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Imaging the Alpine mantle transition zone with receiver functions

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Assessing the thermal state of the mantle transition zone (MTZ) is of great importance for understanding mantle dynamics providing crucial clues to unravel present and past tectonic regimes. The complex tectonic history related to closure of the Alpine Tethys has left, in addition to evident surface signatures in the Alps, its imprint on regional upper-mantle structures due to oceanic and continental lithosphere penetration. To provide new insights on the state of the Alpine MTZ, we exploit P-to-S wave conversions (receiver functions) to detect the 410- and 660-km discontinuities. We compiled a dataset of teleseismic earthquakes (M$>$5.5) recorded by nearly 90 permanent stations distributed in a 1000 km by 500 km wide region encompassing the Alpine chain. For the time period 1999-2007, we obtained about 6000 high-quality receiver functions yielding a reliable image of the Alpine MTZ. The resulting image of the depth-projected and stacked receiver functions shows significant signal related to the 410- and 660-km discontinuities (P410s and P660s respectively). The P410s is found at a depth close to that predicted by global models; weak signal continuity is observed only south of the Alps. In contrast, signal from the P660s is continuous and strong throughout the whole Alpine region but at depths greater than predicted by global models. Due to this relative deepening of the P660s, the MTZ is thickened by about 10 km north of the Alps and by 40 km south of the Alps and in the Western Alps; the latter outlining a roughly 300 km-wide and 1000 km-long ENE-WSW directed thickness anomaly. Considering the, respectively, endothermic and exothermic character of the 410- and 660-km phase transitions, the observed 40-km thickening of the Alpine MTZ reflects a negative temperature anomaly of at least 400°C. Both location

and amount of this anomaly agree with large-scale tomography models indicating accumulation of cold material in the transition zone beneath the Alpine-Mediterranean region that are interpreted as remnants of former subducted and detached slabs of the Alpine Tethys ocean.