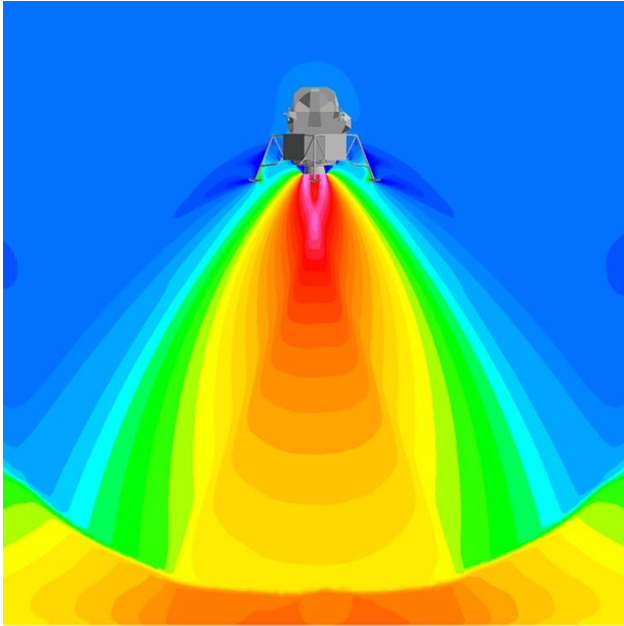


Thruster Plume-surface Modeling



Name of Technology:

Predict Plume-surface Interaction

Participating NASA Centers:

KSC (Lead); GSFC, JSC, LaRC,

Technological Area:

T7.01 Predictive Numerical Simulation of Rocket Exhaust Interactions with Soil

Vision for the Technology:

Lander design, surface operations and equipment are affected by the plume-surface interactions. NASA needs the ability to predict the effects of propulsive landing vehicles (i.e. induced plume), as a function of vehicle scale and configuration, and landing site characteristics.

Challenges:

Analysis from the limited Apollo mission photos/videos indicates huge regolith excavation rates. Current tools are unvalidated with test data from a relevant environment. Since the moon and Mars have different environments, the physics of plume-surface interaction will be different. Without a predictive plume tool, the lander's design may be over or under designed yielding unanticipated damage

to sensors, critical equipment, and nearby assets.

NASA Seeks to Meet the Following Specs:

Successful validation of models with ground test and flight data. Acceptable uncertainties vary with parameter; most are on the order of 25%.

The analysis tools need to predict:

- (1) Site alteration dimensions
- (2) Lander induced environments
- (3) Ejecta size, velocity, and distance

Overview of Student Project:

NASA seeks innovative image sensor technology solutions for situational awareness on long duration missions. Solutions may include new technologies as well as improving current with radiation protection.

Innovative Areas Student Projects Can Address:

- Develop predictive software tool
- Computational Fluid Dynamics modeling of plume
- Combining current CFD data along with gaming engines, such as [Unity](#), [Unreal](#), etc. for predictive modeling.

Project Phases

- I. Analytical critical analysis and characteristics
- II. Computational Predictive modeling

Research Funded by NASA on this Topic:

Proposal Number: 22-1- Z7.04-1934
[Wall Shear Measurement Technology for Plume Surface Interactions](#)

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Proposal Number: 22-1- Z7.04-1530
[Rapid Parametric Sensitivity Analysis for
Plume-Surface Interaction Simulations](#)

Proposal Number: 19-2- Z7.04-2726
[Measurement and Modeling of High Speed
Polydisperse Granular Flow Under
Plume/Surface Interaction Conditions](#)

Proposal Number: 18-2- T9.01-6552
[A Scalable Gas-Particle Flow Simulation Tool
for Lander Plume-Surface Interaction and
Debris Prediction](#)

References:

[T7.01 Predictive Numerical Simulation of
Rocket Exhaust Interactions with Soil](#)

[T6.02 Predictive Numerical Simulation of
Rocket Exhaust Interactions with Lunar Soil](#)

[Z7.04 Lander Systems Technologies \(2019\)](#)

[Z7.04 Landing Systems Technologies \(2022\)](#)

[NASA - Plume Surface Interaction \(PSI\)](#)

[The Science of Plume Effects](#)

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