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Seismic Waveform Inversion by 2D Curvilinear Grid Finite Difference Method

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Seismic waveform inversion uses waveform difference between observations and synthetics as a misfit function to constrain the detailed structure. Tromp et al. (2005) proposed adjoint kernels, which are used to construct gradients of misfit function in inversion problems, can be obtained by two forward modellings. In present study, the 2D curvilinear finite difference method (Zhang & Chen, 2006) is utilized to calculate adjoint kernels based on forward, backward and adjoint wavefields. The curvilinear finite difference method can implement topographic free surface boundary conditions by the traction imaging method with high accuracy than conventional rectangle grid finite difference methods, and it requires less computing cost than the finite element based methods.
In this study, the waveform inversion algorithm of adjoint method based on curvilinear grid finite difference is validated by numerical tests on checkboard models and borehole models. In the inversion part of the algorithm, the gradients of misfit function are used by conjugate gradient (CG) and limited-memory Broyden-Fletcher-Goldfarb-Shanno (L-BFGS) methods respectively to iteratively adjust initial uniform model to the final-best model. Moreover, in reality, topography effect is common and cannot be ignored in wavefield simulation and waveform inversion. The topography effect is investigated from inversion results with different topography scales and a test on a real crust structure with surface topography is also conducted.