2-Dimensional Incompressible and Compressible Mantle Convection

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Abstract

COMSOL Multiphysics® software has been used in computational geodynamics for years. Because very high pressure in the mantle even significantly compressed the mantle up to ~40%, it is crucial to consider the mantle compressibility in computational geodynamics. COMSOL Multiphysics allows consideration of mantle compressibility using the CFD module and I benchmarked COMSOL Multiphysics using diverse governing equations: 1) anelastic liquid approximation (ALA), 2) truncated anelastic liquid approximation (TALA), 3) extended Boussinesq approximation (EBA) and 4) Boussinesq approximation (BA) by varying dissipation and Rayleigh numbers [1]. The results from the benchmark show excellent consistencies with the published benchmark results [2]. With the anelastic liquid approximation, several simple mantle convection models for the Earth and Venus were conducted and the results from the modeling experiments show significant differences in the models considering compressibility and incompressibility [3]. This benchmark and simple modeling experiments indicate that COMSOL Multiphysics® is a useful tool in computational geodynamics.

Reference

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