Investigations on the Effects of Interplanetary Electric Field and Substorm on the Low Latitude Ionosphere-thermosphere System

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In the terrestrial frame of reference, a motional electric field exists in solar wind that is commonly known as interplanetary electric field (IEF). A number of frequency components in IEF are known to directly affect the low latitude ionosphere through the prompt penetration/over-shielding effects although the durations of these effects do not always follow theoretical predictions. In recent times, based on observations by multiple techniques, it was shown that IEF can affect thermospheric neutral 630.0 nm airglow emission, trigger the generation of plasma irregularity structures and modulate the evolution of these structures. Based on modeling investigations, it was also shown that eastward over-shielding electric field is necessary but not sufficient condition for pre-midnight plume event associated with equatorial spread F (ESF). The effects of IEF on the low latitude ionosphere-thermosphere system (ITS) are found to be further complicated by the presence of substorms.

In order to understand the distinctive effects of storm and substorms on the low latitude ITS, an investigation involving two events was undertaken. In one of the events, IEF reveals fluctuations in short temporal scale. It is found that fast fluctuations with periodicity ~40-45 min in the vertical plasma drift over dip equator are causally related with the fast fluctuations in the IEFy (dawn-to-dusk component) and, not with the fast fluctuations in the auroral electrojet indices AE. However, during the interval when a substorm was triggered in association with sharp transitions in IEFy polarity, the drift fluctuations follow the AE fluctuations and are out of phase with IEFy fluctuations. The h'F (base of the F layer) variation over dip equator is also found to be linearly correlated with the variation in the smoothed AE index that varies slowly. In another event, IEF remains steady during the interval under investigation. In this case, it is found that the effects of the onset of the expansion phase of a substorm generate positive bays in the deviations of the north-south component of horizontal magnetic field component (ΔH) during daytime over the low latitude region in the Indian sub-continent as well as in all the stations along the 210 magnetic meridian (MM) chain in contrast to conventional belief. Most importantly, OI 630.0 nm dayglow brightness observations corresponding to two different latitudes over India reveal the imprint of the electric field effects associated with the onset of the substorm. These cases will be presented and synthesized to highlight the complex effects of storm and substorm over low latitude ITS.