On the characteristics behaviour of the VHF and GPS L-band scintillations in the Indian equatorial sectors and their possible impact on the satellite based navigation systems

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SUMMARY

Studies on the temporal and spatial characteristics of scintillations of trans-ionospheric signals at VHF and L-band frequencies during the low and descending phase of the solar activity period 2004 to 2006 over the Indian region using both geo-stationary satellite signals (at VHF and L-band) and GPS signals (at L-band) have revealed that the occurrence of intense scintillations is maximum during the post-sunset hours of equinoctial months and moderate during winter. During the summer, the occurrence of scintillations is low with occasional long duration patches during post-midnight hours at VHF. Whereas, at L-band frequencies (GPS as well as geostationary), scintillations are rarely observed during the summer months. It has also been found that there exists a threshold value of 30 m/s of the post-sunset vertical drift velocities for the onset of intense scintillations during the high sunspot activity year, 2001 and which reduces to 20 m/s during the low solar activity year of 2004.

In this paper we also present, for the first time, the temporal and spatial variations in TEC derived from the simultaneous and continuous measurements made during low sunspot activity (LSSA) period of 2004 - 2006, using the Indian GPS data from the network of receivers (18 Nos) located at different latitudes and longitudes all the way from the equator to the northern crest of the equatorial ionization anomaly (EIA) region and beyond. Over the Indian subcontinent, the EIA crest is found to occur in the geographic latitude zone of 15 to 25°N or from 5 to 15°N geomagnetic latitudes. These studies further reveal that both the location of the EIA crest (in latitude) and its peak value in TEC are linearly related to the integrated equatorial electrojet (IEEJ) strength and increase with the increase in IEEJ.

Further, it was found that the post-sunset vertical drifts at the equator varies linearly with the equatorial ionization anomaly gradient in TEC during afternoon hours and strong scintillation activity at GPS L-band frequencies was observed when ever the EIA gradient exceeds 1.25 and the vertical drift at the equator exceeds 20 m/s during the low solar activity year 2004. These scintillations are often found to be accompanied by the TEC depletions with durations ranging from 5 to 25 min and with magnitudes of 5 to 15 TEC units which correspond to a positional accuracy of the GPS by 1 to 3 meters. Further, during the intense scintillation times (S4>0.45 ≈ 10 dB), the GPS receiver is often found to loose its lock for a short duration of 1 to 4 min, increasing the error bounds effecting the integrity of the SBAS operation. During the present period of study, a total of 395 loss of lock events were observed in the Indian EIA region and this number is likely to increase significantly during the high sunspot activity (HSSA) period, creating severe adverse conditions for the trans-ionospheric communications and the GPS-based navigation systems.

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