Direct Observation of micrometeor differential ablation:

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Meteoric smoke is believed to provide a major source of condensation nuclei (CN) for the formation of ice particles in the Mesosphere and Lower Thermosphere (MLT). Smoke particles may therefore be a necessary precursor to the formation of noctilucent clouds (NLC) and polar mesospheric summer echoes (PMSE). The smoke forms from the condensation of meteoric material ablated from the billions of extraterrestrial particles entering our atmosphere every day. However, it is not clear, from all the chemical constituents evaporated from the meteoroid, which is the best candidate for the formation of smoke. This makes the accurate understanding of the meteoroid ablation process a crucial step towards the complete elucidation of the microphysics of ice layers. We present the first direct observation of meteoroid differential ablation, providing evidence that this is the main mechanism through which micron-sized particles deposit their mass in the MLT. These results are obtained utilizing two state-of-the-art models to correlate temporal behavior in the received signal of observed radar meteor head-echoes with the precise moment at which a particular chemical constituent is predicted to evaporate from the main body. Prior to this work, differential ablation was merely a hypothesis and there was no known mechanism for remote sensing the individual chemical constituents of meteors so small that they create no measurable light. The coupling of a differential ablation model with an astronomical model of the meteoric flux, combined with large aperture radar observations, will therefore enable the origins of meteoroids within the solar system to be related to the deposition of their constituents in the upper atmosphere, and shed new light on their aeronomical impacts.