Plasma and electromagnetic wave simulations of meteors

L. Dyrud (1), Y. Lee (1), S. Boerve (2), J. Trulsen, H Pecseli

(1) Center for Remote Sensing, Fairfax, VA (ldyrud@yahoo.com), (2) University of Oslo

Every day billions of meteoroids impact and disintegrate in the Earth's atmosphere. Current estimates for this global meteor flux vary from 2000-200,000 tons per year, and estimates for the average velocity range between 10 km/s to 70 km/s. The basic properties of this global meteor flux, such as the average mass, velocity, and chemical composition remain poorly constrained. We believe much of the mystery surrounding the basic parameters of the interplanetary meteor flux exists for the following reasons, the unknown sampling characteristics of different radar meteor observation techniques, which are used to derive or constrain most models. We believe this arises due to poorly understood radio scattering characteristics of the meteor plasma, especially in light of recent work showing that plasma turbulence and instability greatly influences meteor trail properties at every stage of evolution. We present our results on meteor plasmas simulations of head echoes using PIC ions, which show that electric fields strongly influence early stage meteor plasma evolution, by accelerating ions away from the meteoroid body. We also present the results of time domain electromagnetic simulations (FDTD) which can calculate the radar cross section of the simulated meteor plasmas. These simulations have shown that the radar cross section depends in a complex manner on a number of parameters. These include the angle between radar and meteor entry, a large dependence on radar frequency, which shows that for a given meteor plasma size and density, the peak reflectivity for the meteor varies but is usually less then 100 Mhz. The simulations also show that the majority of the reflection occurs at the very central high density portion of the meteor, a region that is often much smaller then the radar wavelength.