Northern Limit of the Equatorial Irregularity Belt observed with GPS Signal Scintillations

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The Signal-to-Noise Ratio (SNR) of the L1 (1.6GHz) transmission from the GPS and GLONASS satellites has been recorded at Calcutta (22.58^{o}N, 88.38^{o}E geographic; 32°N magnetic dip) since 1999 by a standalone C/A code Ashtec receiver. The receiver usually tracks 10-15 satellites, sampling different sections of the ionosphere at different look angles from the station. Simultaneously, L-band (1.5GHz) signal from geostationary INMARSAT (65°E) (350km-subionospheric point: 21.08^{o}N, 86.59^{o}E geographic; 28.74^{o}N magnetic dip) and VHF (244MHz) signal from FLEETSATCOM (73°E) (350km-subionospheric point: 21.10^{o}N, 87.25^{o}E geographic; 28.65^{o}N magnetic dip) are also recorded. The SNR of many GPS/GLONASS links, particularly in the southern sky and near overhead, has been found to scintillate frequently in between the local sunset and midnight hours of equinoctial months of high sunspot number years. Scintillations of satellite signals near overhead are caused by irregularities in electron density distribution in an environment of high ambient ionization occurring near the crest of the equatorial anomaly. For the links at lower elevation angles in the southern sky, severe scintillations occur when satellites are viewed 'end-on' through the field-aligned plasma bubbles. During periods of intense scintillations, in the high sunspot number years 1999-2002, it has frequently been observed that 7 to 8 GPS and GLONASS satellite links out of 15 simultaneously show scintillations in excess of 10dB. Spatial contour maps of Scintillation Index (SI dB) and of corresponding signal fades have been obtained from GPS scintillation observations in different local time intervals and seasons of the maximum sunspot number year 2000-2001. The northern limit of the equatorial irregularity belt has been obtained from the maps for different fade depth levels. For example, an SI $\geq$ 15 dB corresponds to a signal fade of 12 dB or more. Under the chosen intensity of scintillations, during August-October 2000 and February-April 2001, the irregularity belt extends to 30-35°N magnetic dip during the initial and developmental phase in the pre-midnight hours (1300-1700UT). In the late evening hours and around midnight (1700-1900UT), when the irregularities start decaying, the northern limit recedes towards the magnetic equator. In the post midnight hours, scintillations are practically absent. In the summer months of May-July 2000, the northern limit could not be determined due to scanty occurrence of scintillations in excess of 15dB. The variation of the northern limit of the irregularity belt is corroborated by observations with INMARSAT. The above information may be useful in planning of SBAS and radio astronomical observations by the Giant Meterwave Radio Telescope (GMRT).