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AIRBURST CONSEQUENCE MODELING USING ARTIFICIAL ABLATION

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ABSTRACT

Tunguska-like collisional airbursts dominate the short-term impact risk due to their sheer numbers, the large fraction that remain undiscovered, and the fact that airbursts do more damage per unit mass over a larger area than surface bursts or cratering events. Relative to larger objects, Tunguska-class objects are the least likely to be discovered with sufficient time to take preventive action, and are the most likely to strike the Earth with no warning at all. The next NEO disaster on Earth will almost certainly be an airburst. Risk quantification for small objects remains a high-priority activity in planetary defense.

Quantifying the NEO risk for small objects requires a detailed modeling capability and understanding of how energy is coupled from the explosion to the atmospheric blast wave that is the primary mechanism for airburst damage. Entry models that include ablation, drag, and fragmentation are widely used to estimate the energy deposition profile, which is often defined as the energy lost from the solid asteroid per unit altitude, as a function of altitude. Hydrocode models are initialized with this energy deposition profile, on the assumption that the energy lost from the object is instantaneously deposited into the atmosphere at that altitude. This assumption is not warranted, because a large fraction of the kinetic energy lost from the solid

object remains in the ablated portion and is entrained into the wake to be dissipated and coupled into the atmospheric shock wave at much lower altitude. An alternative method of using calculated energy deposition profiles to drive hydrocode simulations is to artificially ablate the object in a way that removes the appropriate quantity of kinetic energy as a function of altitude, but allows the hydrocode itself to model the coupling to the blast wave that causes damage at the surface. This method can generate very different damage maps than traditional energy deposition sourcing, and therefore a very different risk estimate.

Comments:

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