Complex slab structure in the Eastern Mediterranean from waveform tomography

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We present a seismic waveform tomography of the Eastern Mediterranean. The Mediterranean domain is a geologically complicated region, which is a result of its complex tectonic and geodynamic evolution. Our understanding of it draws from surface geology, modeling and imaging of the subsurface. Using waveform tomography, we image the upper mantle, illuminating various geodynamically and tectonically interesting structures.

While computationally more expensive than ray-based imaging methods, the advantage of waveform methods lies in their ability to incorporate in a consistent manner all the information in seismograms – not just the arrivals of certain, specified phases. As a result, body and multimode surface waves, source effects, frequency-dependence, wavefront healing, anisotropy and attenuation are naturally and coherently incorporated.

Our tomography makes use of a multi-scale approach, initially using only signals with long periods of 100-150 s. This approach, combined with targeted window picking for different phases, results in a good illumination of the whole upper mantle in the study region. As the data fit improves, more short-period data is gradually included and more detailed structure emerges. Only those parts of seismograms are used in which data and synthetics are similar enough to allow for meaningful comparison.

We go down to periods of about ∼30 s, which corresponds to structures of ∼50 km size in the crust to ∼80 km in the mantle. A comparison of waveforms of independent events that were not included in the inversion shows a good improvement in waveform fit, indicating the robustness of the model with respect to new data.

The resulting model displays several structures that can be correlated with the geology of the region, the most important of which is a clear high-velocity structure that can be identified as the Aegean slab. Similar structures can be linked to the Italian peninsula, the Dinarides, and Turkey. This shows correspondence with other models, although intriguing differences are also observed. In addition to the velocity model, we will also discuss the recovery of density structure using waveform tomography methods.