Influence of tides and gravity waves on the E-valley-F region irregularities

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In the present study, Gadanki Mesosphere-Stratosphere-Troposphere (MST) radar observations of E-Valley-F region echoes and Tirupati meteor radar observations of upper mesospheric winds are primarily utilised to examine the influence of tides and gravity waves on the generation of ionospheric irregularities based on three case studies. The results show that fast descending structures and patchy structures of E-region irregularities are caused by semi-diurnal tides and gravity waves, respectively. The quasi-periodic structures may be caused by Kelvin-Helmholtz (KH) instability, as the estimated Richardson number is less than 0.25. The theoretically computed height extension of the quasi-periodic echoes agrees well with the observations.

Keywords: Gravity waves, ionospheric irregularities, Kelvin-Helmholtz instability, Rayleigh-Taylor instability, tides.

echoing patterns have a close resemblance to the nighttime valley region echoes, which are presumably linked with the intermediate layers formed by meridional wind shear associated with the semi-diurnal/ter-diurnal tidal winds[3].

Radar echoes from the F-region irregularities are observed during the post-sunset hours. These echoes have maximum occurrence during equinox months of solar maximum. Recently, post-midnight irregularities are observed, and their occurrence maximises during the June solstice of solar minimum years[4]. In this case, the low altitude of the F layer and westward electric field might have inhibited the growth of the Rayleigh-Taylor instability (RTI) during post-sunset hours. However, the semi-diurnal variation in the electric field can turn the zonal electric field eastward during midnight hours, which in turn can lift the F-layer to higher heights, favouring the growth of RTI, leading to delayed F-region irregularities.

In the present study, the influence of tides and gravity waves on the generation of E-Valley-F region irregularities is investigated using simultaneous observations of Mesosphere-Stratosphere-Troposphere (MST) radar iono-