Visualising the fate of DFN fireballs using the α-β plot

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As fireball networks grow, the number of events observed becomes infeasible to manage by manual efforts. Automated data pipelines can be established to reduce large fireball datasets. Triangulation of a fireball trajectory can swiftly provide information on positions and, with timing information, velocities. However, extending this pipeline to determine the terminal mass estimate of a meteoroid is a complex next step. Established methods typically require assumptions to be made of the physical meteoroid characteristics (such as shape and bulk density). Those that seek to evaluate such unobserved parameters can be time consuming and impractical to run on large datasets. To determine which meteoroids may have survived entry, and where to concentrate resources for more in depth techniques, there is a general rule of thumb that uses a fireball's final height and velocity. This is a very crude approach where it is assumed that low and slow final parameters are likely the best candidates; the general conditions require for a fireball to produce a meteorite is an end height below 35 km and a velocity below 10 km/s [1].

A much more elegant approach is the dimensionless coefficient method first described by [2] and well outlined in [3] (and see references therein). Two parameters, α (ballistic coefficient) and β (mass-loss), can be calculated for any event with some degree of deceleration, given only velocity and height information. α and β can be used to analytically describe a trajectory with the advantage that they are not mere fitting coefficients; they also represent the physical meteoroid properties. This link allows insights to be made on the incoming body by assessing the groupings of specific α and β values. This is a fast and easy method to implement and run on a large dataset, such has been done by [4] for both the Prairie Network (PN) and Meteor Observation and Recovery Project (MORP) data. We have used a set of ~300 fireballs observed by the DFN to show how visualisation in an α-β plot can quickly identify which fireballs are likely meteorite candidates.

[1] P. Brown et al. (2013) MAPS 48, 270–288.
[2] V. P. Stulov et al. (1995) Nauka, 1995.
[3] E. Lyytinen and M. Gritsevich (2016) P&SS 120, 35–42.
[4] M. I. Gritsevich (2009) ASR 44, 323–334.