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Simulation and inversion of full waveforms for 3-D Earth structures and sources

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Recently, we have seen the first applications of waveform tomography based on complete solutions to the elasto-dynamic equations in 3-D. Given the developments of computational infrastructure and resources waveform tomography may become the method of choice to determine deep Earth structure given appropriate observational coverage. The core of any inversion is the calculation of synthetic seismograms and there are as many approaches as there are numerical methodologies. Here, we discuss advances using a regular-grid spectral element approach and an algorithm based on the discontinuous Galerkin (DG) method. The latter is based on tetrahedral grids. Due to the fact that the DG approach allows the spatial fields to be discontinuous at the element boundaries the method lends itself to the simulation of rupture along of frictional boundaries (dynamic rupture). Combined with the geometrical flexibility of tetrahedral grids ruptures on arbitrarily shaped faults are possible. In addition to these technical developments we show applications of seismic modeling and inversion based on finite frequency techniques, global wave propagation, and Monte Carlo investigation of model uncertainties.