Latitudinal characteristics of strong VHF scintillations due to ESF irregularities and their implication for occurrence of L band scintillations

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ABSTRACT

In recent years, there have been several attempts to "predict" the occurrence pattern of L-band scintillations in low latitude regions caused by equatorial spread F (ESF) irregularities, in view of the role played by these scintillations in degradation of the performance of satellite-based navigation systems. An important aspect of the development of ESF irregularities that has not been considered in these studies is how these structures develop at different heights within an equatorial plasma bubble (EPB) as it rises in the post-sunset equatorial ionosphere due to the growth of the Rayleigh-Taylor (R-T) instability. Irregularities at different heights over the dip equator map to different latitudes, and their spectrum as well as the background electron density determine the strength of L band scintillations at different latitudes.

In this paper, amplitude scintillations on a 251 MHz signal transmitted from a geostationary satellite and recorded at 4 stations located in the Indian longitude zone, spanning dip latitudes from 1.5^0 N to 21.8^0 N, have been used together with L-band scintillation data from several stations of GAGAN ((GPS aided geo augmented navigation) system, the Indian SBAS, GPS network, and theoretical modelling of the scintillations, to investigate this aspect. In particular, it is seen that while the S_4-index, which is the standard deviation of normalized intensity, computed for scintillations on the VHF signal recorded at an equatorial station, may exceed the value of 1, the S_4-index computed for scintillations on the VHF signal recorded near the crest of the equatorial ionization anomaly (EIA) generally does not exceed the value of 1, but tends to unity for saturated scintillations, although the background electron density of the ionospheric F layer peak at the EIA crest exceeds that at equatorial F region peak. Theoretical modelling of these scintillations indicates that this happens because the intermediate scale (~ 100m – few km) irregularity spectrum near the EIA crest is shallower than that found in the equatorial F layer peak, leading to the conclusion that there is greater structuring of an EPB on the top side of the equatorial F region than near the equatorial F layer peak, in the initial stage of development of the EPB before 22 LT. This had been concluded in an earlier paper by analyzing the dominant scale sizes present in the ground scintillation pattern for a VHF signal recorded at an equatorial station. In the present paper, VHF and L-band scintillations recorded at different

latitudes are used to study the implications of this structuring of EPBs on the occurrence and strength of L-band scintillations at different latitudes.