# On the Generation of F-region Plasma Irregularities by Upward Propagating Gravity Waves

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In this paper we study the linkage between the middle atmospheric gravity wave dynamics and the seeding of plasma irregularities associated with equatorial plasma bubble using simultaneous observations made using the high power Rayleigh lidar and the MST radar located at Gadanki (13.5$^o$ N, 79.2$^o$ E), a magnetically low latitude location in India. Temperature measurements using the Rayleigh lidar have been used for characterizing the gravity waves in the middle atmosphere and E region irregularity drifts to study the gravity wave induced electric field in the E region. We present six clean case studies, which occurred under geomagnetic quiet conditions (Ap < 10), where the vertical coupling of the middle atmospheric gravity waves with the E region is clearly noticed. We note clear upward propagation of gravity waves from 40 km to 75 km in the middle atmospheric temperature data for periodicity range of 20 minutes - 2 hours. Further, a clear resemblance is observed in FFT spectra of residual E-region velocity fields and temperature oscillations at 75 km altitudes on most of the nights. Also, the cross correlation analyses of 75 km temperature residuals and E region velocity residuals reveal high correlation coefficients (cross correlation coefficient varying between 0.77 – 0.93). Interestingly, the occurrence periods of F-region irregularity structures (as visible in plasma bubbles) show a clear correspondence with the periodic oscillations in E-region velocity fields governed essentially by zonal electric fields. These observations are intriguing considering the renewed scientific interest in evaluating the gravity wave seeding of equatorial plasma bubble as revealed from the recent investigations from the Brazilian sector. We surmise that under suitable F-region conditions (i.e., pre reversal enhancement in the zonal electric field and the F-layer height) such E-region electric field perturbations can easily map to the F region over the magnetic equator via the magnetic field lines and seed the plasma irregularities manifesting similar occurrence periods in the F region plumes observed by the radar. These results are presented and discussed in the light of the current understanding on the seeding of Rayleigh Taylor instability which governs the occurrence of equatorial plasma bubbles.