Numerical Simulation of Planetary Interiors: Mantle Convection in a 2D Spherical Shell

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Abstract

For getting a closer look insight the dynamics of planets, numerical simulation codes of thermal convection have proved oneself to be a powerful tool. In order to obtain faster results and to study a larger parameter range, the simulation of mantle convection in a two-dimensional spherical geometry should be performed instead of a fully three-dimensional spherical shell. Here, we show the performance and first results of a 2D version of GAIA, a 3D spherical code with strongly temperature dependent rheology [Hüttig and Stemmer, 2008 a,b]

To run a simulation with a reasonable resolution, the code must work with more than one CPU in parallel. Therefore in the next section several approaches for the domain decomposition of a two-dimensional spherical grid are presented. We also introduce a formula to calculate the overhead of data exchange between the domains for the two-dimensional grid.

The performance section illustrates the speedup for up to 256 CPUs. This is shown for both three-dimensinal and two-dimensional grids. Another perfomance test consists in the amount of time the simulation needs for several number of nodes.

The last section illustrates results obtained by using the GAIA Framework with two and three-dimensional spherical grids. In order to compare these results Nusselt number and temperature profiles for both cases have been computed and checked against each other.