Constraints on the state of the Mantle Transition Zone beneath the Alpine region using Ps receiver functions

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Abstract

The Mantle Transition Zone (MTZ), the region between 410 km and 600 km depth, is vital for the Earth's thermal and chemical evolution. Phase changes and associated density variations affect material transfer across this region, thus controlling the convection between upper and lower mantle. The mantle dynamics hold clues for present and past tectonic regimes. We use P-to-S receiver functions (RF) to determine the thickness of the MTZ, a proxy for its current thermal state. We use data from 723 stations across the Alpine region including the AlpArray network and permanent stations from 2016 to 2020, for events with magnitude greater than 6 Mw, and a distance range of 35 to 80 degrees. Seismic records were pre-processed to remove instrument response, filtered using a zero-phase second order Butterworth filter with cutoff frequencies at 0.2 Hz and 0.05 Hz, followed by rotation to radial and transverse components. Ps receiver functions were computed by deconvolving traces with clear P-wave phase from the radial component using iterative time domain deconvolution and extended time multi-taper frequency domain deconvolution. Waves with clear P-, P410s, and P660s were selected and migrated to depth using regional 3D surface wave tomography model, and then back projected onto a 3D grid. The structure of the Alpine Mantle Transition Zone shows evidence for the subduction of the European plate in the western Alps. Punctuated anomalies beneath the Eastern Alps show evidence for uplift of 410 km discontinuity, suggesting localized regions where parts of the slab reaching the transition zone. Further analysis could likely provide clues to the dipping orientation of the subducted slab.