Fortran@50
Application / User Viewpoint

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NCAR

Impact

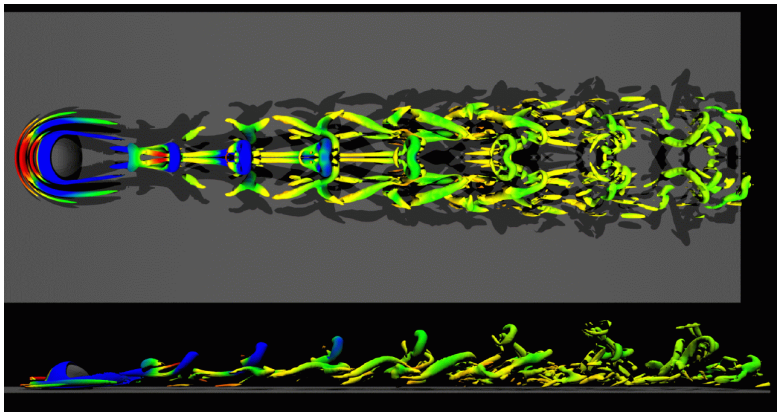
- Hard to understate the impact Fortran has had on application development.
- Though it was intended primarily for programming scientific and mathematical applications its reach extends far beyond that into industry, HPC, parallel computing.
- At NCAR, all of our production applications are written in Fortran (~80% F90, 20% F95).
- Story is similar at the universities.
- Though there is a bit more variety at the other national laboratories and in industry, Fortran remains a important component of their application development programs.

Performance

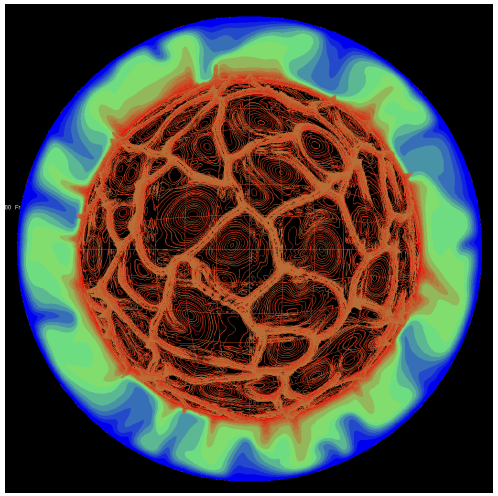
- Lore is that if you want performance you use Fortran.
- Though the gap has narrowed between what the compilers deliver for "well-written" Fortran and C code, Fortran still holds the edge.
- To circumvent expressiveness concerns, many have very successful formula:
  - Fortran for the computational kernels.
  - C for the bookkeeping.
- Extremely successful for F77/C, less so for other combinations.
- Cursory survey of the Gordon Bell winning applications indicates that virtually of of them relied on Fortran in some capacity.

NEK5000 – 1999 Gordon Bell Winner

- **Incompressible Navier-Stokes (unsteady).**
- **Spectral Element Method (high-order).**
- **Ideal for 3D transitional and weakly turbulent flows.**
- **Axisymmetric, 2D, and 3D flow configurations.**
- **Multiple-species transport.**
- **Supports a broad range of boundary conditions.**
- **Handles complex geometries.**
- **376 GF on 4096 Processors of ASCI Red (30% peak).**
- **Scalable coarse grid solver.**

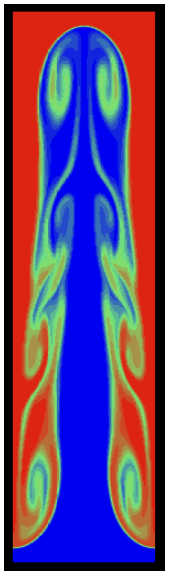


Transitional boundary layers



Deep atmosphere convection dynamics

Heat transfer enhancement



Rayleigh-Taylor instability (mixing)

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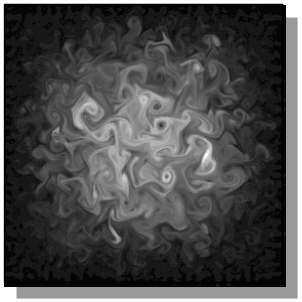
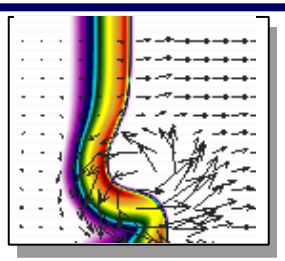
FLASH – 2000 Gordon Bell Winner

