Measurements of simulated micrometeoroids in the laboratory

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Abstract. Each day, several tons of meteoric material enters Earth's atmosphere, with the majority of this material consisting of small dust particles that completely or partially ablate at high altitudes. This large influx of dust particles has been suggested to play a role in a variety of atmospheric phenomena, but it also provides the opportunity to directly measure the dust environment around the Earth. Such measurements have the potential to improve hazard mitigation models for future missions as well as provide important data for better understanding the evolution of the inner solar system. Various methods are used to detect and measure the properties of the meteors depending on their size. Meteor radars are one such method that is sensitive to the most important mass regime in terms of daily mass input (10^{-9} – 10^{-3} g), but there are large uncertainties in the ablation process which lead to uncertainties in the radar measurements. The dust accelerator facility at the SSERVI Institute for Modeling Plasma, Atmospheres and Cosmic Dust (IMPACT) has implemented an experiment that allows for the simulation of micrometeoroid ablation in the laboratory. A pressurized ablation chamber is fitted to the end of the dust accelerator and acts as a proxy atmosphere for the accelerated dust particles. The pressure is monitored by an absolute pressure gauge and can be pressurized from 15-500 mTorr with a variety of gases. The design of the ablation chamber expands on previous experimental efforts and contains a suite of electronics capable of measuring the generated plasma along the entire ablation trajectory with a spatial resolution of 2.6 cm. This allows for a direct measurement of the ionization coefficient, β, which is a critical parameter for interpreting radar measurements. It also allows for the verification of the basic physics in commonly used ablation models. Here we report on new measurements of the ionization coefficient for iron micrometeoroids impacting N_2, air, CO_2, and He gases. Our results indicate potential problems with using the commonly used β values for interpreting ablation data for CO_2 atmospheres (like Mars) and for high-speed meteors on Earth. This can lead to incorrect assessments of hazards as well as misleading data used in models of the inner solar system evolution.