Inferences regarding ionosphere-thermosphere coupling - Indian ionospheric tomography experiment

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The equatorial ionosphere supports a variety of processes like the Equatorial Ionisation Anomaly (EIA), additional stratifications in ionosphere such as formation of F3 layers/topside ledges, and also irregularities like of varying scale sizes like Equatorial Spread-F (ESF). These processes are some of the most persistent manifestations of ionosphere-thermosphere coupling at equatorial and low latitudes. In recent years, there has been a renewed interest in understanding the generation and evolution of F3 layers [1]. At the same time, processes like the Equatorial Ionization Anomaly (EIA) and Equatorial Spread F (ESF) and their inter relationships have been the focus of many studies [2,3]. A variety of optical and radio techniques, including the ionospheric tomography [4], have been employed successfully to explore various aspects of the ionosphere-thermosphere coupling.

The first ionospheric tomography experiment in India, also known as the Coherent Radio Beacon Experiment (CRABEX), explored these coupling processes through ionospheric tomography over equatorial and low latitudes in India [5]. CRABEX used pre-existing NNSS beacon satellites in LEO configuration. The scope of CRABEX was enhanced by having an Indian radio beacon named RaBIT i.e. Radio Beacon for Ionospheric Tomography onboard India's own small satellite "YOUTHSAT', meant specifically for the investigation of the ionosphere over the Indian longitude/latitudes. The network of six beacon receiving stations covering the Indian region from Trivandrum (8.5°N) to Nainital (29°N) set up along the 77-78° E meridian, served for receiving the 150 and 400 MHz beacon transmissions from RaBIT'. The ground receivers at the above locations measure the relative phase of 150 MHz with respect to 400 MHz, which is proportional to the slant relative Total Electron Content (TEC) along the line of sight [6].

These simultaneous TEC measurements are inverted to obtain the tomographic image of the latitudinal distribution of electron densities in the meridional plane. These tomographic images of the equatorial ionosphere along the 77-78°E meridian have been studied for fixed local times during day and night. The tomograms indicate the movement of the anomaly crest, as well as the strength of EIA at various local times. The anomaly crest show significant differences with seasons and solar activity. The nighttime images highlight a significant nocturnal ionospheric variability prevailing on different days. An important aspect, which is observed using these tomograms, is that even minor geomagnetic disturbances influence the EIA crests significantly at times, which were seen evolving over much wider latitudinal extent. The tomograms also reveal the fine meridional structures of ESF irregularities for a few ESF events, which cannot be otherwise mapped without employing powerful ground-based radars. This paper through abovementioned observations will highlight the importance and nature of the neutral-plasma coupling, and the mechanism operating therein.

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