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Meteor velocity determination with plasma physics

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Abstract. Understanding the global meteor flux at Earth requires the measurement of meteor velocities. While several radar methods exist for measuring meteor velocity, they may be biased by plasma reflection mechanisms. This paper presents a new method for deriving meteoroid velocity from the altitudinal extent of non-specular trails. This method employs our recent discoveries on meteor trail plasma instability. Dyrud et al. (2002) demonstrated that meteor trails are unstable over a limited altitude range, and that the precise altitudes of instability are dependent on the meteoroid that generated the trail. Since meteor trail instability results in field aligned irregularities (FAI) that allow for radar reflection, non-specular trail observations may be used to derive velocity. We use ALTAIR radar data of combined head echos and non-specular trails to test non-specular trail derived velocity against head echo velocities. Meteor velocities derived from non-specular trail altitudinal width match to within 5 km/s when compared with head echo range rates from the same meteor. We apply this technique to Piura radar observations of hundreds of non-specular trails to produce histograms of occurrence of meteor velocity based solely on this non-specular trails width criterion. The results from this study show that the most probable velocity of meteors seen by the Piura radar is near 50 km/s, which is comparable with modern head echo studies.

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