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HIGH-FIDELITY BLAST PROPAGATION MODELING FOR HYPOTHETICAL ASTEROID 2023 PDC

Michael Aftosmis[1], **Wade Spurlock**[2], **Jonathan Chiew**[3], **Lorien Wheeler**[4] **and Jessie Dotson**[5]
[1][3][4][5]*NASA Ames Research Center, Mail Stop 258-5, Moffett Field CA 94035*
[2]*Science & Technology Corp. NASA ARC, Mail Stop 258-5, Moffett Field CA 94035*
+1.650.604.4499, michael.aftosmis@nasa.gov

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ABSTRACT

The PDC 2023 hypothetical impact exercise poses an interesting challenge to traditional threat assessment methods since it presents a larger impactor with wider uncertainty than most recent exercises. In this work we examine blast propagation and hazards presented by a specific impactor of this class. We use recent advances in Bayesian inference and probabilistic risk assessment to develop specific impactors that facilitate high-fidelity simulation despite the uncertainty in the early scenario (Dotson, 2017; Wheeler, 2022; Mathias, 2017).

Using information released in the PDC 2023 “Epoch 1” scenario (JPL CNEOS, 2023), the approach uses Bayesian inference to develop a model of asteroid characteristics (e.g. taxonomy, density). These are combined with entry parameter maps from Monte Carlo simulations and statistical analysis to develop probability distributions of likely entry characteristics. Case selection focuses on the larger end of the “most likely” range since these cases are potentially more hazardous. We develop specific impactors with self-consistent properties informed by Bayesian inference. Entry parameter maps were used to select a nominal entry angle of 54° for the simulations for an impactor carrying 10.3 gigatons of total energy. These properties and entry characteristics were then used to develop specific profiles for deposition of energy, mass and momentum with the Fragment-Cloud Model (FCM) entry code (Wheeler, 2017).

FCM provides entry profiles used as inputs for high fidelity entry and blast propagation simulations using NASA’s Cart3D simulation package (Aftosmis, 2016). Large unsteady simulations were performed on meshes of up to 200M cells on

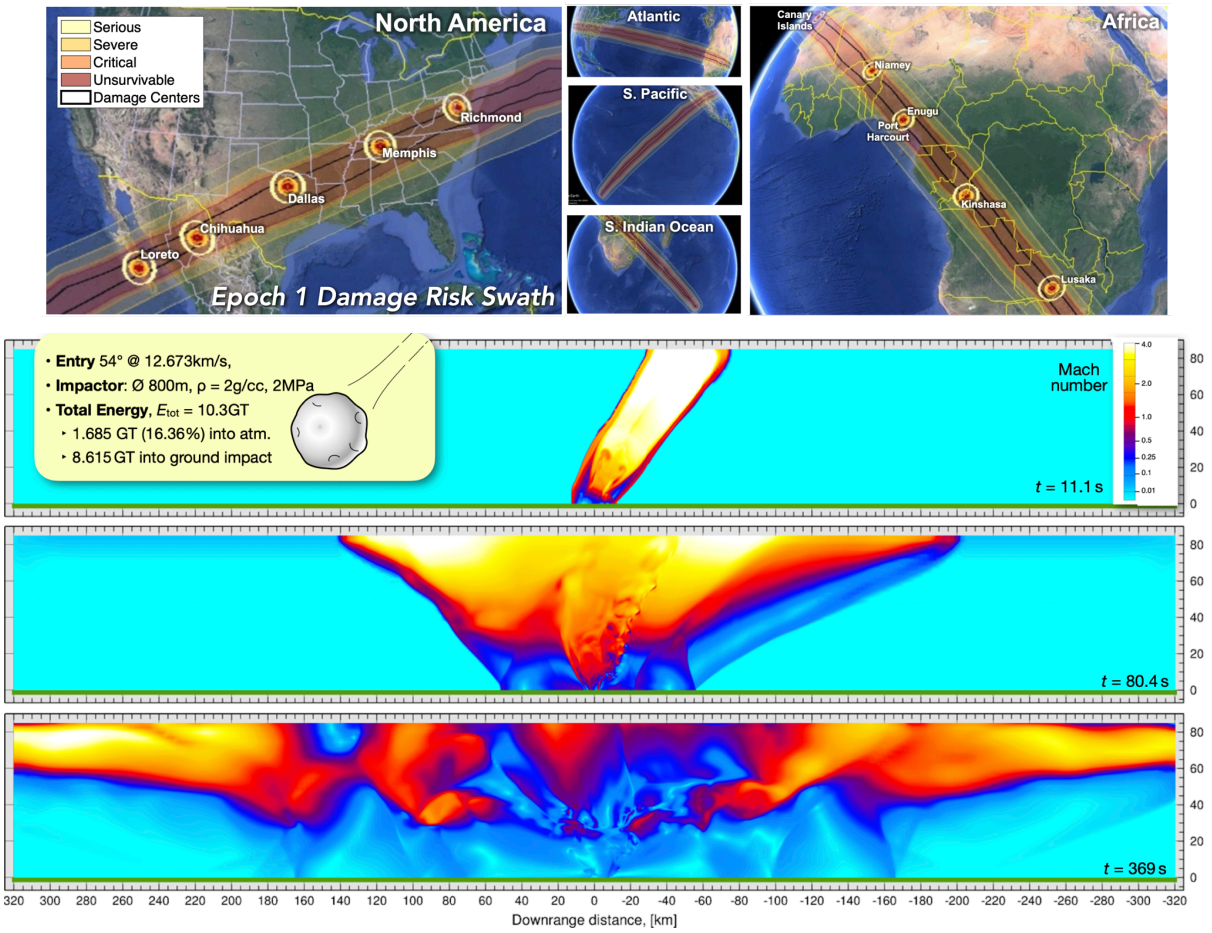

Figure 1. *(upper) Epoch 1 Damage Risk Swath for hypothetical asteroid 2023 PDC. (lower) Preliminary high-fidelity 3D simulation of entry, impact & blast propagation for an Ø800m impactor with 10.3GT of total energy computed on 16,000 compute cores using Cart3D.*

domains that extended 640 km both down- and crossrange. Probabilistic risk assessment for 2023 PDC was used to develop estimates of mean ground damage radii and affected population (Wheeler *et al.* 2022). In the final paper, damage radii from the high-fidelity simulations will be compared to those from NASA's fast-running risk assessment tool (Mathias, 2017).

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

REFERENCES

https://cneos.jpl.nasa.gov/pd/cs/pdc23/ "Planetary Defense Conference Exercise - 2023" Center for Near Earth Object Studies, JPL, accessed Dec. 2022.

Dotson, Mathias, Wheeler, Wooden, Bryson and Ostrowski, "Near Earth Asteroid Characterization for Threat Assessment", *IAA-PDC-17-03-14*, May 2017

Wheeler, L., Dotson, J., Aftosmis, M., Stern, E., Mathias, D. and Chodas, P., "Probabilistic Asteroid Impact Risk Assessment 2023 PDC Hypothetical Impact Exercise Scenario Epoch 1", April 2022.

Wheeler, L., Register, P., Mathias, D., A fragment-cloud model for asteroid breakup and atmospheric energy deposition, *Icarus* **295**:149–169, 2017

Aftosmis, M. Nemec, M., Mathias, D., and Berger, M., "Numerical simulation of bolide entry with ground footprint prediction," *AIAA Paper 2016-0998*, Jan. 2016.

Mathias, D., Wheeler, L., Dotson J., 2017. A probabilistic asteroid impact risk model: assessment of sub-300m impacts. *Icarus* **289:**106–119. 2017.