Modeling & Simulation

SBIR/STTR (09.3/09.B) Topics

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M&S Research Area SBIR/STTR Topics

- **SBIR**
  - Effects of Hardbody-Plume Interactions on Radar Returns
  - Advanced Radiation Transport Models for Next Generation Rocket Exhaust Flowfield Processes
  - Plume EO-RCS Data Fusion
  - Creation of a Global UV-VIS-IR Ocean Background Model That is a Function of Time, Location and Sea State
  - Terahertz Signature Modeling for Kill Assessment and Warhead Materials Identification

Effects of Hardbody-Plume Interactions on Radar Returns

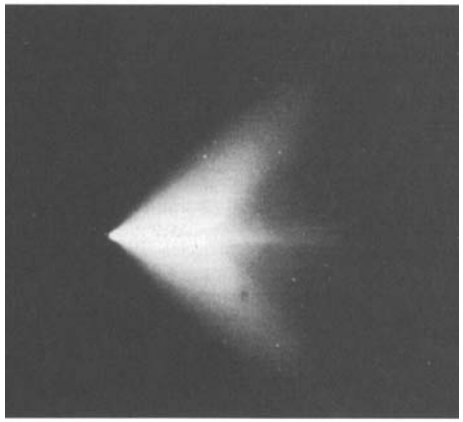
- **Objective:** Determine the conditions under which a missile hardbody radar signature may be significantly changed due to the presence of the exhaust plume because of interactive effects. Develop a modeling tool that simultaneously calculates the combined radar signature from a missile hardbody and exhaust plume accounting for these interactive effects
- **Capabilities Desired:** More accurate representation of a missile for threat characterization during boost phase to support threat identification and typing (solid or liquid propellant).
- **Phase I Goals:**
  - Identify numerical techniques capable of separately computing missile hardbody and plume RCS.
  - Determine an approach for simultaneously computing the coherent RCS of a hardbody and its plume.
  - Develop and test this approach for a simple hardbody shape and attached plume configuration, with plume electrical properties representative of either a solid or liquid hydrocarbon propellant.
  - Quantify differences between the combined plume and hardbody RCS and that of the hardbody alone for at least one set of flight and radar parameters.

Advanced Radiation Transport Models for Next Generation Rocket Exhaust Flowfield Properties

- **Objective:** Investigate the development of first-principles radiation transport algorithms to predict the influence of various exhaust phenomena on the total in-band, spectral and spatial intensity features for use in the next-generation propulsion related signature modeling framework

- **Capabilities Desired:** Development of first principle sub-models for incorporation into existing propulsion related flowfield and radiation signature tools.
  - Solar and earthshine scattering/heating of droplets and particles
  - Heating to and reflection from target vehicle geometries due to expanding or recirculating plume (plume shine)
  - Delayed release of emission from optically thick regions of plume (photon trapping effects)

Apollo 8 translunar injection burn observed at twilight

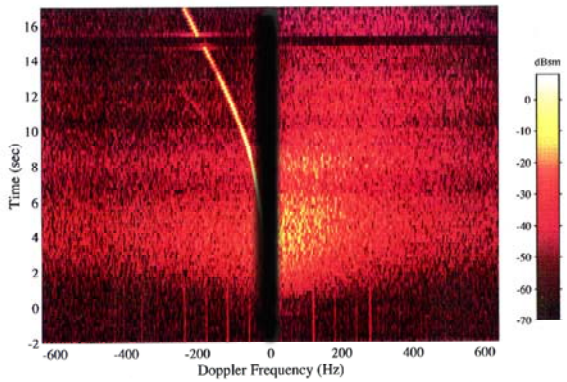


- **Phase I Goals:**
  - Select one pertinent rocket exhaust process and identify first-principles requirements for development of a model
  - Determine portions of electromagnetic spectrum where emission would be present
  - Develop an algorithm for prediction of radiometric signatures and demonstrate
  - Outline approach for integration into next generation flowfield and radiation transport tool FLITES

