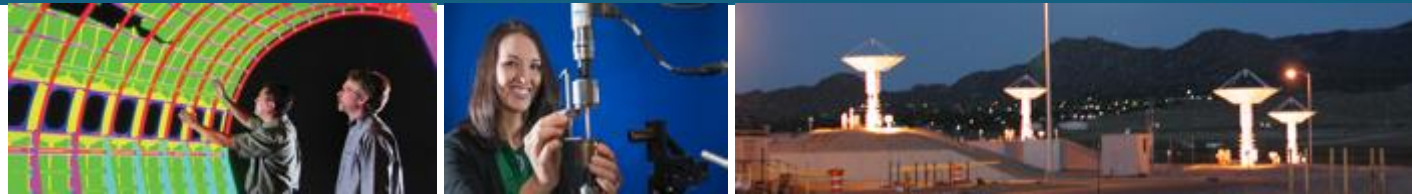




High-Fidelity CFD Workshop 2022: SNL Steady Supersonic/Hypersonic Summary



PRESENTED BY

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2022 AIAA 1st High-Fidelity CFD Workshop

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Spatial Discretization

- 2nd Order structured cell-centered finite volume
- Minmod limiter
- Modified Steger Warming Flux Reconstruction
- Modify entropy fix in wall-normal direction

Nonlinear Solver

- Pseudotransient continuation for steady problems
- Adaptive CFL
 - User limits based on “run schedule”
 - CFL increases/decreases based on linear solver tolerance achieved, optionally solution percentage changes, and optionally line search
 - Can include or exclude temporal term in residual
 - Local/Global CFL options
- Different Linearization Options
 - Approximate Jacobian
 - Automatic Differentiation based Matrix-Free Jacobian

Linear Solver

- Iterations and preconditioning sweeps are set in “run schedule”
- GMRES with block-tridiagonal preconditioning
- Fixed point block-tridiagonal



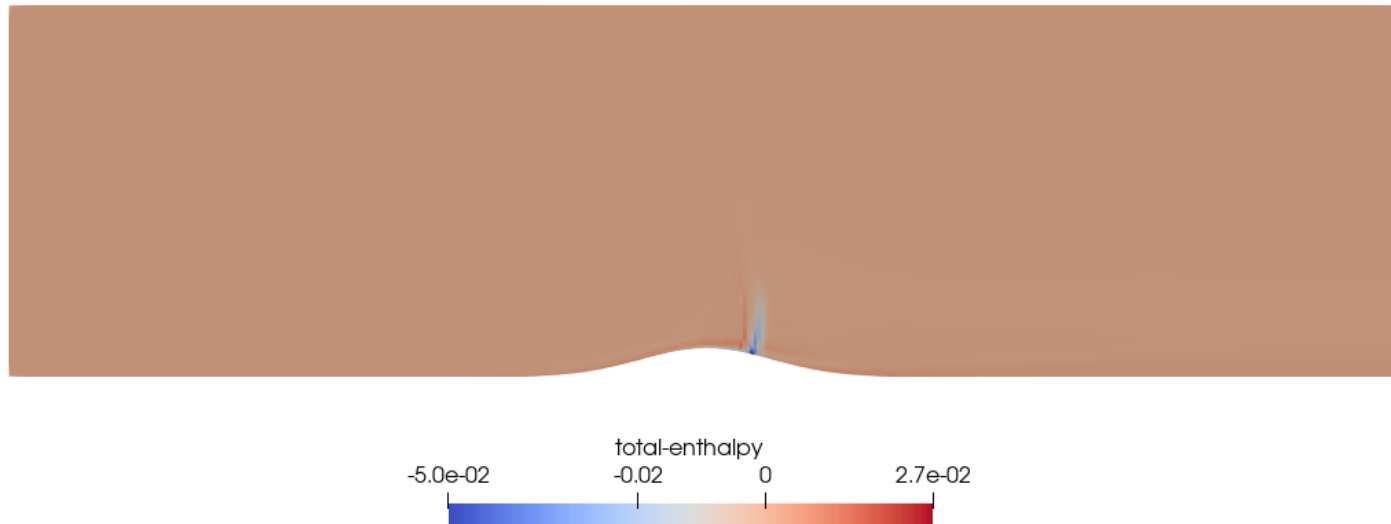
3 | Supersonic Bump Summary



Very weak convergence of L2 total enthalpy (approx. 0.5)

