MULTI-TECHNIQUE REGISTRATION OF ROMANIAN SUPERBOLIDE

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Introduction: Superbolides, i.e. extremely bright meteors produced by entries of meter-sized bodies into terrestrial atmosphere occurs roughly 10-20 times per year over the globe, i.e. are rare events. The majority of observational data for superbolides consist of fireball detections reported from US Government sensors (USG), which provide limited information (mainly irradiated energy, altitude of maximal luminosity and entry velocity for smaller part of the events). Less than two dozen of these events were recorded by groundbased observations.

Infrasound signals of fireballs are usually recorded by professional equipment at great distances (in far zone) after waveguide propagation. Measurements of weak shock waves in the direct propagation zone would enable us both to estimate the parameters of the cosmic body and to study the processes of generation and propagation of infrasonic signals. A comparison of the acoustic and seismic signals, generated by the bolide, provides possibility to estimate poorly known efficiency of seismic waves excitation.

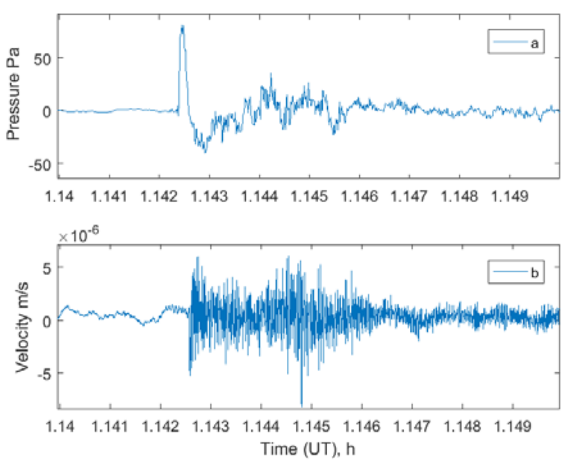

Figure 1. Examples of acoustic (a) and seismic (b) signals produced by the Romanian bolide.

Romanian superbolide: Optical observational data on Romanian superbolide (January 7, 2015) include optical and radiometric records obtained by the European Fireball Network (EN), casual video records from Romania and USG data [1]. The strong infrasonic signals generated by the superbolide were detected by the IPLOR (Plostina infrasound array) array microbarometers, and corresponding seismic signals were recorded by the Romanian Seismic Network (operated by NIEP). It is important to mention here that the main energy deposition took place almost above the area where the IPLOR station is deployed, i.e. the signal was recorded in the area of direct propagation, which is rare. The infrasound signal was also detected by three CTBTO infrasound stations in Germany (I26DE), Russia (I43RU) and Kazakhstan (I31KZ) at large distances.

Analysis of optical data provided the trajectory, the entry velocity, and the light curve [1]. The meteoroid entered the atmosphere at 27.76 km/s at an angle of 43^0 to the horizon. The maximum energy release (maximum luminosity) was observed at an altitude of 42.8 km, the length of the luminous trajectory was ~ 70 km. There is N-wave type of signal on the infrasonic records (Fig.1), which is produced by main conical shock wave arrival. The overpressure amplitude was ~50 Pa, much larger than overpressures routinely observed for small meteors due to large kinetic energy of the event. There are no evident additional arrivals which could be expected due to severe fragmentation of the body, although the noisy train after main arrival still need to be explained.

The analysis of infrasound signals in the direct propagation zone allowed us to determine the location of the source of the signal (i.e. the corresponding part of the trajectory). The source was situated at the end of the luminous trajectory and the signal propagated perpendicularily to it, the altitude of the source was found 8 km lower than the trajectory perhaps because the real atmospheric conditions were not taken into account. The relation between the amplitude of the overpressure and the energy of the source was suggested, which allowed to estimate the energy of the event. The analysis of the seismic records gave possibility to estimate the position of the seismic source and the efficiency of acoustic-seismic coupling. The analysis of the infrasound signals in far zone permited to estimate the energy of the meteoroid.

Summary: Different approaches were used to estimate meteoroid energy based on available optical and infrasound data. Independent estimates of meteoroid energy spreads from 0.1 up to 0.95 kt, the value of 0.3-0.4 kt seems to be the most probable. The combination of different observational methods allows to get more reliable results.

References: [1] Borovicka J. et al. (2017) *Planetary and Space Science* 143, 147-158.