Radio Science Aspects of Radar Meteor Observations: Where Are We?

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Detailed understanding of the radio science of (HPLA and "classical") radar head- and trail-echo radar scattering is required to correctly interpret observations. This understanding depends on mutually informed modeling and observation techniques. Observations yield intra-pulse and pulse-to-pulse details of each event that, via modeling, suggests how the plasma surrounding the meteoroid—and that then forms the meteor trail—is generated and evolves. This in turn reveals insight into underlying physical processes such as sputtering, fragmentation, flaring, and terminal processes relative to the more traditional (differential) ablation view of how the meteoroid interacts with the atmosphere. Details of these processes remain a source of controversy demanding further investigation.

We offer a brief review of current meteor observations and results from several radars (including Jicamarca, Arecibo, PFISR, and MU) and suggest that careful calibrated and coordinated observations from these radars will reveal important new details of the meteor radio science and meteoroid processes. These details emerge as a result of the diversity of frequencies, viewing angles relative to the geomagnetic field, and latitudes/seasons that constrains data interpretation and models and will, for example, yield progressively better determines the whole-earth meteoroid mass flux. Of particular importance is common-volume, multi-frequency, multi-mode radar observations of individual meteor events. We review some recent radar meteor observations and observational techniques and suggest new techniques for multi-radar meteor observations and for cross-calibration of these radars. We also suggest renewed classical Low-Power, Small-Aperture (LPSA) radar meteor observations that will connect these results to those from HPLA radars. Modeling/simulation studies of the radar scattering process and of meteor related electrodynamics are also proposed.