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A parametric analysis of lithospheric imaging by Full-Waveform Inversion of teleseismic body-waves

Stephen Beller (1), Vadim Monteiller (1), Stéphane Operto (1), Guust Nolet (1), and Jean Virieux (2)
(1) Géoazur, Université de Nice Sophia-Antipolis, France, (2) ISTerre, Univeristé Joseph Fourier, France

With the deployment of dense seismic arrays and the continuous growth of computing facilities, full-waveform inversion (FWI) of teleseismic data has become a method of choice for 3D high-resolution lithospheric imaging. FWI is a local optimization problem that seeks to estimate Earth's elastic properties by iteratively minimizing the misfit function between observed and modeled seismograms. Recent investigations have shown the feasibility of such local inversions by injecting a pre-computed global wavefield at the edges of the lithospheric target.

In this study, we present all the methodological ingredients needed for the application of FWI to lithospheric data. The global wavefield, which is computed in an axisymmetric global earth with AxiSEM, is injected in the lithospheric target by the so-called total-field/scattered-field method. The inversion, which is implemented with an adjoint formalism, is performed following a multiscale approach, proceeding hierarchically from low to high frequencies. We further perform a parametric analysis in a realistic model representative of the Western Alps.

This analysis mainly focus on the FWI sensitivity to the source characteristics. One key issue is the estimation of the temporal source excitation, as there might be some trade-off between the source estimation and the subsurface update. We also investigate the imprint of the sources repartition on the spatial resolution of the imaging, the FWI sensitivity to the accuracy of the starting model and the effects of considering a complex topography. Seismic modeling in the FWI models allows us to assess which parts of the teleseismic wavefield significantly contribute to the imaging.