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Development and benchmarking of an open-source numerical model for natural convection at high Prandtl number.

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We present the development and benchmarking of a numerical solver for high-Prandtl-number convection, as a simplified conceptual model of magma and/or mantle dynamics. The open-source numerical toolkit OpenFOAM, based on a finite volume method, is a potentially good candidate for this kind of simulations because it provides customized instruments for continuum mechanics High Performance Computing simulations and for pre/post-processing. OpenFOAM offers solvers for low Prandtl numbers fluids simulations (air, ocean ...) but not yet for high Prandtl numbers simulations. In this work, we show the initial validation steps for the development of a high-Prandtl-number fluid solver, using the buoyantBoussinesqPimpleFoam solver as the starting point and considering for simplicity a 2D vertical slice. Comparison with previous works shows that vertical temperature profiles, vertical velocity and temperature isolines are reproduced with good accuracy. The presence of some discrepancies on the streamfunction will require further investigation concerning the integration algorithm. Results on the behavior of a horizontal statistically homogeneous convective system are finally presented.