Reentry simulation and radiation model

Strongly coupled reentry physics makes necessary the simultaneous solution of various phenomena to predict the thermal behavior of a reentry vehicle. The plan for the first year is to produce a working multiphysics code, based on simple models but incorporating the effects of radiation and ablation.

Radiation reentry physics

At reentry conditions the air in the boundary layer can be in non-local thermodynamic equilibrium.

Considerable portion of the boundary layer can be at thermal equilibrium even for small sized vehicles.

For large vehicles almost all boundary layer is in local thermodynamic equilibrium.

Radiation Model

Radiative Properties

The Specair code was used to compute spectral intensities of air at 6000, 7000, 8000, 9000, 10000 and 10890K at 0.1, 0.5 and 1 atm.

Spectral intensity and integrated intensity over all wavelengths at 10980K and pressures equal to 0.1, 0.5 and 1 atm.

Correlations appropriated to implement in computer codes were fitted from spectral data computed with Specair code.

Solution of the Radiation Transfer Equation (RTE)

Approximation: Tangent slab approximation and gray gas properties.
Numerical method: Computationally cheap $S_N$ or Discrete Transfer.

Divergence of the radiative heat flux along the stagnation line computed with the current radiation model.

DPLR has a partial radiation model to CN emission and no absorption model, which can be implemented in conjunction with the developed model.

Results obtained with partial coupling between the radiation model and DPLR can be seen on Paul Bauman’s poster.