REVISED MASSES FOR THE CANADIAN METEOR NETWORK FIREBALLS

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Introduction: We have developed a novel approach that employs actual atmospheric conditions at the concurrent location of a fireball in its trajectory interpretation [1]. This approach can be used to obtain more reliable parameter estimates since it uses an improved representation of the atmospheric density. Thus, the fireball mass obtained with the new approach differs from the estimates obtained by using the isobaric altitudes derived from the exponential atmospheric model, i.e. without taking into account the corrections for the realistic atmospheric conditions. This is especially crucial for potential meteorite droppers, i.e. low velocity fireballs, with small ablation rates and consequently, high terminal-to-initial mass ratio.

The methodology has been recently proven by its successful application in the case of the Annama fireball enabling quick recovery of the Annama meteorite [2, 3]. The obtained results also compare well to other mass-determination methods, see e.g. [4, 5, 6].

Meteorite Observation and Recovery Project (MORP): The network was operational in Canada in 1971–1985. It consisted of 12 observatories, each equipped with five cameras, a meteor detector, and exposure control systems. A detailed MORP fireball database including the event, leading to the recovery of the Innisfree meteorite is presented in [7]. The aim of this study is to calculate the fireball masses in more accurate way by taking more reliable atmosphere models into account. The MORP holds one of the most detailed published databases, which helps discussing the accuracy of the results, and validating any global behavior.

The data reduction steps: Following the method described in [1] we implement an atmospheric height correction method that utilizes more realistic atmospheric models to analyze the fireballs. The first considered atmospheric model is the Standard Atmosphere model, which divides the atmosphere in several regions where a mathematical adjustment fits globally the mean atmospheric conditions. The second is the MSIS-E 90 model, which is based on previous version (MSIS-E 86) and includes tabulated atmospheric data according to the Earth longitude, latitude and height coordinates, as well as the solar activity of the time studied.

To evaluate our results we made calculations using the assumption of an exponential atmosphere, traditionally used in many meteor studies, which allows the use of a simple analytical expression to determine the relationship between the height above sea level and air density, see e.g. [8]. The comparison between the results of the models revealed that it is crucial to account for the realistic atmospheric conditions in fireball analysis.

Conclusions: The use of exponential atmosphere model tends to overestimate both the initial (pre-atmospheric) mass and its mass-loss rate along the trajectory. Particularly, the terminal masses (at the final luminous point of the atmospheric flight path), are seriously affected. The implementation of appropriate atmospheric models within the meteor equations of motions leads to an increased accuracy in the results.

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