NUMERICAL SIMULATIONS OF METEOR HEAD PLASMA RADAR CROSS SECTIONS

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Abstract

Meteor head plasma is regularly detected by ground-based radars. With accurate knowledge of the radar transmitted power and gain pattern, the radar cross section (RCS) of the meteor head plasma can be measured. However, because of the plasma nature of the meteor head, the relationship between the measured RCS and the meteor plasma parameters is not straightforward. The parameters of the head plasma are critical for an accurate estimate of the parent meteoroid mass. We present a forward model of radar scattering from meteor plasma using a finite-difference time-domain model of the electromagnetic wave interaction with the plasma. This model computes the meteor head RCS for a given meteor plasma distribution, typically given as a Gaussian or other distribution with a peak plasma density and a characteristic size. We then relate measured RCS values to the input size and density parameters to better characterize the meteor plasma. We present simulation results that show that the RCS is directly related to the overdense meteor area; that is, the area of the meteor inside which the plasma frequency exceeds the radar frequency. We further present updates to the modeling scheme that allow for characterization of bistatic scattering, as well as improvements to the model to allow simulations of radar frequencies between 10 MHz and 1 GHz.