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Massively parallel Simulations of Mantle and Core Flows in 3D spherical Shells

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Massively parallel computations are needed for a realistic numerical simulation of convective flows in the mantle and in the molten core of the Earth. For the core flow not the generation of the geomagnetic field but the small flow scales induced by the extremely small Ekman number (ratio of viscous to Coriolis forces) are a major computational challenge. In contrast, the Coriolis force is negligible for mantle convection. Here, the main challenge is to incorporate huge variations of the rheological properties due to stress, pressure and temperature dependency of viscosity.

As part of the extreme computing initiative of the DEISA consortium (Distributed European Infrastructure for Supercomputing Applications) our finite volume approach for simulating core and mantle flows is currently adapted and optimized for massively parallel computation. We will discuss the solution strategy and present first results on the scaling efficiency.It is the aim to run efficient applications on architectures with up to 16000 processors. This will allow simulations with an unmatched resolution in the order of roughly 10^9 volume cells. With such a resolution, simulations of core and mantle flows can be calculated in a much more realistic parameter range giving a firmer understanding of the dynamics of the deep terrestrial interior.