CSCS
Centro Svizzero di Calcolo Scientifico
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Eurohack 2018: Team A-QuICC

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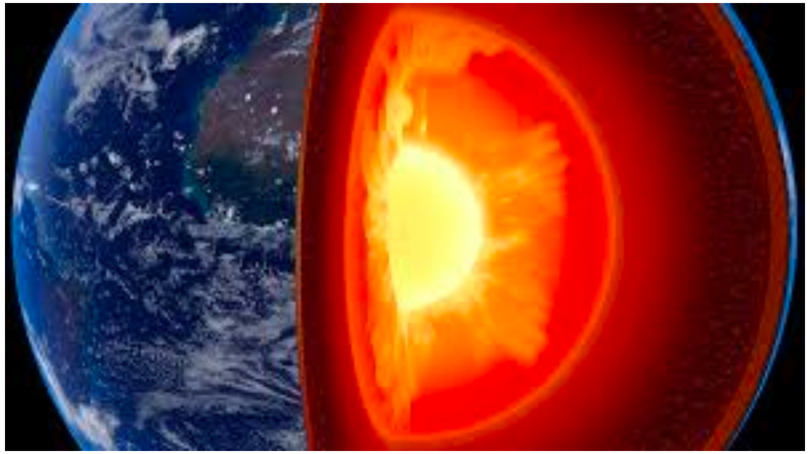
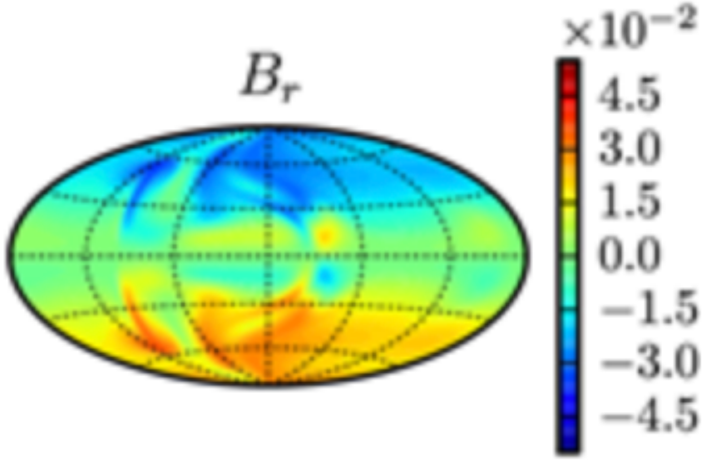
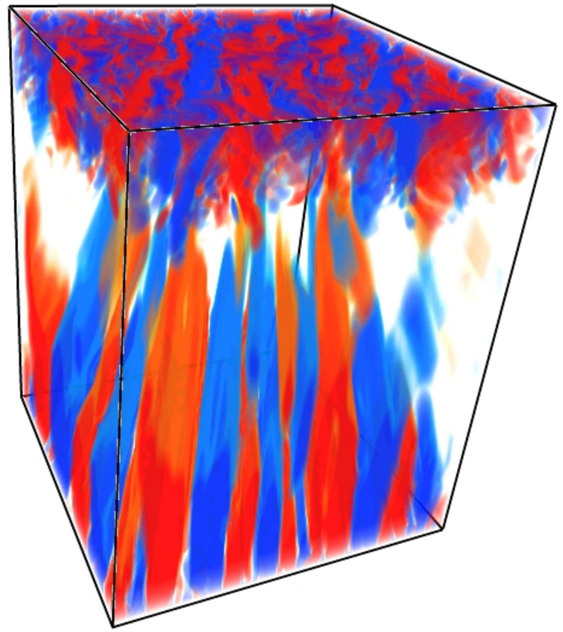
Scrum – 2.10.2018

Overview of QuICC (Quasi-Inverse Convection Code)

Simulations of 3D convection driven, rotating fluid flows in spheres, cylinders or Cartesian geometries







Fully spectral C++ code that requires transforming between physical and spectral space for calculation of the nonlinear terms in the Navier-Stokes equations

Goal for the Eurohack

Complete 1 full path: physical $\longrightarrow$ spectral $\longrightarrow$ physical

For 3D transforms of Fourier, Chebyshev, Legendre and Worland polynomials using GPUs

Mini-app: a set of transforms for the scalars and gradients for a spherical case, which are tested against reference solutions and the current CPU implementation

Approach

Begin with the most simple changes and advance to higher complexity

1. Switch to cuFFT from FFTW
2. Alter the Chebsyhev to use the cuFFT
3. Use CUDA/? for Legendre transforms

For each implementation we are concerned with:

Timing (hoping for a speed-up)
Communication costs
MPI parallelization
Memory management

Current status

Yesterday we:

1. implemented the change to cuFFT
2. began the alterations for the Chebyshev transforms (DCT $\longrightarrow$ DFT)
3. included CUDA in the cmake files
4. Began working on Legendre transforms

Obstacles:

Slow down due to copy to device costs for FFT
cuFFT has no DCT so more coding required for Chebyshev
Misunderstanding of Eigen's CUDA possibilities
Many small FFTs and not one large FFT

Plan for remaining time

Begin with the most simple changes and advance to higher complexity

1. Switch to cuFFT from FFTW
2. Alter the Chebsyhev to use the cuFFT
3. Use CUDA/? for Legendre transforms

Focus areas

- First step: get everything to work (even if slower)
- Second step: optimization

Abstract

QuICC is a fully spectral C++ code that simulates convection driven fluid flows applicable to planetary and stellar interiors in spherical, cylindrical and plane-layer geometries. The code requires transforming the data between physical and spectral space multiple times per step, using FFT, Chebyshev, Worland and Legendre transforms. Our goal for this week is to port a full transform path (i.e., from physical to spectral and back to physical) for a scalar variable as required in a spherical case.