Poor nonlinear convergence upon refinement

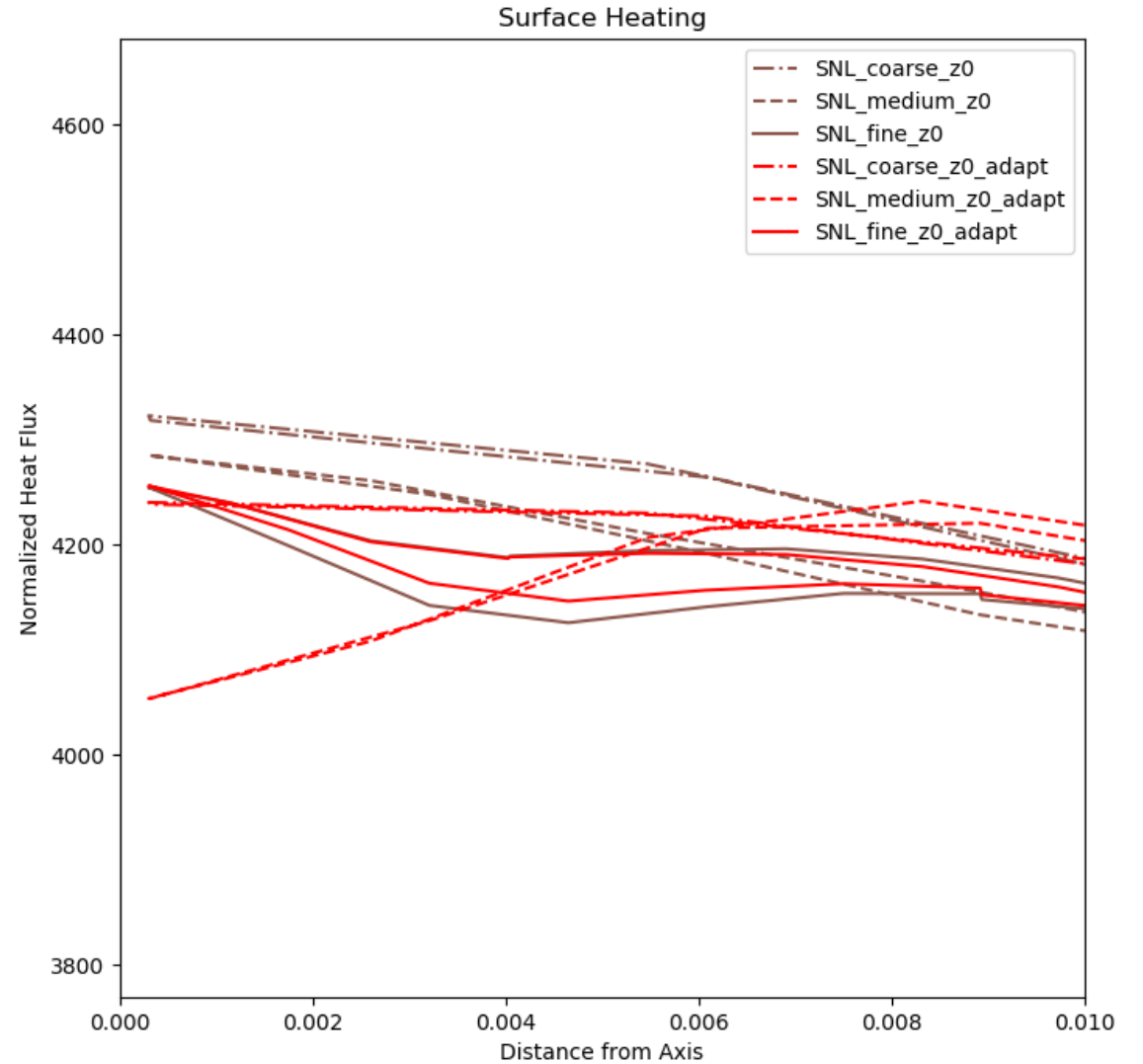
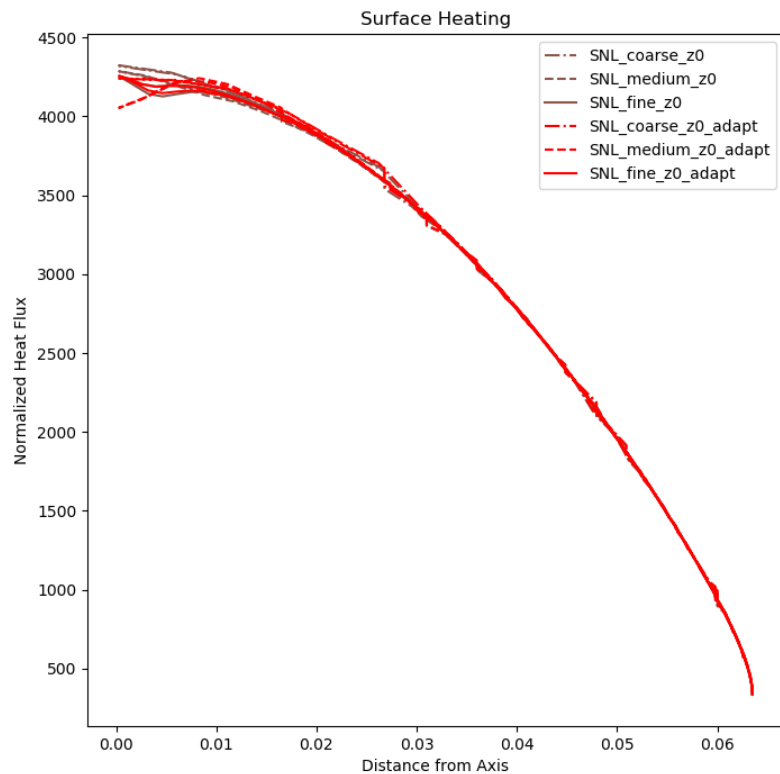
- Exact sensitivities do not help
- Static pressure fully recovers despite shock?



4 Blottner Sphere Summary

Sensitivity to boundary layer dissipation

- Finest mesh arguably a worse result
- Adaptivity makes this worse





Nonlinear convergence can be difficult to achieve for finest mesh

- Inexact Jacobian would not converge with automated schedule
- CFL controller strategy required more linear iterations with AD-based matrix-free Jacobian
- Aggressive CFL schedule leads to NaN

Laminar cone cases had convergence difficulties on coarser meshes

- AD-based matrix-free Jacobian needed to get deep convergence