The 2013 Chelyabinsk Airburst Event

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ABSTRACT:
On Feb. 15, 2013, a small asteroid exploded about 40 km to the south of the Russian city of Chelyabinsk. Its proximity to a population center led to many injuries and widespread blast damage, but also yielded a plethora of serendipitous data in the form of video footage from security and dashboard cameras. Combined with seismic, infrasound, and satellite records, this data provides a rich and multi-faceted means to determine the projectile size and entry parameters, and develop a self-consistent model of the airburst.

The best estimate of the kinetic yield (explosive energy) is 400-500 kilotons, making Chelyabinsk the most powerful such event observed since the 1908 Tunguska explosion (3-5 megatons). Analysis of video combined with subsequent on-site stellar calibrations enable precise estimates of entry velocity (19 km/s), angle (17° elevation) and altitude of peak brightness (29 km). This implies a pre-entry diameter of ~ 20 m and mass of ~12,000 tonnes.

Hydrodynamic models can now be initialized with extremely accurate energy depositions at correct locations, and results can be compared to observations used to validate the models and better understand the physical phenomena associated with airbursts. According to observation-based size/frequency curves, Chelyabinsk is approximately a once-per-century event, Tunguska is about once-per-millennium. These two outliers suggest that the curves underestimate the frequency of large airbursts. Models suggest that they are more damaging than nuclear explosions of the same yield (traditionally used to estimate impact risk). The risk from airbursts is therefore greater than previously thought.

BIO:
Mark Boslough has been a Member of the Technical Staff at Sandia National Laboratories since 1983. He is also an adjunct professor in the Earth and Planetary Sciences department at the University of New Mexico. He received his BS in physics from Colorado State University in 1977, and his MS and PhD in applied physics from Caltech in 1978 and 1983, respectively under the guidance of Prof. Tom Ahrens. In 1994 he was a member of a team that gained international recognition for using a supercomputer to correctly predict the effects of the impact of Comet Shoemaker-Levy 9 on Jupiter. His research has been featured in National Geographic, Scientific American, Time Magazine, the New York Times, and many other magazines and newspapers. His honors include CSU Distinguished Alumnus and Fellow of the Committee for Skeptical Inquiry. Asteroid 2003 MB1 “73520 Boslough” was named in recognition of his contributions.

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