NASA SBIR/STTR Technologies

Advanced Nongray Radiation Module in the LOCI Framework For Combustion CFD

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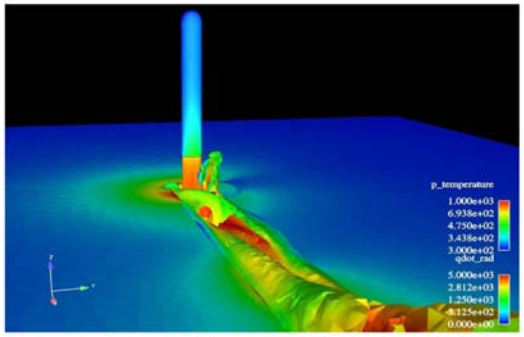
NASA Phase II STTR

Identification and Significance of Innovation

- NASA/MSFC will be the lead center for designing launch pads for Ares rocket series, as part of Project Constellation.
- Radiative heat fluxes from particles in Ares SRB plume can be a significant part of total heat flux to launch pad and base of first stage.
- In Phase I, we successfully demonstrated feasibility of developing accurate, highly scalable radiation module in LOCI-Chem.
- In Phase II, CFDRC-MSU team will develop an innovative, comprehensive, high -fidelity radiation module in the LOCI CFD framework .
- At the end of Phase II, NASA and OEMS will have a suite of radiation models that will help design safer and more efficient rockets of the future.



Radiative heat flux and particle temperature contours for Phase I nominal rocket case, obtained from Loci-CHEM

Technical Objectives

- Develop and implement improved nongray and particle radiation models;
- Implement innovative linear system solvers, higher order differencing schemes and quantitative characterization of model uncertainties;
- Verify radiation tool using method of manufactured solutions (MMS).

Work Plan

- Implement WSGG and Malkmus narrow band nongray and particle radiation models.
- Develop innovative and efficient matrix preconditioners/solvers and higher order discontinuous Galerkin discretization schemes.
- Verify the module using MMS and validate it against benchmark data as well as test rocket data provided by NASA/MSFC.

NASA Applications

- Better design launch pads for Ares rockets, in which radiative heat fluxes from the solid rocket booster (SRB) plume to the launch pad must be considered.
- Improve predictions of multiple plume environments, including gas-generator dumps, RSRM-V plume and overall heat transfer to the base of the first stage.
- Better predict heat loading on combustor walls due to gaseous radiation .

Non-NASA Applications

- The radiation module will be highly relevant to rocket engine manufacturers and universities developing rocket engine technology.
- Will be applicable in the furnace, automotive and boiler industry.

Subcontractors: Mississippi State University (Dr. Edward Luke)

NON-PROPRIETARY DATA