Role of atmospheric coupling processes on Equatorial Spread-F (ESF)

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Plasma irregularities in the nighttime equatorial F region, known as Equatorial Spread F, have been the subject of extensive experimental and theoretical investigations over the last several decades. First the initiation of EPB irregularities is primarily by gravitational Rayleigh-Taylor instability. Later, these secondary instabilities take over and a wide spectrum of irregularities is developed. The development of Equatorial Spread F (ESF) extending from the bottomside to the topside of the equatorial-ionosphere leads to generation of irregularities with scale sizes extending over seven orders of magnitude from cm range to hundreds of kilometres. Day-to-day variability of ESF itself is very difficult and challenging problem to predict. For the generation of irregularities, a certain perturbation in the bottomside of the F layer is necessary. This is one problem which needs further study. Atmospheric gravity waves (AGWs) are believed to provide the required initial seed for the equatorial plasma bubble (EPBs), however, the coupling processes that lead to the transfer of energy from AGWs to the plasma at the base of F-layer is not yet understood. Recent studies suggest that the modulation by AGW manifest as zonal large scale wave structure (LSWS) at the bottom side F-layer and the (EPB) irregularities are observed to be developing at the up-welling of these zonal LSWS. These zonal structures together with pre-reversal enhancement of eastward electric field (PRE) appear to control the location and onset of ESF.

In the present work, we have considered the propagation of electromagnetic waves through the irregular ionosphere in the L-band frequency range using dual frequency (f1 = 1.575 GHz and f2 = 1.227 GHz) GPS receivers. The GPS scintillation observed at our low latitude station Varanasi have been analyzed during the year 2011. The wavelike structures in ionospheric TEC have been found before the onset of ESF which is also confirmed by occurrence of scintillation. Efforts have been made to identify possible precursors of Equatorial Spread F (ESF) using the Total Electron Content (TEC) at Varanasi during the two equinoxes of low sunspot number of year 2009. Large Scale Periodic Structures found prior to TEC bite out can be taken as possible precursors to ESF. A threshold value of the peak to peak amplitude of this wave structure is chosen 2.6 TECU above which there is a possibility of ESF or TEC bite out with S4 > 0.26. Spectral Characteristics of irregularities have been also discussed.