Multiscale Seismic Full-waveform Tomography of the Crust and Mantle beneath China and adjacent regions

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The late Mesozoic and Cenozoic plate tectonic evolution of the broad Asian region is associated with the northwestward subductions of the Pacific and Philippine Sea plates in the east and the collision and convergence of the Indo-Australian with the Eurasian plates along the Tethys tectonic belt in the southwest. To better understand the subsurface behavior of subducting slabs and their effects on the tectonic evolution of the overriding plates, we are conducting a multiscale full seismic waveform inversion at the period from 30 to 120 s based on spectral-element and adjoint methods. This is intended to provide a high-resolution seismic model of the crust and mantle down to ~2000 km depth under China and adjacent regions.

For the forward and adjoint simulations we use the newly developed spectral-element solver Salvus (Afanasiev et al., 2019), which allows us to simulate the 3D visco-elastic wavefield in highly heterogeneous, attenuating and anisotropic media, while respecting surface topography and internal discontinuities. We compare observed and synthetic waveforms based on time-frequency phase misfits, and compute sensitivity kernels with respect to the vertically and horizontally propagating/polarized P and S velocities ($V_{PH}$, $V_{PV}$, $V_{SH}$, $V_{SV}$) and density ($\rho$). Finally, we take advantage of the iterative solution of the nonlinear inverse problem with the help of the L-BFGS algorithm to update the structural model.

For this study we selected 386 earthquakes in the moment-magnitude range 5.0 ≤ Mw ≤ 6.8 that occurred in the region between 2009 and 2018. Our final dataset contains 1,281,216 three-component recordings from the above events recorded at 2,426 unique stations. To reduce the risk of convergence towards a local minimum, we divide the whole inversion procedure into three successively broadened period bands (70-120 s, 50-120 s, 30-120 s). The starting model is extracted from the Collaborative Seismic Earth Model (Fichtner et al., 2018) and we will conduct the inversion from longer to shorter period. The primary goal of this ongoing study is to probe into the Mesozoic and Cenozoic plate tectonics and mantle dynamics of the Asian continent setting in two unique tectonic systems (Indo-Australia-Eurasia and Western-Pacific Subduction Zones) with a holistic viewpoint, rather than discuss several hot topics in isolation.

References