Whole Earth Full-Waveform Inversion With Wavefield Adapted Meshes

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With the steadily increasing availability and density of seismic data, full-waveform inversion (FWI) can reveal the Earth’s subsurface with unprecedented resolution. FWI, however, carries a significant computational burden. Even with the ever-increasing power of high-performance computing resources, these massive compute requirements inhibit substantial progress, and require algorithmic and technological innovations for global and continental scale inversions. In this contribution, we present an approach to FWI where we achieve significant computational savings through wavefield adapted meshing [1] combined with a stochastic optimization scheme [2]. This twofold strategy allows us (a) to solve the wave equation at lower costs, and (b) to reduce the number of required simulations. In laterally smooth media, we can construct meshes which are adapted to the expected complexity of the wavefield. By optimally designing a unique mesh for each source, we can reduce the computational cost of the forward and adjoint simulations by an order of magnitude. The stochastic optimization scheme is based on a dynamic mini-batch L-BFGS approach, which adaptively subsamples the event catalogue and requires significantly fewer wavefield simulations to converge to a model than conventional FWI. An additional benefit of the dynamic mini-batches is that they seamlessly allow for the inclusion of more sources in an inversion without a considerable additional computational cost. We demonstrate a prototype FWI for this approach towards a global scale inversion with real data.