The Chelyabinsk airburst shockwave

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The Chelyabinsk airburst of 15 February 2013 was exceptional because of the large kinetic energy of the impacting body and because the airburst that was generated created significant damage and injuries in a densely populated area. The butterfly-shape of the damaged area (Popova et al., 2013) is explained from the fact that the energy was deposited over a range of altitudes. Some uncertainty remains about the source energy of the airburst, because it is not known precisely at what pressure glass is expected to break. Reasonable results were obtained for energies of 300–520 kt TNT and over pressures of 500–1000 Pa, assuming that the time dependence of the energy release followed the meteor lightcurve (Popova et al. 2013).

Additional information about the airburst characteristics may be extracted from the arrival times of the shockwave at various locations and from pressure records. Arrival times of the shock wave were derived from video observations. From the analysis of these shock wave arrival times, a range of altitudes of energy deposition was derived (Popova et al. 2013). The observed arrival times were compared with model estimates, taking into account the real wind and atmospheric conditions. Results of the numerical simulations were compared with recorded sound signals, which were often quite complex. Borovicka et al. (2013) suggested that subsequent acoustic arrivals corresponded to separate fragmentation events. This hypothesis is tested.

There were no instrumental records of overpressure in the damaged area. However, seismic records exist from locations surrounding a coal mine at Korkino, situated in the damage area close to the meteoroid trajectory, almost immediately below the region of highest energy deposition. Its seismic control system to monitor land slides recorded the blast wave from the meteoroid entry indirectly due to coupling to the ground. This is the only instrumental record of the airburst close to the meteoroid trajectory. An analysis of these records and a comparison with numerical simulations will be presented.

References: Borovicka J., Spurny P., Brown P. et al. 2013, Nature 503, 235–237; Popova O., Jenniskens P., Emel'yanenko V. et al. 2013, Science, 342, 1069–1073.