3-D seismic full-waveform inversion of the Taurus-Zagros region in Iran and Turkey

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We present an interpretation of a 3-D velocity model resulting from a regional analysis of earthquake waveforms. This model contains 3-D structure of the crust and upper mantle beneath the Arabian-Eurasian collision zone in eastern Turkey and Iran. We use full-waveform inversion (FWI) of three-component recordings from permanent networks. FWI can exploit all parts of a seismogram, including body and multi-mode surface waves in a broad range of frequencies. This allows us to constrain seismic structure of both the crust and the upper mantle.

In our method we simulate 3-D visco-elastic wavefields using a spectral-element method (Fichtner et al., 2018). Our numerical mesh honors topography of the surface. 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 and without a need for crustal corrections.

For this study we obtained seismic waveform data of 59 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 398 broadband seismic stations belonging to the two national Iranian networks and freely available seismic stations of the Turkish Network, made available by IRIS.

Starting from the first generation of the Collaborative Seismic Earth Model (Afanasiev et al. 2019), we first constrained longer-wavelength structure. To this end, we considered 3-component recordings from a subset of 37 events in the period range from 50 to 80 s. This band was successively broadened by reducing the shorter period from 50 s to 40 s, and finally to 20 s. For each period band, the number and the length of measurement windows are increased; the number of events is also increased to 59 to use the complete dataset. After 46 iterations our model can explain recordings of events, which were not used in the inversion. The results provide to discuss about high-velocity anomaly beneath the Zagros and the shallow low velocities beneath Central Iran using cross-sections to investigate lateral variation of seismic velocity in the lithosphere.

REFERENCES