Overview of a New NASA Activity Focused on Planetary Defense

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**OBJECTIVE & APPROACH**

**OBJECTIVE:** Develop Predictive Impact Assessment tools to support decision makers in the event of discovery of an impact by a Potentially Hazardous Asteroid (PHA)

**APPROACH:** Characterize PHAs, modify NASA codes to conduct physics-based simulations of meteor entry/breakup, surface damage and bound associated risks

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**TASK 1: PHA CHARACTERIZATION**

- Collect physical properties of PHAs from literature and from in-house study of meteorites, ground-based observations, and eventually, in situ measurements.
- Focus on needs for simulation of entry/breakup, risk assessment and kinetic mitigation (impact and nuclear stand-off – collaboration with LLNL)
- Modeling of PHAs as they exist in the space environment

**TASK 2: ATMOSPHERIC ENTRY & BREAKUP**

- Modify re-entry codes: Flow solver (DPLR), Radiation solver (NEQAIR) for conditions up to 20 km/s and 300 bar stagnation pressures.
- Modify materials response codes FIAT and TITAN to account for meteor ablation; these codes are routinely used for entry capsule thermal protection system design
- Apply thermal-structural code MARC to fragmentation of meteors
- Expand input databases to account for meteor ablation species
- Develop models for fragmentation and ablation
- Modify “fast” engineering code (TRAJ) to capture results of high fidelity simulations along flight paths accounting in “real time” for ablation, shape change, fragmentation and ablation
- Validate simulations by comparison to observed meteor entries: light curves, decelerations, and deduced near-field energy deposition
- Validate by comparison to ground test results of re-entry capsule design approach, e.g., arcjet tests that mimic “physics” involved in meteor entry and comparison to pre-test predictions

**TASK 3: PROPAGATION OF NEAR-FIELD ENERGY DEPOSITION TO SURFACE**

- Modify NASA Flow Solver Cart3D to account for exponential atmosphere, hydrostatic equilibrium and subroutines to capture surface overpressures and wind profiles.
- Entry/breakup predictions from Task 2 used as basis for near-field energy deposition along the trajectory. Disturbance is propagated in the atmosphere with Cart3D
- Surface damage for land impacts based on Cart3D overpressures and winds. Outputs from Cart3D will be coupled to GEOLAW code and models of ocean topography to predict damage tsunami created by PHAs
- Future applications will include simulations of damage from crater formation and ejecta

**TASK 4: RISK ASSESSMENT**

- Compute propagation of the near field shock front to the far field accounting for transfer of mass, energy and momentum through the exponential atmosphere. Products are surface damage (land/tsunami)

See companion papers by:

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