- **Astrophysical thermonuclear explosions.**
- **Euler (PPM), realistic EOS, nuclear reaction network, gravity, radiation transport, etc.**
- **Wide range of compressibility.**
- **Wide range of length and time scales.**
- **Fairly simple geometries.**
- **238 GF on 6420 Processors of ASCI Red (11% peak).**

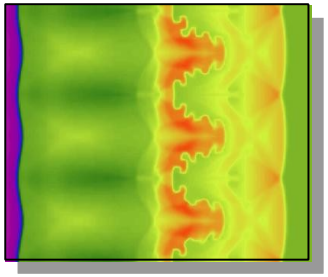


Compressed turbulence

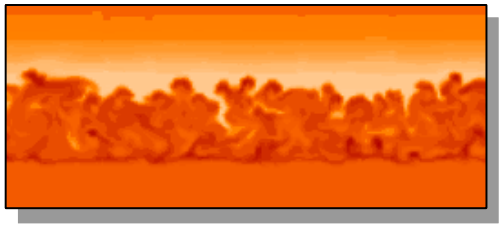


Flame-vortex interactions

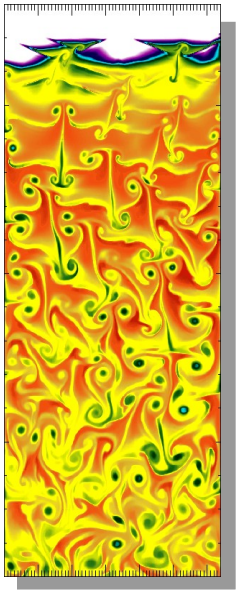
Richtmyer-Meshkov instability

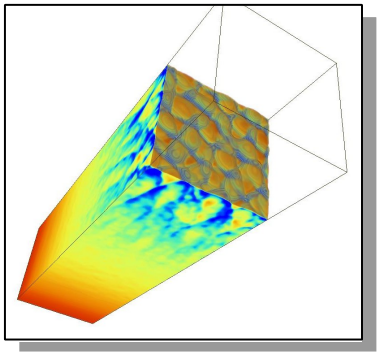


Laser-driven shock instabilities

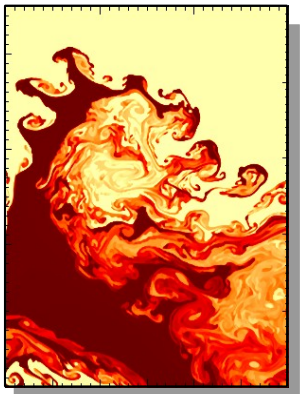


Nova outbursts on white dwarfs

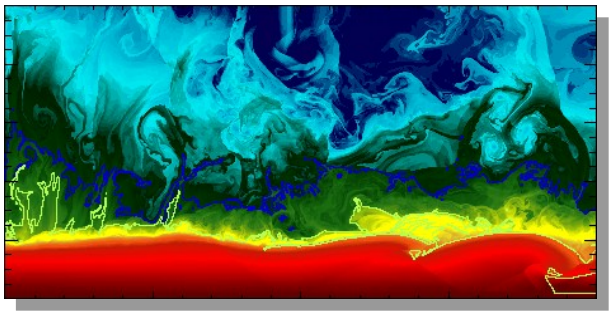




Cellular detonations



Rayleigh-Taylor instability



Helium burning on neutron stars

Rosner, Fryxell, Dursi, Zingale, Olson, Calder, Ricker, Tufo

Concerns I

- Training, or lack thereof, is a significant challenge.
- The bulk of the active application developers are as old as the language.
- Folks just starting out typically have no knowledge of Fortran so we have to train them ourselves.
- CS departments don't even know what Fortran is, much less offer courses on it.
- Other departments / programs have stepped up but coverage isn't uniform.
- Fear is that over time Fortran will become a dead language (e.g., like Latin, used only for high mass).

Concerns II

- The Fortran standard continues to evolve.
- Fortran 90, 95, 2003, and 2008 … make Fortran more and more C/C++ like.
- The added complexity makes the compiler's job much more difficult and often results in reduced performance.
- Add the previous concern, lack of adequate training, and the situation becomes much worse.
- Fear is that in joining the "modern" languages, Fortran will lose its identity and therefore many of its attractive features (e.g., performance).

Prediction

- Training, though problematic, is becoming more organized and, with the advent of computational science programs, hopefully will find a home in the (near) future.
- Concerns regarding the evolution of Fortran are well founded but as long as one restricts his/her passions, high levels of performace are still achievable.
- Fifty years has created a tremendous code legacy that will be hard to erase.

Most Frequent Response

And it’ll be around for another fifty.