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TSUNAMI FROM PLUME-FORMING COLLISIONAL AIRBURSTS

Mark Boslough[1] and Galen Gisler[2]
[1] *Sandia National Laboratories, PO Box 5800, Albuquerque, NM 87185*
505-845-8851, mbboslo2@sandia.gov
[2] *Physics of Geological Processes, University of Oslo, PO Box 1048 Blindern, 0316 Oslo, Norway, 505 920 2722, galen.gisler@fys.uio.no*

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ABSTRACT

Hydrocode-based models of the 1908 Tunguska explosion suggest that it was a plume-forming impact, analogous to the 1994 collisions of Comet Shoemaker-Levy 9 fragments on Jupiter. Prior to the first hydrocode simulations of the Tunguska explosion (Boslough and Crawford, 1997) it had typically been modeled as a point source. Equivalent explosive yield estimates were based on this approximation, and were derived from seismic records, barograms, and measurements of fallen trees. These estimates were calibrated with nuclear weapons effects data, effectively neglecting the directionality, mass, and momentum associated with a the asteroid. The point-source approximation, combined with other simplifications, led to significant overestimates of the Tunguska yield.

One of the most widely-accepted point-source estimates of the Tunguska yield was that of Ben-Menahem (1975), who used records from four seismic stations and compared them to modern records associated with Soviet and Chinese nuclear tests. He concluded that the ground motion resulted from a vertical point impulse of 7 x 10^{18} dyn sec, which would be generated by a nuclear explosion with a 12.5 megaton yield at an altitude of 8.5 km. However, simulations of a 3-megaton collisional airburst by Boslough and Crawford (1997) show that within the first minute of impact, the upward-directed momentum associated with the atmospheric plume reaches 7 x 10^{18} dyn sec. The reaction impulse from a 3 megaton collisional airburst is therefore similar to that of a 12.5 megaton nuclear explosion. This momentum is coupled through the atmosphere to the surface, so its seismic signal gives it the appearance of being a larger explosion than it actually was.

We suggest that a similar enhanced long-period momentum coupling from an over-water airburst as a possible third impact-induced tsunami source mechanism (in addition to the transient cavity and airblast-driven wave generation). As the atmospheric plume accelerates upward, it generates sustained high pressure at the surface, creating a long-period source function that displaces the water downward and radially outward from the epicenter. We will present preliminary results from numerical simulations to test this idea and find out if there are conditions under which it may be a significant contributor to airburst-generated tsunami.

References

Ben-Menahem, A. 1975. Source parameters of the Siberian explosion of June 30, 1908, from analysis and synthesis of seismic signals at four stations. Phys. Earth Planet. Inter. 11:1-35.

Boslough, M. and D. Crawford. 1997. Shoemaker-Levy 9 and Plume-Forming Collisions on Earth. Near-Earth Objects: Annals of the New York Academy of Sciences. 822:236-282.

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