High-resolution teleseismic body-wave tomography with a 3D initial crustal model for crust-to-upper mantle images in highly heterogeneous media.

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Local and teleseismic body wave inversions are two approaches commonly used to obtain 3D Earth velocity models for shallow and mantle scale, respectively. However, each method used separately is poorly resolved at the mantle/crust boundary while imaging that interface is important to understand the geodynamic processes (e.g. magmatic underplating, mantle delamination, crustal thinning or thickening) occurring at this depth. In order to develop a high-resolved final velocity model, the two approaches were combined. First, an irregular grid was settled, with a higher density of nodes at crustal scale (from 0 to 40 km) and an increasing node step when approaching the limits of the model. Then, an a priori 3D crustal velocity model (from an independent local tomography) was inserted within the 1D IASP91 lithospheric one. Finally, the teleseismic tomographic inversion was carried out at crust-to-upper mantle scale using this new mixed initial model and teleseismic data. We applied the method on a real case that includes both tectonic and magmatic processes, the North Tanzanian Divergence (NTD). Synthetic tests showed that we had no resolution between 0 and 35 km. However, a fine crustal grid with the 3D local model helps to better constrain ray paths, limiting the artefacts and smearing from the mantle to the crust, enhancing details, sharpening the velocity anomalies and modifying the geometry of anomalies at depth (> 150 km). Following these tests, we propose then a final scheme in which we include the a priori crustal 3D velocity model in the finer crustal grid, and we prevent the inversion from modifying it. This insertion of strong crustal constraints in teleseismic inversion provides sharper spatial resolution at both crustal and mantle scales, including areas with poor ray coverage, beneath the NTD region. Our strategy allows to counteract the degradation of the results in areas with low velocity zones (such as rift and hotspot), where the seismic rays go around these anomalies.