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HIGH-FIDELITY BLAST MODELING OF IMPACT FROM HYPOTHETICAL ASTEROID 2021 PDC

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ABSTRACT

The PDC 2021 hypothetical impact exercise poses an interesting challenge to traditional threat assessment methods since it combines a potentially large impactor with minimal warning time. With large uncertainty in the early observational data, this case presents a particular problem for high-fidelity simulation techniques since many of the key input parameters are simply unknown. In this work, we show how recent advances in Bayesian inference and probabilistic risk assessment can be used to develop specific impactors that facilitate high-fidelity simulation in spite of the early uncertainty (Dotson, 2017; Wheeler, 2020; Mathias, 2017)

Using only information released in the PDC 2021 “Day 0” scenario (JPL CNEOS, 2021), the approach uses Bayesian inference to develop a model of asteroid characteristics (taxonomy, density, etc.). These are combined with entry parameter maps from Monte Carlo simulations and statistical analysis to develop probability distributions of likely entry characteristics. To spawn specific cases for simulation, the mean and median energies of these entries were used to develop self-consistent impactors with asteroid properties informed by the Bayesian distributions. These properties and entry characteristics were then used to develop specific profiles for

deposition of energy, mass and momentum with the FCM entry code (Wheeler, 2017). These profiles were then used as inputs for high fidelity blast propagation simulations using NASA's Cart3D simulation package (Aftosmis, 2016).

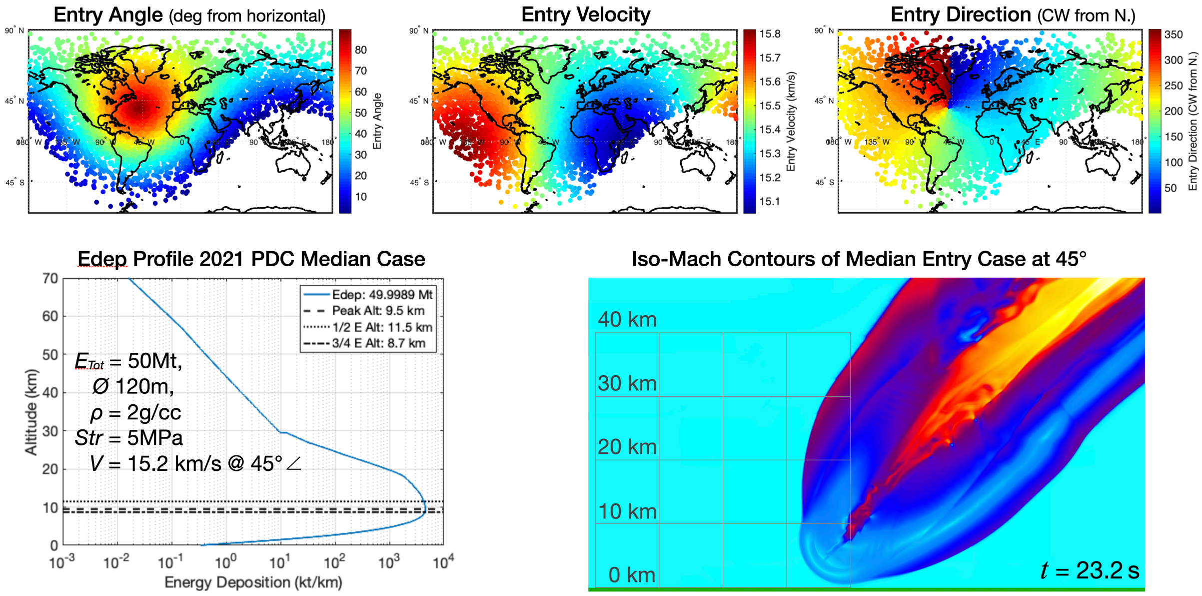

Figure 1. *(upper) Entry angle, velocity and direction for hypothetical asteroid 2021 PDC. (lower) Energy deposition profile for 50 MT median case with 120m diameter & blast propagation from high-fidelity simulation used to compute ground overpressure footprint.*

Probabilistic risk assessment for 2021 PDC was used to develop maps of mean ground damage radii and affected population (Wheeler *et al.* 2020). These maps were used to select a nominal entry angle of 45° for the simulations at both the median (50 Mt) and mean (250 Mt) energies (pre-entry kinetic energy). The footprint eccentricity model (Aftosmis *et al.*, 2019) allows generalization of footprints computed at this entry angle to provide likely damage footprints at other impact locations. In the final paper, damage radii from the high-fidelity simulations will be compared to those from NASA's fast-running risk assessment tool.

Comments: (Oral or Poster) Prefer Oral, but Poster is also OK.

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