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Recent developments for passive imaging of the continental lithosphere

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Recent dense regional deployments offer new opportunities to improve the spatial resolution of tomographic images of the continental lithosphere. This is particularly important for subduction zones and continental orogens, which are heterogeneous over a very wide range of scales. Significant progress has been made thanks to the reformulation of the inversion problem using a full 3D covariance matrix, which allows us to take into account the well-known correlation between density and Vp, as well as between Vp and Vs. With this new approach, robust 3D models of density, Vp, and Vs can be obtained by inverting teleseismic P and S waveforms. For surface waves, we have shown that phase velocity maps can be obtained by Helmholtz tomography, with a resolution close to the wavelength of Rayleigh waves, without solving an inverse tomography problem. Indeed, the principle of this method is to interpolate the seismic wavefield sampled at the station positions with the wave equation using generalized smoothing splines. From the amplitude and phase of the wavefield, we can then simply derive the phase velocity model in the region under study. This new tomographic approach reveals the structures beneath continents in unprecedented detail, in particular the thick crustal roots beneath mountain ranges. We will illustrate the potentials of these new imaging methods with recent results obtained in western Europe, Cascades, southern Peru and Taiwan. We will also present some preliminary attempts to combine body and surface waves in joint inversions to further improve these passive imaging methods.

Keywords: seismic tomography, subduction zones, lithosphere, full waveform inversion