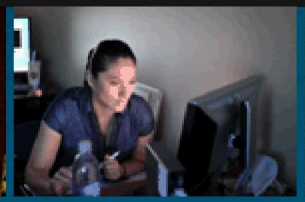
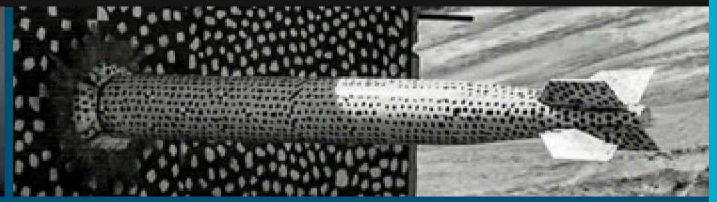
SAND2018-6733PE

Proposed High-speed Compressible Problem for the 6th High-Order Workshop





PRESENTED BY

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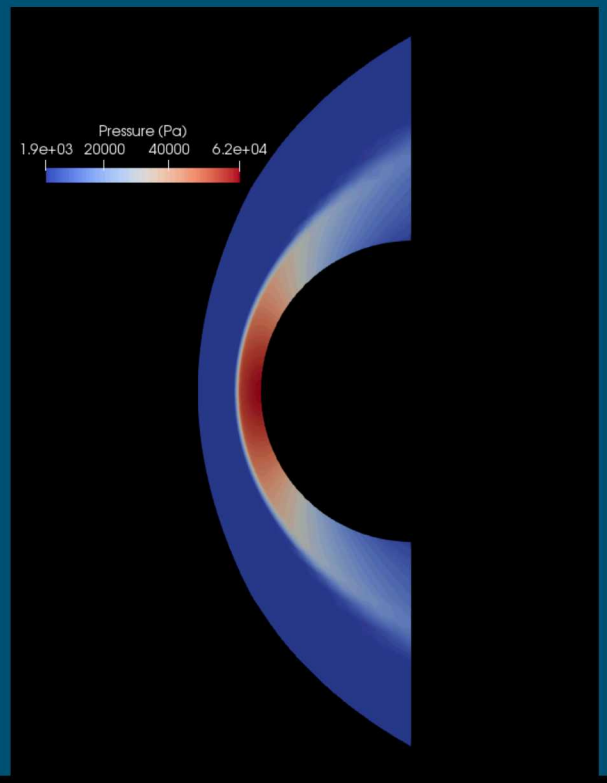
Blottner Sphere

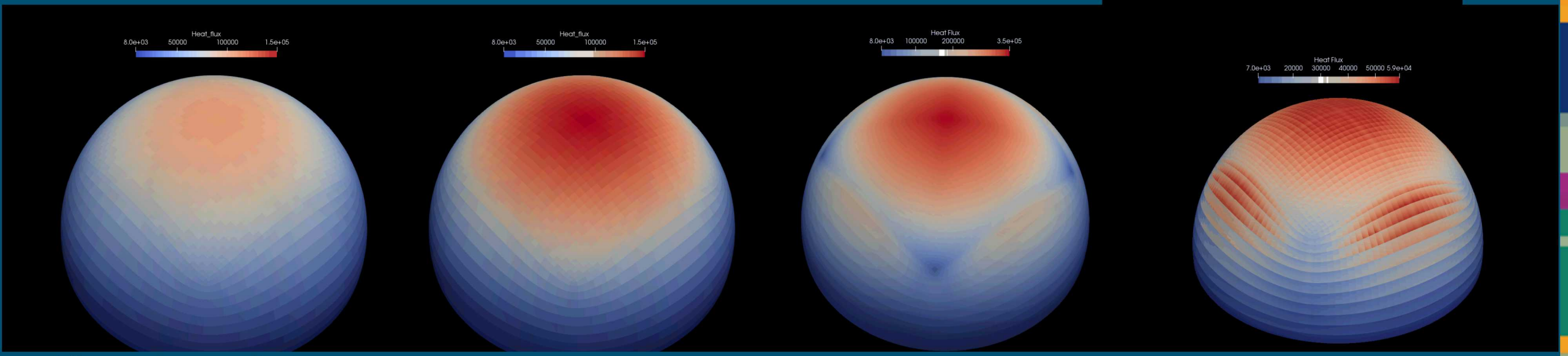
- Blottner, F. G., "Accurate Navier-Stokes Results for the Hypersonic Flow over a Spherical Nosetip," Journal of Spacecraft, Vol. 27, pp 113-122, 1990.

