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Simultaneous Inversion of Multiple Waveforms (SIMW) for SKS splitting measurements: Performance and limits derived from synthetic tests

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The application of teleseismic shear wave splitting measurements to detect large-scale azimuthal anisotropy is a well established approach. In most cases core-refracted shear waves (SKS, SKKS) are used to determine the strength and orientation of S-wave anisotropy in the upper mantle beneath a seismic recording station. However, especially for temporary seismic networks, if any, only shear wave recordings with low signal-to-noise-ratios (SNR) of low-magnitude earthquakes are available for few source regions on Earth. Resulting SKS- or SKKS-phase observations usually provide only non-stable splitting parameters for the given backazimuths. Thus, due to missing well recorded SKS- or SKKS-phase observations, the results are often interpreted under the assumption of a single anisotropic layer instead of possibly existing multi-layer anisotropic structures. The latter one can only be recovered with recordings from different backazimuths.

In order to improve the backazimuthal coverage the SIMW method (Simultaneous Inversion of Multiple Waveforms) allows to simultaneously invert SKS waveforms of different seismic events from the same source region by concatenate the individual waveforms recorded at a single seismic station. In particular, it is possible to include low-amplitude and noisy records. This strategy can increase the observational data in search for multilayer cases. So far, the method was successfully tested with real data of the Norwegian Seismic Array (NORSAR), Gräfenberg array (GER) and several other stations in central Europe.

Here we systematically perform SIMW by using synthetic SKS wavelets with different SNRs and from different backazimuths. Inversion of the concatenated waveforms is handled by using the SplitLab package by Wüstefeld et al. (2008). Our synthetic tests demonstrate that especially for backazimuths close to Null directions we can improve the splitting results by using multiple event waveforms with low SNR compared to a single event of the same source region with much higher SNR. Also for other backazimuths improvements can be observed.