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Topic: Impact Effects & Consequences

ASTEROID IMPACT RISK ACROSS TRANSITIONAL HAZARD REGIMES

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ABSTRACT

Asteroid impacts can cause a wide range of damage through multiple potential hazards, from localized blast waves or thermal radiation, to tsunami inundation, to global climatic effects. The level of risk posed by these hazards depends not only upon their extent and severity, but also upon the likelihood of the various damage ranges. Some consequences may be more moderate but very likely, while others may be unlikely but catastrophic. Evaluating the risk from these hazards involves substantial uncertainties across all aspects of the problem, including the properties of the asteroid itself, the specifics of its entry, and the complex high-energy damage physics involved. NASA's Asteroid Threat Assessment Project performs Probabilistic Asteroid Impact Risk (PAIR) assessments that use fast-running entry and hazard models to evaluate millions of impact cases representing the distributions of these many uncertain parameters.

Most previous asteroid impact exercise scenarios and damage simulation studies have focused on the more likely smaller and moderate asteroid sizes, for which local blast damage is the primary hazard. Larger impactor sizes such as those in the current 2023 PDC hypothetical asteroid impact scenario, however, bridge across the transitional regimes where larger regional and global hazards also become driving concerns, and where the scale of damage pushes the bounds of current modeling and simulation tools. Prior assessments of aggregate impact risks from the general asteroid population have indicated that global effects drive long-term average risk levels despite the rarity of such events, while average tsunami risks are relatively low despite the likelihood of ocean impacts. When considering a specific impact threat, however, the significance of each potential hazard depends greatly on the specific

asteroid properties or impact factors at hand. Some of these factors could be refined as observational information is gained, while others remain inherently unknown or poorly constrained.

In this study, we provide a more in-depth look at hazard risk modeling factors for asteroids in the transitional size regime of the 2023 PDC hypothetical impact exercise scenario. We use our PAIR model to evaluate which hazards are likely to drive the greatest damage and risk across the potential impactor sizes, and investigate key sensitivities and uncertainties at play in current risk modeling results. Initial assessment of the first epoch of the PDC scenario shows significant average risks from all primary hazards (local blast and thermal ground damage, tsunami, global effects), along with wide damage uncertainty ranges (from minor to catastrophic) across the possible impact sizes and locations. We compare how much remote or mission-based observational refinements to the asteroid properties could constrain risk estimates throughout the scenario. We will also consider where current damage modeling uncertainties may affect risk estimates in a notable way beyond the uncertainties in the asteroid properties or impact location. These assessments aim to help inform what further simulation studies or model developments may be most valuable for improving risk assessments, and what ground-based or mission-based observational data could be most critical to supporting effective response decisions.

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Comments:

Oral presentation preferred, poster ok