Very Small Meteors – Computer models and data comparisons

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ABSTRACT

In this paper we describe, for very small meteors with terminal altitudes above 90 km: (1) a theoretical model of meteor sputtering, ablation and deceleration, and associated numerical computations; (2) a comparison the computer model results with radar scattering data; (3) a theoretical description of the interaction of the ablated meteor molecules with the background air, including scattering and ionization, and numerical computations of the resulting distributions of ions, electrons and neutral molecules surrounding the meteor and in the wake. Two separate numerical models are described – the first based on a Monte Carlo approach, and the second based on a quasi-fluid approximation. Both models lead to the conclusions that, for meteors in the microgram mass range with velocities in the 30 km/s range, plasma concentrations close to the meteor are in the 10^9 to 10^{10} electrons/cm^3 range, extending over distances of the order of 1 cm. The electron temperatures remain close to ambient, and the dimensions of the plasma cloud are slightly smaller than the electron Larmor radius. Hence the plasma motions are dominated by electron-neutral and ion-neutral collisions, including charge exchange. The electron plasma frequency is of the order 10^9 s^{-1} and the electron-neutral collision frequency is of order 10^5 s^{-1}, with the result that the electron motions will be dominated by electrostatic forces, causing the electron spatial distribution to nearly coincide with the ion distribution. The radar scattering properties of these sorts of plasma distributions are discussed.