Investigation of Ionospheric Spatial Gradients for GAGAN Error Correction

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The Indian Space Research Orgnisation and Airports Authority of India are jointly implementing GPS Aided GEO Augmented Navigation (GAGAN), to meet the Required Navigation Parameters (RNP) for aircraft operations. Such a system provides the user with orbit, clock and ionospheric corrections besides ranging signals. One of the prominent parameters affecting the some of the RNP of GAGAN is ionospheric delay. As the Indian subcontinent comes under low latitude region and covers the equatorial zone in the south-asian latitudes, it suffers from the ionospheric equatorial anomaly.

It is well known that the ionospheric anomalies are functions of the parameters such as ionospheric gradients and the wave front speed. Among the visible satellites, if an ionospheric gradient exists in the line of sight direction between user and a particular satellite, Total Electron Content (TEC) changes greatly within minutes. Due to which user acquires degraded positional accuracy apart from reduced integrity information. In this paper initially typical storm days and quiet days data due to TEC stations of GAGAN network is considered. By arbitrarily choosing a particular reference elevation angle of typical satellite vehicle, Vertical TEC1 (VTEC1) is estimated at the Ionospheric Pierce Point (IPP1). Over a short period of time when the satellite moves to a different location such that the nearly same reference elevation angle is being viewed by another known reference station, the VTEC2 is estimated at IPP2. Subsequently, the ionospheric spatial gradient is derived from the difference of both VTEC1 and VTEC2. And these spatial gradients are function of distance between the two IPP locations.

In order to identify spatial gradients, Jiyun et al. (2006) proposed a 'Time step method'. By considering the distance between the Ionospheric Pierce Point (IPP) at epoch ti and IPP at epoch ti-1, the vertical ionospheric gradient (σVIG) is estimated as

$$\sigma^{k}_{u\,VIG}(t_i) = \frac{TEC^{k}_{u}(t_i) - TEC^{k}_{u}(t_{i-1})}{D_{t_i,t_{i-1}}}(mm/Km) \qquad (1)$$

Where $D_{t_i,t_{i-1}}$ = Distance between the IPPs corresponding to time epochs t_i and t_{i-1}

These aspects which contribute to errors in SBAS corrections are investigated and the preliminary results are very encouraging. The outcome of this paper will be helpful for GAGAN applications.

Keywords: TEC, IPP, Spatial Gradient, GAGAN

References

[1] Jiyun Lee, Sam Pullen, Seebany Datta-Barua, and Per Enge, *IEEE/ION Plans,* **506-514**, (2006).