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Double-Difference Measurements in Global Adjoint Tomography

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The adjoint method efficiently incorporates 3D seismic wave simulations and Fréchet kernels in seismic tomography, and has been successfully applied to exploration and global-scale imaging problems. It is well known that the success of inversions is closely tied to the chosen misfit function. The recently proposed double-difference (DD) method for adjoint inversions (Yuan et al. 2016) minimizes systematic errors in structural inversions related to source parameters, such as origin times, source time functions, etc. Moreover, since the DD method is based on differential measurements between station pairs, bias in structural inversions due to an uneven distribution of stations is also reduced.

In this study, our aim is to take advantages of the DD method in real full-waveform inversion problems based on earthquake data. Our main focus is to demonstrate it at the global-scale adjoint tomography. To this end, we closely follow the global adjoint tomography strategies presented in Bozdag et al. (2016) and first consider extending phase misfits, such as multitaper cross-correlation measurements, to the DD approach. The major challenges are to reduce the computational cost of making differential measurements on every station pair and assimilating misfits of all phases in DD measurements. We have initiated the first tests with surface-wave data only. We explore how to incorporate body waves in double-difference adjoint tomography and implement various other misfits, such as instantaneous phase measurements, in the context of global inversions. We discuss how we can implement DD measurements into global adjoint tomography studies in a feasible way and present our initial results.