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Crustal anisotropy inferred from a single receiver-function splitting analysis - a tool for temporary seismic stations

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Previously proposed methods to infer crustal anisotropy from receiver functions require a more-or-less complete azimuthal coverage of the teleseismic events, as they are based on periodical variations of amplitudes and arrival times of the crustal Ps phases (e.g., Rümpker et al., 2014). In temporary deployments of seismic stations, the necessary azimuthal coverage, often, cannot be acquired.

Our new approach is based on an extension of the well-known H-κ-stacking algorithm of Zhu and Kanamori (2000) to anisotropic media. In the inversion we use the polarizations and arrival times of the two crustal Ps- and PpPs-phases to simultaneously constrain the thickness of the crust, H, the average P to S velocity ratio, κ, the fast-axis orientation of the crust, φ, and the percentage of anisotropy, a. The calculations are based on solving the eigenvalue problem of the anisotropic system matrix defined by Woodhouse (1974).

In the algorithm we rotate the receiver functions into the polarization direction of the fast and slow traveling crustal phases using variable fast-axis orientations. This enables a separation of the energy of the fast and slow traveling phases and serves to stabilize the inversion. In the stacking procedure we sum up the energy of the rotated components of the receiver functions based on simple crustal models, by systematically varying the corresponding parameters. The maximum of the stacking function is obtained for the model parameters (H,κ,φ,a) that best explain the observed receiver functions.

We apply the method to synthetic waveforms as well as to data from the Swiss seismic network and test for different (limited) event distributions.

We show that it is possible to obtain all parameters from one receiver function only, if the backazimuth of the event is different from the fast or slow axis direction (thus excluding “null” measurements).