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Global Adjoint Tomography

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We will present our initial results of global adjoint tomography based on 3D seismic wave simulations which is one of the most challenging examples in seismology in terms of intense computational requirements and vast amount of high-quality seismic data that can potentially be assimilated in inversions. Using a spectral-element method, we incorporate full 3D wave propagation in seismic tomography by running synthetic seismograms and adjoint simulations to compute exact sensitivity kernels in realistic 3D background models. We run our global simulations on the Oak Ridge National Laboratory's Cray XK7 "Titan" system taking advantage of the GPU version of the SPECFEM3D_GLOBE package. We have started iterations with initially selected 253 earthquakes within the magnitude range of 5.5 < Mw < 7.0 and numerical simulations having resolution down to $\sim$27 s to invert for a transversely isotropic crust and mantle model using a non-linear conjugate gradient algorithm. The measurements are currently based on frequency-dependent traveltime misfits. We use both minor- and major-arc body and surface waves by running 200 min simulations where inversions are performed with more than 2.6 million measurements. Our initial results after 12 iterations already indicate several prominent features such as enhanced slab (e.g., Hellenic, Japan, Bismarck, Sandwich), plume/hotspot (e.g., the Pacific superplume, Caroline, Yellowstone, Hawaii) images, etc. To improve the resolution and ray coverage, particularly in the lower mantle, our aim is to increase the resolution of numerical simulations first going down to $\sim$17 s and then to $\sim$9 s to incorporate high-frequency body waves in inversions. While keeping track of the progress and illumination of features in our models with a limited data set, we work towards to assimilate all available data in inversions from all seismic networks and earthquakes in the global CMT catalogue.