Refinement of Bolide Characteristics from Infrasound measurements

N. Gi (1), P. Brown (2)

(1) Department of Earth Sciences, University of Western Ontario, London, Ontario, Canada (ngi@uwo.ca)
(2) Department of Physics and Astronomy, University of Western Ontario, London, Ontario, Canada

The characteristics of bolides produced by meter-sized and larger near-Earth objects (NEOs) impacting the Earth offer a window into the structure and strength of small NEOs. Fragmentation behavior, energy deposition with height and total energy yield when correlated with pre-atmospheric orbits may be used to broaden our understanding of the physical properties, structure, and characteristics of small near-Earth asteroids (NEA) both individually and as a population. With the development of the International Monitoring System (IMS) in the late 1990s as part of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO), infrasound stations have been continuously collecting low frequency sound for more than a decade. Infrasound is ideal for remote sensing of bolides as such low frequency acoustic waves do not suffer significant attenuation over long distances, making detection and characterization of bolides at long ranges possible.

Previous works [1,2] have particularly focused on empirical determination of bolide kinetic energy. These works have either been based on extrapolation of ground-level explosions or comparison between infrasound and satellite measurements [2]. When applied to bolides, these empirical period and amplitude estimates may sometimes vary by a factor of several from independent estimates such as those provided by US government sensors [3]. A possible reason for these discrepancies may be the role of secondary bolide characteristics such as height, speed and entry angle in modifying infrasound period and amplitude detected at a particular station. As of mid-2013, the NASA Jet Propulsion Laboratory (JPL) fireball data [3] provides the ground-truth secondary characteristics of bolides, which permits examination of the role these factors play in modifying the apparent infrasound energy estimates.

This study examines the infrasonic signals produced by bolides and aims to find the correlation between measured infrasound parameters at IMS stations (dominant signal period, amplitude, and total acoustic energy) and bolide secondary characteristics (height of burst, entry angle, and speed) using data from [3] as ground-truth estimates. In particular, this study explores how the bolide burst height affects infrasonic energy estimates to develop better empirical algorithms to improve the accuracy of bolide kinetic energy.

References

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