SUPRACENTER: LOCATING FIREBALL FRAGMENTATIONS USING DIRECT ACOUSTIC WAVE ARRIVALS RECORDED BY SEISMOMETERS. W. N. Edwards and A. R. Hildebrand, Dept. of Geology & Geophysics, University of Calgary, Calgary, Alberta, Canada T2N 1N4.

Introduction: As large meteors penetrate deeper into the Earth's atmosphere stresses and pressures increase often causing the bolide to explosively fragment. This fragmentation may occur as a single large event (terminal burst) or as a cascading series of smaller explosions. Acoustic waves produced by these explosions can and have been recorded by nearby seismometers [1, 2]. Using acoustic wave arrival times and ray tracing, the position of these explosions, or supracenters can be found in four dimensions (3 spatial + 1 temporal). The process is analogous to earthquake location, but is complicated by atmospheric winds that can reach significant fractions (≤20%) of local sound velocities in the upper atmosphere. SUPRACENTER, a new computer program, has been designed specifically to locate these explosive events in a moving and stratified atmosphere.

The SUPRACENTER Program: Designed as a series of command functions for Matlab, SUPRACENTER includes several types of fitting, weighting and residual options. ASCII text files are used for input of seismic station coordinates, arrival times and custom model atmospheres. In the absence of a custom atmosphere the 1978 U.S. Standard Atmosphere is used.

Morávka Meteorite Fireball: Although SUPRACENTER has demonstrated its ability to locate individual terminal bursts [3], it is also capable of determining a fireball's trajectory and velocity. The recent fall of the Morávka meteorite [4] and the seismic detection of several of its fragmentations [5], have provided the opportunity to test this ability. Using (1) the model atmosphere of Brown et al. [6] for the Morávka region (2) the arrival times as identified by Borovička and Kalenda [5], and (3) the satellite observed time of 11:51:52.5 UT, SUPRACENTER located the positions of 6 fragmentations along the fireball's trajectory.

Overall positions were in good agreement with those of [5], yet lay consistently south of their solutions, most notably event K which was repositioned ~1.5 km to the southwest. These differences are due to the simpler, but less accurate, isotropic atmosphere and wind adjustments used by [5]. All fragmentation solutions exhibited very low traveltime residuals with mean absolute values ranging between 0.17 and 0.43 seconds. Comparison of SUPRACENTER's solutions from the perspective of the Kunovice video shows improved alignment with the recorded fireball fragment trajectories. Fitting a trajectory to the repositioned fragmentations gives an azimuth of 171.8^{o}, elevation angle of 18.9^{o} and a fireball velocity of 22.1 km/s. These values are similar (within 2-4 degrees & 0.5 km/s) to those derived for the fireball through video analysis [4].

Conclusions: When the acoustic arrivals of several explosive fragmentations from a fireball are recorded by seismometers, both the trajectory and velocity of the fireball can be accurately determined by locating the supracenters of individual fragmentations.

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