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# A new technique to construct a 3-D shear-wave velocity model based on P-to-S converted waves: implementation of ray tracing and inversion

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The main target of this study is to develop a new tool in which P-to-S converted waves are exploited to construct a fully 3-D shear-wave velocity model of the crust. A reliable 3-D structure is a key point in all branches of Earth sciences because most geological bodies may vary considerably in their lateral dimension. Our technique combines the strength of receiver functions, i.e. shear-wave velocity sensitivity, and builds on more and more used seismological dense networks.

For the benchmark study we focus on the Central Alps, and perform the analysis of RFs using a dataset composed of the last 20 years' of high-quality data recorded at 81 permanent broad-band stations. We selected data from teleseismic events of magnitude greater than 5.2 in an epicentral distance range between 30˚ and 90˚, leading to more than 5 800 earthquakes, and resulting in more than 200 000 traces in total.

Synthetic RFs are obtained from 1-D velocity models which are extracted from the 3-D structure along rays, and then compared to observed RFs. For each trace we consider a spherical approximation of ray propagation using a global velocity model (IASP91, Kennett and Engdahl, 1991) for the teleseismic part, while we adopt Cartesian coordinates and a local velocity model for the crust. We compute rays according to Snell's law and the shooting method to make the P-S converted wave arrive at the stations. This allows us to construct the ray coverage map of the studied area.

For the inversion we parameterize a multi-layer crustal model for shear-wave velocity, with a flexible mesh for the depth of the interfaces, which adapts to the discretized model of local Moho. For each layer we define the velocity at the top and at the bottom, so that the velocity jump between neighbouring layers produces a discontinuity. We envisage to manage the inversion by the stochastic Neighbourhood Algorithm approach (NA, Sambridge, 1999).

Our first focus of application is the Central Alps, where a well-defined Moho map (Spada et al., 2013) and high-resolution P-wave velocity-model (Diehl et al., 2009) are available. Later, we plan to extend the 3-D shear-wave velocity inversion method to the entire Alpine domain in frame of the AlpArray project, and apply it to other areas with a dense network of broadband seismometers.