

Three-Dimensional Numerical Studies on the Interplay between Variable Thermal Conductivity and Post-Perovskite Phase Transition

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Numerical models of three-dimensional mantle convection have been developed in order to study the interplay between the perovskite to post-perovskite (pv-ppv) phase transition near the core-mantle boundary and variable thermal conductivity. A time-dependent convection in a three-dimensional rectangular box of 3000km height and aspect ratio 6x6x1 is considered. We employed an extended Boussinesq approximation, where the effects of latent heat release and viscous dissipation are included. The viscosity of mantle materials is assumed to be dependent on temperature and depth. Spatial mesh divisions of up to 512x512x128 are utilized, by the help of newly developed algorithm for the Earth Simulator, in order to resolve the interplay between the bottom phase transition and the variations in thermal conductivity and viscosity, which may play an important role in the dynamics of plumes in the lower mantle, as much as possible. In addition to the endothermic phase transition at 660km depth, the pv-ppv transition is modeled as an exothermic phase change located at 200km above the bottom surface. We take into account the temperature-dependence of thermal conductivity, which mimics the effects of radiative heat transfer expected to be dominant in a hotter part of the mantle. The temperature at the core-mantle boundary is also systematically varied, in order to adapt the spatial variations in thermal conductivity and viscosity in the mantle. The effect of the interplay on the convective flow patterns will be further discussed, by comparing the cases with and without the variation of thermal conductivity.