A heterogeneous ion-chemical model of the mesosphere and MST radar echoes over low latitude

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The role of mesospheric dust as both source and sink for electrons and ions has been considered to derive a detailed ion-dust model scheme for low latitude mesospheric region between 60-90 km. In addition to the well known processes for the formation of the conventional positive molecular and hydrated ions and negative ions, other channels for the formation of single and multiple charged dust ions have been considered in this model to satisfy the charge neutrality criteria.

The model derived charged and uncharged dust density profiles show layered structure with respect to height. These structures are found to be independent of dust size in the lower mesosphere and dependent on size in the upper mesosphere heights. These charged dust particles can enhance radar scattering by introducing inhomogeneities in the ambient ionisation similar to that of the charged ice-aerosols in generating the Polar Mesospheric Summer Echoes (PMSEs) and Midlatitude Summer Echoes (MSEs). Under equilibrium conditions the charged and neutral dust densities show an inverse dependence on dust sizes; typically for a steady state condition the required total dust concentration is of the order of 2 x10^1-2 x 10^5 cm^{-3} for the dust size range of 70 – 1nm over the height range of 60-90 km.

Using the MST radar facility at Gadanki (13.5^0 N, 79.2^0E) seasonal variation of the back-scattered echoes of 53 MHz signals has been studied for the period 1998-2002. The main characteristics of the variations of the return echo power show the presence of primary and secondary scattering layers between 70-75 km, and 65-70/80-85 km respectively. These layer heights compare well with the layered structure of the charged dust particles brought out by the model, which indicate a possible role of mesospheric charged dust aerosols in the generation of Low Latitude Mesospheric Echoes (LMEs).

A seasonal variation of the heights of these scattering layers has been observed in MST radar data over Gadanki. The model computations are repeated using electron density profiles for different seasons and corresponding height profiles of dusty ions derived. The model results compared well with the MST radar observations.