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MULTI-INSTRUMENT STUDY OF MOVING PLASMA STRUCTURES IN LOWEST SOLAR ACTIVITY PERIOD 2008-09

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Abstract. This paper provides first simultaneous observations of moving plasma structures in Indian zone using GPS-TEC along with Airglow photometer, MST Radar and Ionosonde

1 INTRODUCTION

The occurrence of EPB/ESF in any given longitude sector depends upon various factors which encompass instantaneous and cumulative sources in the evening and daytime ionosphere. The nighttime equatorial and low latitude ionosphere exhibit high day-to-day variability even during geomagnetically quiet conditions. Over and above the day-to-day variability in the source mechanisms, it has long been known that the ESF occurrence rate is also highly affected by seasons and the phases of the solar activity cycle. Intriguing aspect for occurrence of EPB/ESF is that there exists a longitudinal variability in the sources that may trigger them.

If an EPB is tracked right from the initial phase with an estimation of its drift velocity, the occurrence of the same in neighboring longitude sectors may be anticipated. Simultaneous observations of an EPB from different locations provide vital information on the generation, evolution and lifetime of a plasma bubble before it diffuses- losing the density gradients. GPS (Global Positioning System) has provided us with such an opportunity, which has been utilized for global and regional scale of ionospheric studies in recent past. The GPS has enhanced the capacity of other classical observing instruments like airglow photometer, Radar and ionosonde, thus providing new dimensions for data interpretation. The different perspectives of post-sunset ionospheric irregularities with respect to the observing instrument have been presented in the paper.

2 OBSERVATIONS

We utilized the potential of multi-instrument approach to cover the vast spatio-temporal domain of low latitude nighttime ionospheric variability. The observations from GPS receivers located at Bangalore, Hyderabad and Gadanki have been used in coordination with airglow photometer, MST Radar and ionosonde Located at Gadanki.

3 RESULTS

The first coordinated measurement from all the observing systems were available for two nights i.e. 23 december 2008 and 21 january 2009 (other than radar observations, which are for 21 january only). We present the results obtained for both the cases in the following perspectives.

3.1 TRACKING THE DEPLETIONS

The occurrence of depletions in airglow and GPS-TEC has been confirmed by ionosonde observations of ESF. A new approach has been employed to track the EPBs in spatio-temporal domain and the evolution, drift and diffusion of TEC depletions have been quantitatively measured and reported. The drift of depletions is found to be about 65-75 m/sec towards east which is also corroborated by airglow and ionosonde data.

3.2 RELATION BETWEEN S4 AND ROTI

Noteworthy difference is obtained between the amplitude and phase scintillations for the observed TEC depletions. The amplitude scintillations have been absent whereas the phase scintillations as represented by ROTI show very small increase for the TEC depletions.

3.3 POST-SUNSET ENHANCEMENT IN ELECTRON DNEISTY

First simultaneous observations of post-sunset enhancement in airglow intensity, GPS-TEC and foF2 have also been reported. The enhancement in all the parameters occurs before midnight and is different from those reported by Dashora and Pandey (2005) in GPS-TEC.

3.4 POST-MIDNIGHT PLUME OCCURRENCE

Also on the night of 21 January 2009 (in post midnight hours) a ESF plume structure was observed by MST radar co-occurrent with depletions in GPS-TEC in different longitude sectors and a rise in height of F layer preceding the occurrence. The occurrence of post midnight plume and TEC depletions has been discussed in light of fresh and/or active-fossil bubbles drifting in the nighttime equatorial ionosphere.

4 CONCLUSIONS

- Since no geomagnetic activity was recorded around the days of observations reported in this study, the cases clearly mark the low latitude nighttime ionospheric behavior during the lowest solar activity phase.

- The TEC depletions appear without L-band amplitude scintillations and lower phase scintillation during both the pre- and post-midnight hours. This as well as very low values of zonal drifts probably mark the effect of low solar activity on background ionospheric currents and the fields thereof.

- Also, the observation of very small difference between the line of sight doppler velocity and the spectral width in the radar plumes in pre and post-midnight hours necessitate to redefine the critical parameters which delineate between fresh and active-fossil EPBs.

- We discuss the implications of such multi-instrument studies in forthcoming observational campaigns