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Global thermal models of the lithosphere

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Unraveling the thermal structure of the outermost shell of our planet is key for understanding its evolution. We obtain temperatures from interpretation of global shear-velocity (V_S) models. Long-wavelength thermal structure is well determined by seismic models and only slightly affected by compositional effects and uncertainties in mineral-physics properties. Absolute temperatures and gradients with depth, however, are not well constrained. Adding constraints from petrology, heat-flow observations and thermal evolution of oceanic lithosphere help to better estimate absolute temperatures in the top part of the lithosphere. We produce global thermal models of the lithosphere at different spatial resolution, up to spherical-harmonics degree 24, and provide estimated standard deviations. We provide purely seismic thermal (T_S) model and hybrid models where temperatures are corrected with steady-state conductive geotherms on continents and cooling model temperatures on oceanic regions. All relevant physical properties, with the exception of thermal conductivity, are based on a self-consistent thermodynamical modelling approach. Our global thermal models also include density and compressional-wave velocities (V_P) as obtained either assuming no lateral variations in composition or a simple reference 3-D compositional structure, which takes into account a chemically depleted continental lithosphere. We found that seismically-derived temperatures in continental lithosphere fit well, overall, with continental geotherms, but a large variation in radiogenic heat is required to reconcile them with heat flow (long wavelength) observations. Oceanic shallow lithosphere below mid-oceanic ridges and young oceans is colder than expected, confirming the possible presence of a dehydration boundary around 80 km depth already suggested in previous studies. The global thermal models should serve as the basis to move at a smaller spatial scale, where additional thermo-chemical variations required by geophysical observations can be included.