Investigation on the geomagnetic storm time nocturnal equatorial zonal plasma drift using GAGAN geostationary satellites measurements

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With the advent of Indian Satellite Based Augmentation System (SBAS) i.e. GPS-aided GEO augmented navigation (GAGAN), an exclusive experiment to estimate the zonal drift of the nocturnal L-band scintillation irregularities has been commenced at Equatorial Geophysical Research Laboratory (EGRL), Tirunelveli, India. Two SBAS enabled Global Navigation Satellite System (GNSS) receivers have been installed at EGRL to record signals from GAGAN geostationary satellites of GSAT-8 (PRN 127) and GSAT-10 (PRN 128). These signals are further processed to estimate the zonal drift of the L-band scintillation irregularities on equatorial spread-F days.

During quiet period, the nocturnal equatorial ionospheric plasma drifts eastward in the zonal direction and downward in the vertical direction. This quiet time drift pattern could be understood through dynamo processes in the nighttime equatorial ionosphere. The estimated zonal drift exhibits a systematic eastward plasma flow during the quiet period with seasonal amplitude variability. However, during geomagnetic storms the drift reverses to become westward on several occasions. During the geomagnetic storm of 17 March 2015, it has been observed that the estimated nocturnal westward plasma drifts coincided with the vertically downward plasma drift measured using the collocated ionosonde at the EGRL. After ~17:00 UT (~22:10 local time) on 17 March 2015, the vertical plasma drift became downward and coincided with the westward zonal drift - a rarely observed feature of low latitude plasma drifts. The vertical drift turned upward after ~18:00 UT, while the zonal drift became eastward. The main emphasis is given to the distinct bipolar type variations of vertical and zonal plasma drifts observed at ~18:00 UT. The vertical plasma drift is understood in terms of the competing effects between the storm time prompt penetration and disturbance dynamo electric fields. Whereas, the westward drift is attributed to the storm time local electrodynamical changes mainly through the disturbance dynamo field in addition to the vertical Pedersen current arising from the spatial (longitudinal) gradient of the field (Bagiya et al., 2018).

Moreover, the analysis based on the estimated zonal drift is underway to improve the recently developed L-band scintillation forecast method for the low latitudes (e.g. Bagiya et al., 2015; Sridharan et al., 2014).

Reference:

Bagiya, M. S., R. Sridharan, S. Sunda, L. Jose, T. K. Pant, and R. Choudhary (2015), Impact of the perturbation zonal velocity variation on the spatio/temporal occurrence pattern of L band scintillation —A case study, J. Geophys. Res. Space Physics, 120, doi:10.1002/2015JA021322.

Bagiya, M. S., Vichare, G., Sinha, A. K., & Sripathi, S. (2018). On the nocturnal downward and westward equatorial ionospheric plasma drifts during the 17 March 2015 geomagnetic storm. Journal of Geophysical Research: Space Physics, 123. https://doi.org/10.1002/2017JA024703.

Sridharan, R., Mala S. Bagiya, S. Sunda, R. Choudhary, T. K. Pant, L. Jose (2014) First results on forecasting the spatial occurrence pattern of L-band scintillations and its temporal evolution Journal of Atmospheric and Solar-Terrestrial Physics, 119, 53–62.