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Theoretical modelling of the topside electron density distribution in the Indian equatorial and low latitude ionosphere using DU_LLTD Model

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The spatial and temporal distribution of ionospheric electron density in the Indian equatorial and low latitudes during high solar activity conditions is theoretically simulated. The Dibrugarh University Low Latitude Temperature and Density (DU_LLTD) Model, which operates by simultaneously solving the time-dependent equations of continuity, momentum and energy balance equations along the ED (eccentric dipole) geomagnetic field lines (Bhuyan et al., 2001a,b) is used to generate the density profiles at different heights for solar maximum equinoctial condition.The effects of E × B drift, horizontal wind, magnetic field, solar activity, photoionization rate, chemical reactions and solar EUV flux are considered as inputs for the calculation of electron/ion density. Heating due to photoelectrons, collision between ions, ions and electrons, rotational heat transfer, vibrational heat transfer and thermal conductivity are considered for the calculation of electron and ion temperatures (Bhuyan et al., 2008).

The density measured by the Ionospheric Plasma and Electrodynamics Instrument (IPEI) on board the ROCSAT -1 over the 75°E and 95°E meridian at 600km altitude has been utilized to examine the latitudinal and longitudinal distribution within the Indian sector. A longitudinal gradient in ion density higher towards 95°E develops during the noontime and afternoon hours when the EIA is at its peak. The density gradient persists till evening hours when pre-reversal enhancements occur. The vertical E × B plasma drift velocity measured simultaneously by ROCSAT -1 for the same space-time configuration has also been studied.

The model generated densities are compared with the densities measured in situ by the ROCSAT -1 satellite (at height ~ 600km). A quantitative agreement between simulation results and the actual measurement has been observed. Besides reproducing the normal diurnal features of density, the simulations of the formation of Equatorial Ionization Anomaly (EIA) including the North South asymmetry have been made within reasonable limits of accuracy. Executing the model under similar E × B plasma drift conditions as exist between 75°E and 95°E, the observed longitudinal variation in electron density between the two longitude sectors as recorded from in situ measurements using ROCSAT -1 is reproduced theoretically using DU_LLTD model. Results show that among the other existing factors, the vertical E x B plasma drift across the equatorial region acts as a major source of the observed longitudinal structure.

References

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