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Heterogeneities in the core-mantle boundary region inferred from thermo-chemical multiphase mantle convection in a three-dimensional spherical shell

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Numerical simulations of thermo-chemical multiphase convection in a three-dimensional spherical shell are used to model lateral heterogeneities in the core-mantle boundary region. Compositional heterogeneities in the mantle are generated by melt-induced differentiation followed by subduction of differentiated materials, and the post-perovskite phase change is included in the model with composition-dependent parameters. In order to calculate seismic anomalies from the temperature, composition and phase change anomalies obtained from the thermo-chemical mantle convection calculations, phase assemblages and physical properties of the relevant materials are calculated using self-consistent minimization of free energy, dependent on temperature, pressure and chemical composition. By comparing the seismological structures generated in these 3D spherical-shell geodynamic models with the features obtained from global tomography images, both in the physical domain and spectral space, the origin of large-scale lateral heterogeneities in the core-mantle boundary region can be directly constrained.