Modelling convection with large viscosity gradients in the cubed sphere

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A numerical method solving thermal convection problems with variable viscosity in a spherical shell is presented. Several features of earlier programs solving the same problem in Cartesian geometry are adopted because of their efficiency and robustness: finite volume formulation, multigrid flow solver, parallel implementation. A recent composite mesh gridding technique for a spherical surface, termed the cubed sphere has proven to be successful in solving other partial differential equations in geophysical problems. It is used here because of its various advantages: absence of geometrical singularities, same metric on each block, simple coupling of adjacent blocks. In addition, it is a mesh where grid-based methods proven efficient in the Cartesian context can be implemented, since it is reasonably close to uniform. Although as in the Cartesian case, convergence rates decrease with increasing viscosity gradients, global contrasts up to 10^6 are obtained at a reasonable cost.