicates the trend of TEC is well captured by NavIC system as shown in Figure 1. However, the absolute magnitude of TEC differs by a few TECU. These variations are found to be quite systematic with a annual trend. The minimum difference is observed during March-May 2018. However, the random errors between NavIc and GPS bias adjusted TEC are found be within 30%. The solar activity during March-May 2018 was unusually low and this may be the reason for such minimum difference. However, the bias adjusted TEC difference can be due to various reasons such as the error in retrival technique and need further investigation.

In this paper, the variation of difference between NavIC and GPS is presented for different geomagnetic conditions as well during the geomagnetic storms. The ionospheric response during solar storms are investigated to see if there is any time difference between the TEC measured by GPS and NavIC. However, we are not able to find any significant time variation between these two system. This is very important as the time variation can correlated with CME speed and indicate the extra ionization between 22000 km and 36000km. Since there is no significant time difference in the response of GPS and NavIC to the CME, the reason for such biases still unresolved. In this paper, we present these discripencies in TEC observation to ionospheric community. We expect the observations will open up a new direction of ionsopheric studies using a combination of NavIC and GPS.

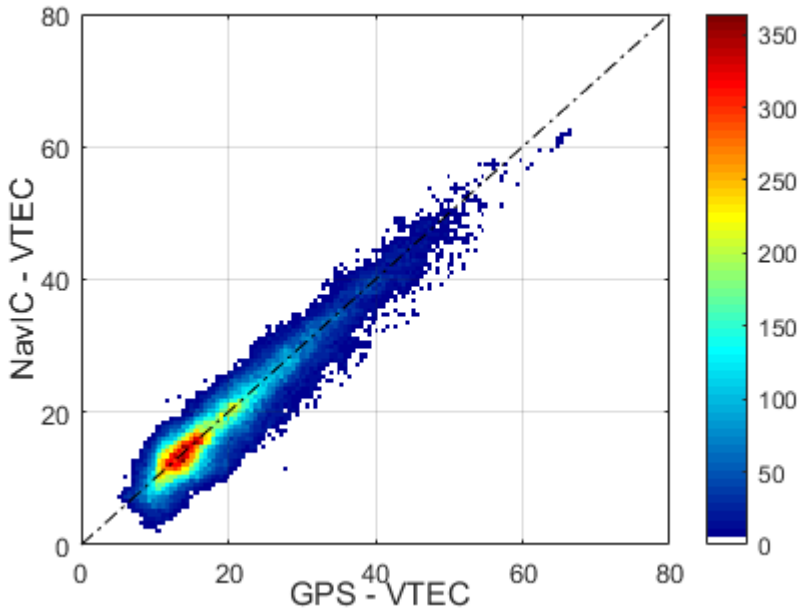

Figure 1: Correlation analysis for period of one year