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A Benchmark Test for Thermal Evolution Models of Moon and Mercury

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Although there were now numerous mission towards the planets of our solar system already, the data basis remains relatively poor, especially for Mercury. We can therefore prepare ourselves for the upcoming results and perform test that allow some anticipation of the measured data. Because no material is available, which could have been analysed in a laboratory, numerical models are the most promising tool at the moment.

However, depending on the code used for the numerical model, the results might differ. Very often they depend strongly on the initial conditions and a precise check is impossible. Nonetheless two different models should deliver the same results, given the same initial conditions and modelled processes. We introduce a benchmark test of two thermal convection codes, fed with exactly the same initial conditions. In both codes the planetary mantle is modelled as an internally and bottom heated, isochemical fluid in a spherical shell. The principle of this convection model is widely accepted and is used for various models of thermal evolution of terrestrial planets.

We are solving the dimensionless hydrodynamical equations, derived from the conservation of mass, momentum and energy. The first code was originally written by S. Zhang (1993) and employs a combination of a spectral and a finite difference method. The second code was developed by C. Hüttig (2008) using a dual-mesh finite volume method. It enables thermal convection models to utilize spatially varying viscosities. We are going to show benchmark tests for the Earth's Moon and Mercury, as these can be regarded as end members regarding there interior structure with respect to the core size.