The International Beacon Satellite Symposium *BSS2010*
P. Doherty, M. Hernández-Pajares, J.M. Juan, J. Sanz and A. Aragon-Angel (Eds)
Campus Nord UPC, Barcelona, 2010

IONOSPHERIC DEPLETION DETECTION OVER THE INDIAN REGION USING A SINGLE FREQUENCY DETECTION ALGORITHM

M. Cueto[*], I. Hidalgo[*], E. Sardón[*], G. Um[†] and M. Bailey[†]

[*] GMV
[†] Raytheon

Abstract: Plasma depletions (or bubbles) are strong reductions in the ionospheric F-region plasma density due to the appearance of a Rayleigh-Taylor instability in the post-sunset, producing severe radio signal disruptions when crossing them. Most of the plasma depletions are confined on the Appleton Anomaly region, which also shows the presence of strong scintillation activity (having consequently a severe effect on the L band signals propagation). Therefore, the geographic latitude of the Indian region between 15º and 25º N is expected to be frequently affected by the presence of plasma depletions.

Satellite Based Augmentation Systems (SBAS) support regional GNSS augmentation through the transmission of additional satellite-broadcast messages. In those systems, a network of double-frequency reference stations is used to estimate the ionospheric delay over the region. This ionospheric information is broadcast to the single-frequency SBAS users through an ionospheric model of grid vertical Total Electron Content (TEC) values, called Grid Ionospheric Vertical Delays (GIVD). In addition, the SBAS system also broadcasts for each grid point a conservative bound on the estimated GIVD accuracy, known as Grid Vertical Ionospheric Error (GIVE).

Due to the small scale of the plasma depletion and the limited number of reference stations, these phenomena are difficult to detected by the SBAS ground systems, that mainly provide ionospheric large scale information. Therefore the ionospheric delay transmitted to the user in the SBAS message could not take into account the feasible presence of a depletion event in the satellite-user line of sight. In this case, a single frequency algorithm to detect the presence of plasma depletions at user level would improve the ionospheric contribution estimation and therefore, the user positioning and integrity.

The GPS Aided Geo Augmented Navigation (GAGAN) is the SBAS for India being developed by Raytheon, ISRO and Airports Authority of India. This paper briefly provides a high-level description of the GAGAN Depletion Detection Algorithm developed by GMV and Raytheon to detect the existence of plasma depletions for single frequency users in the lines of sight of the incoming measurements for each satellite and epoch.

The GAGAN Depletion Detection algorithm is mainly based on exploiting the properties of the difference between the ionospheric-large-scale-corrected code and the ionospheric-large- scale-corrected phase single frequency measurements (for each epoch and satellite): this combination allows us to remove the geometric and large-scale ionospheric contributions from the observables, focusing the analysis on the small-scale ionospheric variations as well as error & multipath contributions.

Examples of plasma depletion detection using IGS Indian data for different conditions (solar activity, cycle slip presence, etc) are also provide.