Suggested New Observing Strategies for Radar Meteor Observations

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Abstract

Thorough understanding of the radio science aspects of radar meteors is required to correctly interpret observations, to inform modeling, and to design new observational modes. For example, it has been argued that meteoroid fragmentation is a dominant feature even in classical trail-echo radar results but how best to further explore this result? We suggest that common-volume radars operating at two or more nearby frequencies and/or that two, or more, radars viewing a common volume at widely differing aspect angles will yield vastly more information on the meteoroid processes giving rise to the mutual radar signatures. In particular, we present a modeling study of the head- and trail-echo signatures at 40, 45, and 50 MHz of variable trail-length and fragmenting-meteoroid radar meteors. This reveals that simple scattering scenarios, e.g., the head/trail-echoes from a few meteoroid fragments, evolve somewhat differently at the different frequencies in a decipherable manner. We also note the importance of multiple aspect angle common-volume radars and of combining optical and radar observations.

Discussion

By any measure modern radar meteor research is vibrant even if it was once declared "dead" [1]. The radio science and meteoroid-process insights permitted by HPLA (High-Power, Large-Aperture) radar meteor observations have also prompted the re-examination of what additional information might be available from classical "trail-echo" LPSA (Low-Power, Small-Aperture) radar meteor observations [2, 3]. Additional insight into meteor science is available from the integration of radar meteor results with those from optical meteor observations that have now convincingly revealed meteors up to ~200 km altitude [4] thus raising the question of why these are apparently not seen with radars. These advances have been accompanied by considerable debate surrounding the interpretation of what we describe as the head-, trail-, range-spread, fragmenting-, and flare-echoes as well as details of the classical "specular" trail-echoes. Various interpretations include under- versus over-dense meteors, Bragg scattering from instability-generated fluctuations, fragmentation, simple or differential ablation, sputtering, flaring, etc. While modeling of the radio science aspects of all of these processes is necessary [5], so is new data. To this end we suggest new radar techniques that would in principle be capable of distinguishing among the various interpretations just outlined. The most obvious approach, which we explore, is using two or more nearby radar frequencies illuminating a common volume. This approach can be applied to both HPLA and LPSA radars and has in a limited sense been done at both Arecibo [6] and ALTAIR [7] where common-volume radars at widely separated frequencies are available. We give examples of common meteoroid head- and trail-echo features as they would be observed at 40, 45, and 50 MHz in zenith-looking radars and classical trail-echo radars pointed at low elevation angles. We note that even more information is gained from those likely rare events seen by a classical trail-echo radars viewing the meteor zone in a volume common to a zenith-looking HPLA radar such as those at Arecibo and Jicamarca.

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