Global Detection and Flux of Superbolides

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Superbolides are defined [1] as fireballs with peak absolute magnitude in excess of 100 times that of the full moon, namely M > -17. The size of such objects is typically meter-scale and correspond to airbursts having total energies of ~0.1 kilotons of TNT equivalent explosive yield. Influx estimates suggest the global frequency of superbolides is approximately one impact per 1-2 weeks [2]. As a result, global monitoring is required to detect such impacts. For comparison, it is expected that any one camera location on Earth will only record a superbolide under clear, dark skies once every few decades [3].

Detection of superbolides is important as many of the instrumentally observed fireballs producing meteorites are derived from the superbolide population [4] and hence we expect many superbolides to be meteorite producers. Additionally, the ablation behavior of large events provides direct evidence for the strength and structure of small Near Earth Objects (NEOs), which is important for both planetary defence [5] and in unravelling the origins of small NEOs [6].

While ground-based networks have provided the highest fidelity information on the ablation of a few superbolides [7], statistical information is becoming available from US government sensor (USG) releases [8] and detections by the International Monitoring System (IMS) of the Comprehensive Test-Ban Treaty Organization [9]. Several superbolides have either been directly [10] or their dust clouds indirectly detected [11] by earth orbiting satellites.

Data from US Government sensor detections, in particular, has provided orbits, total optical release and height of peak brightness for over 100 events, allowing the first coarse population study in this size range [3]. Seismic and infrasound networks have recorded several dozen superbolides [12,13] but with less ancillary information per event than from USG data. In principle, the hydroacoustic network operated by the IMS should be capable of detecting airbursts, provided acoustic energy can be coupled into the SOFAR (sound fixing and ranging) channel in the ocean. No positive hydroacoustic detections of airbursts have been published to date.

In this talk a summary of possible recent hydroacoustic superbolide detections from the IMS Reviewed Event Bulletins (REBs) will be presented and discussed. Benefits and limitations of seismic and infrasound superbolide measurements will be explored and the future of detections using new techniques discussed. The physical and orbital properties of superbolides from USG data will be presented and interpreted. Finally, a compilation of flux measurements from all techniques will be compared to estimate the best current energy-frequency distribution curve for meter-scale impactors at Earth.

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