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3D seismic velocity model of the Taurus-Zagros region of Iran and Turkey using full-waveform inversion

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In this study we present the results of an ongoing 3D full-waveform inversion for the Arabian-Eurasian collision zone in eastern Turkey and Iran. This is intended to extract as much information as possible from available seismograms in order to constrain seismic structure in both the crust and the upper mantle.

In our method we simulate the 3D visco-elastic wavefield using the newly developed spectral-element solver Salvus. Our numerical mesh honors topography of the surface and internal discontinuities. We compare observed and synthetic waveforms using time frequency phase misfits. Using adjoint techniques, we then compute sensitivity kernels with respect to the model parameters, which are V_{SV}, V_{SH}, V_{PV}, and V_{PH}. Finally, the kernels enable the iterative solution of the nonlinear inverse problem with the help of the L-BFGS algorithm.

For this study we obtained seismic waveform data of 143 earthquakes within the magnitude range of Mw 4.5 to 6.3 that occurred in the region between 2012 and 2016. These events were recorded by 271 broadband seismic stations belonging to the two national Iranian networks and freely available seismic stations of the Turkish Network, made available by IRIS. For data management and workflow organisation we employ the Large-Scale Seismic Inversion Framework (LASIF), modified to operate with the Adaptable Seismic Data Format (ASDF), which facilitates simulations on large HPC clusters.

Starting from the first generation of the Collaborative Seismic Earth Model, we first constrain longer-wavelength structure. To this end, we consider 3-component recordings from a subset of 41 events in the period range from 50 to 80 s. This period range is successively broadened to include shorter periods; for instance, the lower end of the period range was meanwhile extended to 35 s. For each period band, the number and the length of measurements are increased to ultimately comprise almost complete seismograms, and also the number of events is increased to use complete of dataset.