



Specular meteor observations and full wave scattering modelling: observing faint meteors

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There is a continuous flux of meteoroids entering the Earth's atmosphere, which are decelerated and heated by collisions with atmospheric molecules, and, depending on the meteoroid kinetic energy, they vaporize and form an ambipolar diffusing plasma trail, which is easily detectable using radar remote sensing. Specular meteor observations are a widely used radar technique to measure winds at the Mesosphere and Lower Thermosphere (MLT). The altitude dependent lifetime (decay time) of the meteor plasma columns provides valuable information about the mean temperature of the atmosphere. Part of the success of these systems is based on the efficient scattering process compared to meteor head echoes.

Here we present observations with the Middle Atmosphere Alomar Radar System to detect the faintest observable meteors using the specular geometry, but a focused beam with a beamwidth of 3.6° and the full power of 866kW of the system. We compare our observations to an orbital dynamics model of JFC comets and derive a meteor velocity distribution for the observed population.

Further, we performed extensive modeling using a full-wave scattering model based on the model presented in Poulter and Baggaley, 1977. We conducted extensive simulations with the full-wave scattering model to investigate how different plasma distributions would affect the detectability of the meteoric plasma cylinders considering the initial trail radius, diffusion, and electron line density. The obtained reflection coefficients are validated with the triple frequency CMOR (Canadian Meteor Orbit Radar) measurements convolving them with the Fresnel integrals. Our results indicate that the plasma distribution can significantly alter the detectability. Further, the model shows that the observed decay time depends on the polarization of the transmitted wave relative to the meteor trajectory, which also revealed resonance effects for certain critical plasma frequencies.