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Small-scale thermal and thermal-chemical convection in the Deep Mantle and Seismic Expression of Post-Perovskite Transition from Multiscale Analysis

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There exist much 3D seismic heterogeneities at the base of the mantle, which may
be attributed to post-perovskite (PPV) phase transition or chemical heterogeneities. To study the irregular seismic structure that may be caused by the undulations of the PPV phase boundary, we have carried out finite-element simulations with high local resolution in the D" region , up to 3 km in both directions, in a cylindrical geometry, which includes the PPV transition and also the spinel to perovskite transition at 660 km depth.The mantle rheology employed has both Newtonian diffusion and non-Newtonian dislocation creep rheologies. The influence of a greater propensity of non-Newtonian creep for PPV is also investigated. From the temperature field, we can compute the 2D shear wave velocity field from a seismic equation of state. Usinga curvelet transform we then decompose the seismic velocity fields into wave packets to account for the events-to-stations illumination and obtain the multiscale seismic expressions from the numerical simulations. The results reveal lens-shaped PPV structures , much similar to the patterns obtained from seismic imaging by van der Hilst et al. (2007).The lens structure shows sensitivity to the Clapeyron slope.Analysis of thermal-chemical anomalies from a subducting slab with crustal material shows a
high sensitivity of the seismic expression near the CMB to the seismic velocity
coefficients of the oceanic crust under high pressure conditions.