Study of thermospheric gravity wave characteristics and their behavior in relation to the occurrence of equatorial plasma irregularities in the post sunset time using radio, and optical measurements

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Abstract:

Plasma irregularities in the equatorial latitudes (also known as Equatorial spread F; ESF) severely affect trans-ionospheric radio communications. Prediction of occurrence of ESF is still a challenging problem of ionospheric physics. Gravity waves (GWs) are thought to be the seed of perturbation that causes these kind of irregularities. Daytime wave dynamics prepares the ionosphere conducive for this nighttime phenomenon. Conventionally, variation in peak F-layer height (hmF2), critical frequency (foF2), or integrated electron content (IEC) have been attributed to be of GW origin. But these can also be caused by electric field, meridional wind, temperature, and wave activity. To avoid such ambiguity, GW information in those region have been derived by monitoring the different height of ionosphere. This involves monitoring the phase offset (according to GW dispersion theory, downward phase propagation is associated with wave propagation in upward direction, Hines, 1960) in the height variations of constant electron densities (isoelectron density contours) corresponding to fixed transmission frequencies of digisonde. Time periods obtained are only considered to be of GW origin if that time period is present in the variations of multiple isoelectron density contours which show phase propagations. And height and time differences from phase offset information have been used to derive GW scale sizes.

We have carried out such analysis from location under the trough and crest of equatorial ionization anomaly (EIA), Trivandrum (8.5^0 N, 76.9^0 E; 0.07^0 N MLAT) and Ahmedabad (23.0^0N, 72.5^0E; 14.9^0 N MLAT), respectively.

In addition, we have estimated the gravity wave characteristics in the daytime optical airglow emissions that originate at thermospheric altitudes from Hyderabad (17.5^0 N, 78.4^0 E; 8.9^0 N MLAT), India (a location between crest and trough of EIA). The magnetic data is analyzed to obtain electrojet information.

We present the result of combined radio, optical, and magnetic datasets to arrive at the GW characteristics and their response to different geomagnetic conditions prior to the occurrence and non-occurrence of the ESF.