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On the Possibility of Constraining Bright Meteor Shock Wave Forming Altitudes –Theoretical Consideration of Relationship to Radar Observed Meteor Head Echo/Height Termination Heights in MLT

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All optically detectable meteors, as well as many of the strong radio-detectable meteors, produce shockwaves prior to their terminal stage in the MLT (Mesosphere-Lower Thermosphere) region of the atmosphere, at altitudes between 75 km and 100 km. The strengths of the meteor-generated shock waves depend on meteor atmospheric velocities and the values of the relevant Knudsen number. However, practical detection and determination of the altitude at which these shock waves form have not been possible up to this point because of their rapid spatial and temporal attenuation, as well as the presence of radiative phenomena that extend to the meteor wake.

Moreover, while shock waves generated by bright meteors in MLT appear during the transitional flow regimes, good estimates of the relevant meteoroid parameters (such as velocity, shape, bulk density and size), and the altitudes at which shock waves are generated, remain elusive. This is largely because of the uncertainty introduced by the presence of the ablation-amplified hydrodynamic shielding, which subsequently alters the considerations of the flow regime.

To address this, we consider a measurement of the radar detectable meteor head echo (MHE) termination altitudes. The size of MHE plasma radius depends upon altitude, and it scales with the atmospheric mean free path and meteoroid velocity. Thus, the MHE termination altitudes are also strongly correlated with meteoroid parameters and the flow regime, and could be used to indicate the formation of the denser hydrodynamic shielding and flow fields around a meteoroid. Since these are the precursors to the appearance of the shock wave, knowledge about these phenomena can be used to better predict the onset of shock fronts.

Consequently, we suggest that the radar-detectable MHE termination points can be used as a reasonable indicator of the meteor shock wave formation. Moreover, this can be used to better characterize and constrain the meteoroid properties, altitudes and flow regime parameters associated with the shock wave formation.

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