Impact of NASA'S Entry Systems Modeling Project on Planetary Mission Design: VEXAG

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Rationale: Every mission that enters an atmosphere relies on specialized expertise and tools for entry system design.
We are the only cross-cutting Agency project serving this critical and NASA-unique function.

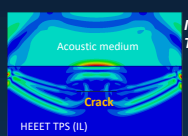
What is the Entry Systems Modeling Project?

Our mission is to develop high-impact computational models and conduct validation testing, driven by mission requirements, that can be delivered in 2-4 years to reduce mission risk and improve performance for Entry, Descent and Landing.

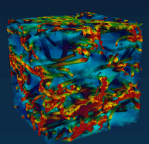
Focused research in four elements:

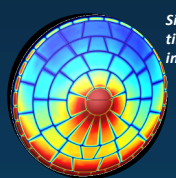
Predictive Materials Modeling

- Micro- to engineering-scale analysis tools
- Full 3-D material response and TPS sizing
- TPS reliability: How flaws and features turn into failures



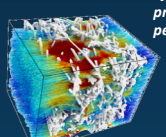
Identifying flaws inside TPS materials





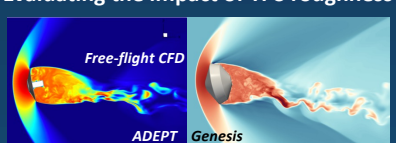
Simulated recession of tiled MSL heat shield including gap fillers

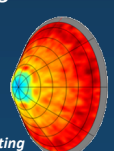
Microscale modeling of material properties and performance



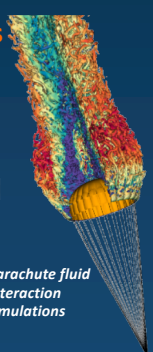
Computational and Experimental Aerosciences

- Simulating parachute inflation & dynamics
- Investigating vehicle dynamics using Free-Flight CFD and Magnetic Suspension Wind Tunnel
- Evaluating the impact of TPS roughness





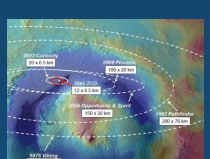
Heating augmentation from rough surfaces



Parachute fluid interaction simulations

Guidance, Navigation, and Control

- Improving tools and developing advanced guidance and control algorithms



Shock Layer Kinetics and Radiation

- Shock layer radiation databases and models for all solar system destinations
- Reduced TPS margins and mission risk

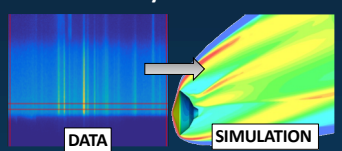
Electric Arc Shock Tube

Potential benefits for a Venus mission:

ESM could work with a Venus mission to retire risk through analysis, and provide state-of-the-art EDL tools:

Shock Layer Radiation

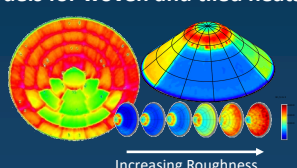
- Benchmark radiative heating data & codes
- Radiative heating & kinetic rate studies to reduce mission relevant uncertainty



Electric Arc Shock Tube data and CFD of flow around an aeroshell

Roughness Heating Augmentation

- Risk and margin reduction via tailored roughness heating models for woven and tiled heatshield designs.

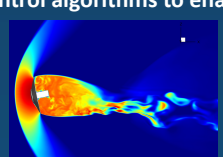


Augmented heat transfer measurements on ballistic range models

Entry Dynamics / Guidance & Control

- Capsule dynamic stability assessment
- Free-flight CFD augments ground tests and flight traceability
- Advanced guidance and control algorithms to enable aerocapture maneuvers.

Dynamic free-flight CFD solution of ADEPT



Advancing Woven TPS & Thermostructural Models

- 3-D material response of complicated geometry
- Advancing thermostructural and woven TPS models, including fracture and failure

Simulating woven TPS materials