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Inferring core-mantle boundary heat flux pattern from seismic tomography models using mantle convection simulations

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The heat flux pattern at Earth's core mantle boundary (CMB) imposes a heterogeneous boundary condition on core dynamics that likely affects the geodynamo. Owing to the temperature dependence of seismic velocities, this pattern is classically approximated as proportional to the lowermost layer of seismic tomography models for the global mantle. Two biases undermine however such a simple linear relationship: 1) other contributions than thermal (compositional, mineralogical) influence seismic velocities and 2) the radial average inherent to tomographic models might distort the local thermal state at the CMB. We analyze here mantle simulations of thermochemical convection where, owing to their spatial characteristics, specific mantle components are easily identified: hot thermochemical piles, "normal" mantle and, when post-peroskite (pPv) is included, cold region where it is present. Synthetic seismic velocities (i.e. based on the mantle simulations) are then computed based on thermal, compositional and mineralogical sensitivities and a formalism to infer CMB heat flux from seismic shear velocity anomalies is finally derived. We then illustrate using of a single tomographic model how this applies to actual seismic shear velocity anomalies. Maps of CMB heat flux derived with this approach vary, depending if pPv is included or not in the interpretation. All models however involve the attenuation of low heat flux anomalies beneath large low shear velocity provinces (LLSVPs), while large heat flux patches are enhanced, both with respect to the classical linear interpretation.