Plume EO-RCS Data Fusion

- **Objective:** Combine both electro optical and radar data sources to improve MDA next generation propulsion related modeling fidelity. This improvement is based on the model capturing both classes of observables that have been seen in missile exhaust plumes

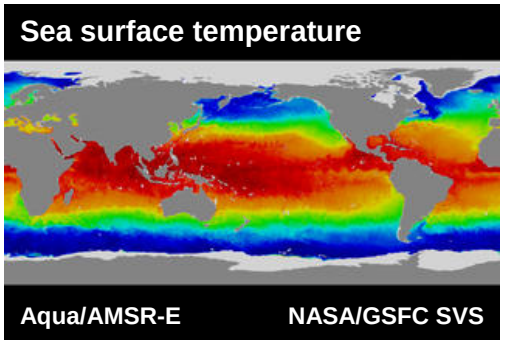
- **Capabilities Desired:** Development of first principle validated models that can accurately and consistently describe processes for predicting both EO and RF propulsion related signatures. Processes may include but are not limited to
  - 3-D effects from multiple nozzles flowfields, angle of attack, jet vanes
  - Plasma chemistry models for all propellant combinations

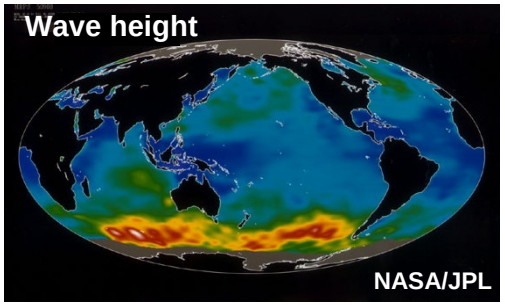


- **Phase I Goals:**
  - Select one pertinent rocket exhaust process and identify first-principles requirements for development of a model
  - Determine how EO and Radar Observables are impacted by the process
  - Identify candidate data sets for comparison to model predictions
  - Evaluate postulated process and its impact using available data

Creation of a Global UV-VIS-IR Ocean Background Model That is a Function of Time, Location and Sea State

- **Objective:** Develop advanced software algorithms and use them to create a high fidelity time-variable ocean background model for battlespace sensor and system trade studies in the ultraviolet, visible and infrared wavebands
- **Capabilities Desired:** UV-VIS-IR radiance model of ocean surfaces that...
  - Accurately models the physical aspects of the oceans and how these physical aspects influence the temporally- and spatially-variable radiance of an ocean surface under different Sea State conditions, and
  - Can be integrated into a MDA scene generation tool that models other aspects of the battlespace environment





- **Phase I Goals:**
  - Define a robust physics-based ocean radiance model
  - Demonstrate the primary algorithms to be used for UV/VIS/IR ocean radiance
  - Prototype code that uses one or more of the primary ocean radiance algorithms
  - Create a plan for validating the new ocean model
  - Show how new model can be integrated with a MDA scene generation tool that models other aspects of the missile defense battlespace environment

Terahertz Signature Modeling for Kill Assessment and Warhead Materials Identification

- **Topic Objective:** Develop techniques and tools for high-fidelity, first-principle, chemistry and physics-based modeling of sub mm (Thz) absorption and emission spectra resulting from missile intercept debris fields for threat warhead materials such as nuclear material.
- **Capabilities Desired:**
  - High-fidelity, first-principle, physics-based tool to generate sub mm signature predictions for a range of interceptor, targets, geometries, and closing velocities.
- **Phase I Goals:**
  - Develop and demonstrate an approach for modeling sub mm absorption and emission spectra resulting from missile intercept debris fields using high-fidelity, first-principle, chemistry and physics-based tools.
  - Perform an initial assessment of the feasibility of doing THz warhead typing exploitation for the Ballistic Missile Defense System.