Diagnostic Possibilities Utilizing Radio Wave Heating of Mesospheric Dust Clouds

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Important observational manifestations of sub-visible mesospheric dust are Polar Mesospheric Summer Echoes PMSE which are produced by radar scattering from electron irregularities produced by dust charging. It has been experimentally observed that the PMSE strength can be artificially modified by using a ground-based ionospheric heating facility to perturb the electron irregularity source region that is believed to produce PMSE. Recently it has become evident that significant diagnostic information may be available about the charged sub-visible dust layer from the temporal behavior of the electron irregularities during the heating process which modifies the background electron temperature. Particularly interesting and important time periods of the irregularity temporal behavior are during the turn-on and turn-off of the radio wave heating. Past work has primarily utilized full computational models that provide the temporal evolution of the electron irregularities during heating. Interesting and important behavior has been predicted. For example, during the turn-off of the radio wave heating, an enhancement in the amplitude of radar echoes was predicted and experimentally observed and has been termed 'PMSE overshoot'. Other important temporal behavior experimentally observed has been reproduced by current computational models. However, such computational models often do not readily provide all possible physical insight which can maximize the possibilities for diagnostic information. The objective of this presentation is to consider more quantitative approaches to obtain diagnostic information by utilizing simplified analytical models. Particular emphasis will be placed on analytical modeling the electron irregularity temporal evolution during the radio wave heating turn-on and turn-off periods. First, several past computational models will be discussed that have been used to model the temporal evolution of PMSE during ionospheric heating. Next, simplified analytical models that have been recently developed will be presented and the results compared to the computational models as a reference. The analytical models will then be used to provide further insight into the physical processes during radio wave heating of the PMSE source region as well as explore further diagnostic possibilities for the charged dust layer.