Original simulation used axisymmetric solver

3D solvers show serious mesh and numerical sensitivity

$$M = 0.5$$
$$Re_D = 1.8875e6$$
$$\gamma = 1.4$$
$$\mathrm{Pr} = 0.72$$
$$T_w = 98.89\ K$$
$$T_\infty = 75.58\ K$$





Cell-centered FVM, Face limiting
Eliminate wall-normal entropy fix

Cell-centered FVM, Face limiting
With entropy fix

Node-centered FVM, stencil limiting
With entropy fix (different scale)

P = 1 unstructured collocation elements
With artificial viscosity (different scale)

Questions to address with this problem

Can high-order converge to heat flux solution with fewer DOFs than cell-centered FVM?

- 1% error?
- 0.1% error?

Can high-order get converged solution faster than cell-centered FVM?

- Can showcase the success of different linear solve techniques
- Explicit codes welcome, but probably won't want to emphasize this question

Do high-order methods reduce or increase mesh sensitivity of the solution?

What are boundary layer solutions sensitive to?

Does adaptivity accelerate convergence?

What yplus is required to predict a good heat flux with each method?

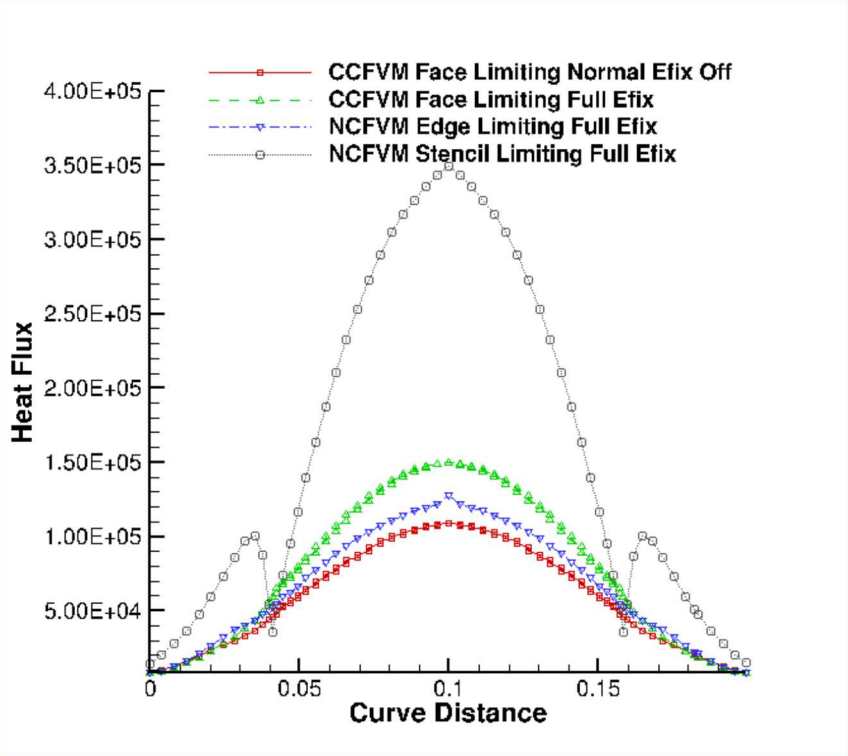


Figure: Z-plane comparison of heat flux profiles on the same mesh
Target is approximately 1.1e5

More details

Test leaders provide:

- Structured (5 block) and unstructured (hex and tet) linear mesh sequences
- (If someone volunteers) A sequence of high-order curved meshes
- Best practice finite volume solutions with tau bench time-to-solution

Metrics:

- Heat fluxes:
  - Peak heat flux convergence
  - Integrated heat flux convergence
  - Heat flux profile along intersection with z-planar slice, y-planar slice, and 45 degree planar slice (deviation from axisymmetric)
  - Min/Max y-plus for each solution
- Field quantities:
  - Stagnation line temperature
  - Stagnation line pressure

Modifications

- Use adaptivity or shock fitting
- Make a mesh your solver likes better (wedges, tighter grid spacing, etc.)

Verification Problems

- Shock tube
- Laminar Joukowski Airfoil