COORDINATING SATELLITE BOLIDE DETECTION IN THE VISIBLE AND INFRARED WITH COLLECTION OF DUST IN THE STRATOSPHERE

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NASA has now been collecting, curating and distributing dust collected in the stratosphere for more than 15 years. This has been a hit or miss affair. The planes, now WB57 and ER-2 aircraft, are sent up at essentially random times and at random places, from the point of view of the dust sources. The presumption is that by the time extraterrestrial dust has settled though the atmosphere down to the lower stratosphere, where it is collected at 20 km altitude, the source populations have been mixed and original source information has been largely lost.

The stratospheric dust collection program has always accepted the possibility that specific bolide clouds could be sampled, provided that (1) prompt notification of the program supervisor (MEZ) could occur, (2) a plane was available, and (3) the plane was in the vicinity of the reported bolide. Factor 1 has always been lacking, and factors 2 and 3 are somewhat probabilistic in nature. Fortunately, this situation may now be changing.

It is desirable to examine bolide dust for a number of reasons. First, this would give us more data on the atmospheric ablation process. It would also provide the identity of the bolide bodies, which almost never provide recovered meteorites. To date only five meteorites with precise pre-atmospheric orbits have been recovered. Finally, analysis of recovered bolide dust will provide "ground" truth, driving a vast improvement in the calibration of satellite visual data with asteroid physical properties.

The US has since August 1972 been observing the Earth's surface from satellite platforms using visible to infrared (IR) detection systems. The primary purpose of these "capabilities" has been the verification of nuclear test treaties. In the intervening years to March 1996 a total of 262 detections of probable bolides (small asteroids and/or comets entering the atmosphere) have been made. There have been 23 visible-only detections, 212 IR-only detections, and 27 detections by both visible and IR systems. The largest up to March 1996 was over the Marshall Islands on Feb 1, 1994. This bolide was estimated at a 50-70 Kt pre-entry energy; evidence suggests that this was a 5-20 m diameter asteroid traveling at 25 km/s.

We have now compared the listing of detected bolides with the history of NASA stratospheric collection efforts. We have identified one bolide that may have serendipitously been sampled in the course of a series of flights of our conventional collection surfaces *plus* four Large Area Collectors (LAC) flying on an ER-2 aircraft. This was an especially bright bolide observed over Colorado Springs, CO, on the night of Nov. 21, 1995. One week later we were collecting stratospheric dust west of the observation location. Considering that it can take up to several weeks for fine dust to fall from the higher altitude at which this bolide was observed to the

collection altitude, the week delay was just about right. Unfortunately, meteorological data indicate that the bolide dust should have been drifting eastward, rather than westward, during this period. Still it is possible that samples from higher altitude ablation were collected, since the bolide was entering from the west-north-west and passed over the collection area before passing Colorado Springs. We are now examining the pertinent collector plates to determine whether they appear out of the ordinary. We have not, however, removed any samples for analysis. The collectors are U2085, U2086, and L2037 to L2040. They are available for allocation in whole and/or in part.

In the past the satellite observations of the Earth has been rather spotty, with detections being made on a relatively ad hoc basis. In the near future the satellite observation will be made continuous in time and aerial coverage extended worldwide. These observations obviously permit the time and location of the bolide to be calculated with sufficient accuracy to warrant sending a plane to investigate. Efforts are now being made to permit the timely notification of NASA when these satellite systems detect a new bolide, which should finally close a critical loop.

More recently, several (a swarm?) bright bolides entered Earth's atmosphere over the US the night on October 3-4, 1996. These bodies (probably 3-5 in number, but possibly higher) were detected by satellite IR sensors as well as visually from the ground and by infrasonic detectors. As it happens we were sampling intermittently using LACs between September 26 and October 11, 1996. We have examined all four LACs, and detected nothing unusual visually, but the particles captured on these collectors certainly deserve closer inspection. Since these collectors had only sampled for about half of the time we generally like to see, we sent three of them (L2041, L2043, L2044) back to the ER-2 for additional collection time. However, we have retained collector L2042 as received after October 11. It is available for characterization.

With timely notification, it should be possible in the near future to deliberately sample the dust cloud from specific bright bolides, adding a new dimension to the study of extraterrestrial bodies.

Reference: [1] Tagliaferri et al. (1994) In *Hazards Due to Comets and Asteroids.* (Gehrels T. ed.) pp. 199-220.