Wall modeled large eddy simulation of high-enthalpy hypersonic flows

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Research Objectives

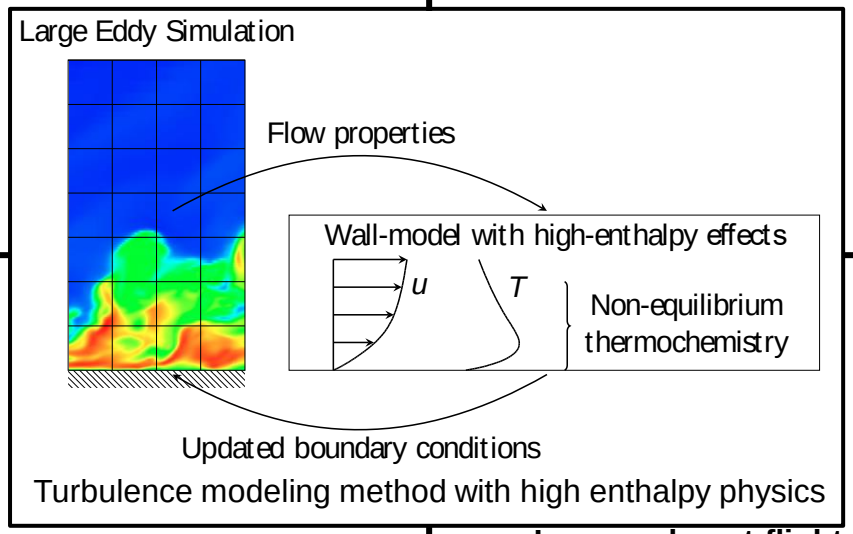
Primary Goal: Develop a computationally tractable wall model for high-enthalpy effects in large eddy simulation (LES) of turbulent flows

Innovation: First LES wall model that includes detailed non-equilibrium thermochemistry

Current state-of-the-art: Lower fidelity (Reynolds Averaged Navier-Stokes) turbulent flow calculations with high-enthalpy effects

Current TRL: 1

Project end TRL: 3 (experimental validation of prediction of key parameters)



Turbulence modeling method with high enthalpy physics

Approach

- Construct a **wall-model for LES that includes high-enthalpy non-equilibrium thermochemistry effects.**
- Test **model reduction methodologies** for near wall non-equilibrium thermo-chemistry.
- Perform **model validation** through comparison with ground-test and in-flight data.
- Demonstrate applicability of WMLES through **simulation of Mars Science Laboratory.**

Potential Impact

- **Improved post-flight reconstruction** through high-fidelity (LES) simulations of full-scale missions.
- Better predictions of **aerodynamic loads and surface heating** for mission design and smaller design margins.
- **Improved understanding of high-enthalpy turbulent flows** and improvements to RANS models frequently used in design.