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Continental scale waveform tomography using both global and regional data: Application to the north american craton

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Yuan et al. (2014), obtained a 3D radially anisotropic shear wave model of North America (NA) through waveform tomography. To build this model, both teleseismic and regional data sampling NA were used. Synthetic seismograms associated with regional data were computed exactly using the spectral element method (RegSEM, Cupillard et al., 2012), while synthetic seismograms corresponding to teleseismic data were computed approximately using normal mode asymptotic coupling theory (Li and Romanowicz, 1995). A Gauss-Newton scheme using approximate kernels (based on the same normal mode theory) was used for the inversion. We present a preliminary update of this model that benefits from our latest methodological developments. First, synthetics seismograms for teleseismic events are now computed using the spectral element method. However, we use a hybrid modeling approach (Masson et al., 2013), which allows us to perform a single teleseismic SEM computation in the background global3D model followed in the subsequent iterations by exclusively regional scale, less costly, spectral element simulations. Second, the gradient in the aforementioned Gauss-Newton scheme is now computed using an adjoint method. This more accurate gradient is used along with an approximate Hessian (that is efficiently computed using normal mode theory). This leads to a hybrid Gauss-Newton scheme that we are testing against both a steepest descent approach (i.e. using the adjoint gradient only) and against the approximate Gauss Newton scheme (i.e. where both the gradient and the Hessian are approximated using normal mode asymptotic coupling theory).