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Problems with the Younger Dryas Boundary (YDB) Impact Hypothesis

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One breakthrough of 20th-century Earth science was the recognition of impacts as an important geologic process. The most obvious result is a crater. There are more than 170 confirmed terrestrial impact structures with a non-uniform spatial distribution suggesting more to be found. Many have been erased by tectonics and erosion. Deep water impacts do not form craters, and craters in ice sheets disappear when the ice melts. There is growing speculation that such hidden impacts have caused frequent major environmental events of the Holocene, but this is inconsistent with the astronomically-constrained population of Earth-crossing asteroids.

Impacts can have consequences much more significant than excavation of a crater. The K/T boundary mass extinction is attributed to the environmental effects of a major impact, and some researchers argue that other extinctions, abrupt climate changes, and even civilization collapses have resulted from impacts. Nuclear winter models suggest that 2-km diameter asteroids exceed a "global catastrophe threshold" by injecting sufficient dust into the stratosphere to cause short-term climate changes, but would not necessarily collapse most natural ecosystems or cause mass extinctions. Globally-catastrophic impacts recur on timescales of about one million years.

The 1994 collision of Comet Shoemaker-Levy 9 with Jupiter led us recognize the significance of terrestrial airbursts caused by objects exploding violently in Earth's atmosphere. We have invoked airbursts to explain rare forms of non-volcanic glasses and melts by using high-resolution computational models to improve our understanding of atmospheric explosions, and have suggested that multiple airbursts from fragmented impactors could be responsible for regional effects.

Our models have been cited in support of the widely-publicized YDB impact hypothesis. Proponents claim that a broken comet exploded over North America, with some fragments cratering the Laurentide Ice Sheet. They suggest an abrupt climate change caused by impact-triggered meltwater forcing, along with massive wildfires, resulted in megafaunal extinctions and collapse of the Clovis culture.

We argue that the physics of fragmentation, dispersion, and airburst is not consistent with the hypothesis; that observations are no more compatible with impact than with other causes; and that the probability of the scenario is effectively nil. Moreover, millennial-scale climate events are far more frequent than catastrophic impacts, and pose a much greater threat to humanity.

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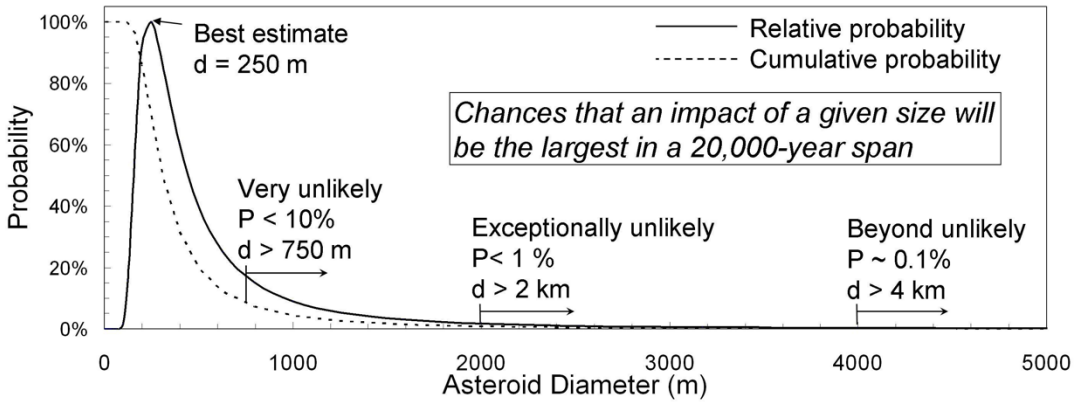

Probability density for largest asteroid impact since Last Glacial Maximum based on power-law size distribution. Comets are orders of magnitude less likely. Grazing trajectory or recent fragmentation further reduces probability.