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Towards a fully probabilistic reconstruction of the elastic, thermal and petrological structure of the Earth's mantle transition zone

Benoit Tauzin (1), Juan-Carlos Afonso (2), Malcolm Sambridge (3), Hrvoje Tkalcic (3), Seongryong Kim (3), and Thomas Bodin (1)

(1) Laboratoire de Géologie de Lyon : Terre, Planètes et Environnement, Université de Lyon, Université Lyon 1 and Ecole Normale Supérieure de Lyon, UMR CNRS 5276, F- 69622 Villeurbanne, France (benoit.tauzin@univ-lyon1.fr), (2) Department of Earth and Planetary Sciences, Macquarie University, North Ryde, Sydney, NSW 2109, Australia. , (3) Research School of Earth Science, The Australian National University, Canberra, ACT 2601, Australia.

An enigmatic patchwork of seismologically observed low-seismic velocity zones (LVZs) has been reported at various scales and locations above the 410-km discontinuity and in the mantle transition zone (TZ). Geodynamical models suggest that this is possibly a distinctive feature of a convective mantle that preserves small-scale chemical heterogeneities. However, its geographical correlation with tectonic environments remains elusive. Our objective is to study the multi-scale physical properties of the TZ in relation with the global distribution, shape, internal structure, and nature of these LVZs. We develop a novel geophysical inversion relying on Bayesian inference. This probabilistic framework is multidisciplinary, with the production of multi-scale elastic TZ models through partition modeling of raw seismic data, and the use of secondary seismic observables (410 and 660 topography, number of seismic interfaces, elastic profile in the TZ) to constrain thermo-physical parameters for a range of plausible mineralogical models and pressure-temperature conditions. Taking a probabilistic approach does not simply mean that we look for a maximum probability solution but rather, within uncertainties and through probabilistic sampling, for an ensemble of compatible solutions. We illustrate the feasibility of using such a framework on data from dense seismic arrays in the US (Transportable Array), NE China (NECESSArray), Japan (F-Net), Australia (WOMBAT), from permanent networks in Korea, and on a global dataset of SS-precursors. We aim at quantifying in a probabilistic sense how previously published mantle-mixing models and laboratory-based data fit seismological observations.