Simultaneous optical and specular radar measurements of low speed meteors

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The measurement of meteoroid masses using either optical or radar techniques requires knowledge of the amount of ablation energy partitioned into photon or electron production. The associated luminous efficiency and ionization efficiency are quantities which have been measured in the laboratory or estimated from meteor measurements. While the range in estimated luminous efficiency estimates is very large (Subasinghe et al., 2017), recent laboratory measurements of the ionization efficiency by DeLuca et al (2018) and Thomas et al (2016) are in comparatively better agreement with the theoretical estimates from Jones (1997). Moreover, both measurements and theory suggest a rapid drop in ionization efficiency for speeds below 20 km/s. In an effort to better estimate which luminous efficiency value is compatible with contemporary values of ionization efficiency we report a series of simultaneous optical and specular radar measurements of low speed ($v<20$ km/s) meteors. We focus on the low speed population as secondary ionization is not a factor and initial trail radii are small, minimizing the model assumptions/corrections required to compute electron line density. By using the large decrease in expected ionization efficiency at such low speeds, we attempt to better define the likely ratio of luminous to ionization efficiency. The optical measurements were performed with two pairs of electron-multiplied charge coupled device cameras (EMCCDs) which operated autonomously and are co-located with the multi-frequency Canadian Meteor Orbit Radar (CMOR). Using the timing and geometry of individual meteors measured by both the radar and multi-station EMCCD systems, the portion of the optical lightcurve producing the specular radar echo is measured and the received echo power used to estimate an electron line density. Following the procedure in Weryk and Brown (2013), the ratio of light production to electron line density provides a direct estimate of the ionization efficiency to luminous efficiency ratio for each event. A total of ~400 simultaneous EMCCD and radar meteors were identified with in atmosphere speeds below 20 km/s from observations in the period 2017 – 2019. A subset of this sample was analyzed in detail. Results of these measurements will be presented and compared to literature estimates for luminous efficiency.