A community benchmark for compressible convection

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The silicate mantle of the terrestrial planets is slightly compressible and goes through a number of phase changes and a decrease in volume as pressure increases. The related physical properties of the silicates, such as density, bulk modulus, coefficient of thermal expansion and heat capacity, change therefore with pressure. Many existing mantle convection codes are based on the simplified Boussinesq or Extended Boussinesq approximations, which ignore the effects of compression. While this simplified approach has been useful in exploring mantle convection modeling, it is difficult to explicitly compare these models with models from seismology or mineral physics. A realistic Earth model for geodynamics, seismology, or mineral physics must take the compressibility and its effects on the mantle into account. With the advances made in high pressure mineral physics research , our knowledge of the physical properties of mantle rock at lower mantle conditions has greatly improved. It has become possible to construct a dynamic model with realistic mineralogical and thermodynamical formulation, where the model results can be readily compared with seismology and geodesy. To aid the further development of compressible convection modeling, a benchmark for compressible thermal convection is formulated by the community within the Computational Infrastructure of Geodynamics (CIG). The initial benchmark problem is 2-D thermal convection of a non-rotating anelastic liquid of infinite Prandtl number in a Cartesian, closed, unit cell. The governing equations are based on Truncated Anelastic Liquid Approximation. The benchmark consists of several cases: steady and timedependent, constant and variable viscosity, and bottom and internal heating. Several numerical and analytical codes participate in the benchmark. We welcome wider participation from the community.

URL: http://www.geodynamics.org/cig; www.geo.lsa.umich.edu/~keken/benchmarks/compr