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Local full-waveform inversion using distant data

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Imaging remote objects in the deep Earth, such as, subducting slabs, mantle plumes, or large low shear velocity provinces and ultra low velocity zones is key for understanding Earth's structure and the geodynamical processes involved as it cools. In order to image these structures, we developed a strategy for performing regional-scale full-waveform inversions at arbitrary location inside the Earth [1]. Our approach is to confine wave propagation computations inside the region to be imaged. This local wavefield modeling is used in combination with wavefield extrapolation techniques in order to obtain synthetic seismograms at the surface of the Earth [2]. This allows us to evaluate a misfit functional and sensitivity kernels can then be computed locally using the adjoint state method [3]. The Green's functions needed for extrapolating the wavefield are computed once for all in a 3D reference Earth model using the spectral element software Specfem/3DGLOBE. We will present benchmark tests demonstrating that the proposed method allows us to image 3D localized structures - this without having to model wave propagation in the entire Earth at each iteration, which is prohibitively costly, thus improving the feasibility of accurate imaging of regional structures anywhere in the Earth using numerical methods. We will show that our method permits to account for additional data in regional inversions, that is to account for distant earthquakes that are located outside the region of the study - preliminary results for the tomography of the north American continent will be presented.

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