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Seismic investigations of the reference thermal structure of the Earth's mantle

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An accurate one-dimensional physical model of the mantle lays the foundations for understanding the dynamics and evolution of the Earth's interior, and provides a reference against which three-dimensional structures can be described quantitatively in terms of the dynamically important variables, temperature and composition. The simplest possible physical model for the mantle is one with constant chemical composition, convecting as a whole. This results in a structure with thin boundary layers at the top and bottom, and an adiabatic temperature gradient in between. Previous modelling studies have indicated that it is difficult to reconcile such a structure with seismic data, when it is assumed that the chemical composition is pyrolitic and the temperature profile follows a 1300˚C adiabat (Cammarano *et al.*, EPSL 232, 2005). One possible explanation for this result is that the actual thermal structure of the mantle deviates from a 1300˚C adiabat. We test this possibility, by designing a set of thermal structures which cover a range of potential temperatures and temperature gradients. These structures lie within limits imposed by the values of inferred MORB-source temperatures and mineral phase-transition temperatures. For each structure, we generate a large number of synthetic velocity models, using datasets of mineral parameters which lie within published uncertainty bounds. We employ several different methods to extrapolate the mineral parameters to high temperatures and pressures which were not included in earlier studies, thereby expanding our uncertainty space. We then calculate the proportion of velocity models per structure whose seismic behaviour gives a close fit to real, global seismic data. This allows us to assess which thermal structures are most consistent with seismic observations, and whether or not a 1300˚C adiabat is the best representation of mantle temperature structure.