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Ongoing and Upcoming Mission Highlights
Key International and Policy Developments
Near-Earth Object (NEO) Discovery
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➔ **Impact Effects & Consequences**
Disaster Management & Impact Response
Public Education and Communication
The Decision to Act: Political, Legal, Social, and Economic Aspects

ADVANCES IN ENTRY MODELING FOR IMPACT RISK ASSESSMENT

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ABSTRACT

A summary of recent advancements in the detailed modeling of asteroid atmospheric entry processes made through NASA's Asteroid Threat Assessment Project (ATAP) is presented. Understanding, and accurately modeling these processes and their associated uncertainties is critical to predicting all downstream impact effects, such as blast wave and thermal damage footprints. Furthermore, there is (perhaps thankfully) a dearth of empirical data for large impactors of the kind that would pose a threat to human populations, on which to anchor and/or validate models used in risk assessments. Therefore, we must rely heavily on detailed theoretical and numerical modeling to develop robust assessments for decision makers. To that end, ATAP has made some significant progress in advancing the capabilities in this area. Two areas in particular are highlighted in the present work: meteoroid ablation mechanisms, and bolide luminosity.

The first research area – meteoroid ablation mechanisms – has focused on performing novel high-enthalpy wind tunnel experiments on meteorites and meteorite

analogs, and utilizing the resulting data to develop high-fidelity models for impactor mass loss at scale. These efforts have resulted in several insights. Of note, these data suggest a differential vaporization process where volatiles are liberated preferentially when the asteroidal material is subject to high heat, while refractory components remain in the molten layer on the surface. A numerical model has been developed which considers this phenomena, and its effect on the bulk impactors effective heat of ablation is examined.

The second research thrust that is discussed is focused on accurate modeling of impactor radiation phenomena. While another submission to the conference will discuss the application of our approach to thermal ground damage modeling, here, we present an overview of our extensive efforts to utilize available ground- and space-based observations of large bolides (~1m diameter, and above) to inform and validate our detailed modeling approaches. These methods have been shown to accurately reconstruct the detailed spectra for the Benesov bolide, as well as approximate the burn footprint for the Tunguska event. Recent effort has focused on reconciling light curve data from multiple sources (all-sky camera networks, GLM, US government sensors), using our validated model, and providing a calibrated model for luminous efficiency which can then be utilized to infer impactor properties such as shape, mass, and composition. This work will be demonstrated through an exemplar case study focusing on a large bolide event with observational data (e.g. Chelyabinsk, Flensburg, etc.).

Finally, our team's assessment on the current maturity of atmospheric entry models, and priorities for future research will be provided.

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Comments:

Within Impact Effects & Consequences, this could fall under Analysis Tools, or Process of Atmospheric Break-up and Airbursts
No preference on timeslot
Oral presentation preferred