**Global Adjoint Tomography**

Matthieu Lefebvre, V. Balasubramanian, E. Bozdag, Y. Chen, S. Jha, J. Hill, D. Komatitsch, W. Lei, M. Turilli, D. Peter, Y. Ruan, J. Tromp  
Oak Ridge National Laboratory

[ml15@princeton.edu](mailto:ml15@princeton.edu)

**Abstract**

Our research addresses the long-standing challenge of imaging Earths interior based on full-waveform inversion. Our “global adjoint tomography” project combines 3D simulations of global seismic wave propagation with the assimilation of data from an exhaustive earthquake catalog. Full-waveform inversion (FWI) combines 3D forward simulations with Frechet derivatives computed in 3D background models to fit complete three-component seismograms.

Using the GPU version of the SPECFEM3D\_GLOBE solver, we initiated our inversion on   
Oak Ridge's Titan system with a selection of 253 earthquakes. This resulted, after 15 iterations, in the first-generation global adjoint tomography model. Such an improved model is essential for understanding mantle dynamics and related surface tectonic processes, for example the origin of hotspots and the forces behind plate motions and earthquakes.

The adjoint tomography workflow consists of four major stages: 1) forward simulations,   
2) pre-processing and construction of adjoint sources, 3) gradient calculation, and 4) post-processing and model update. As part of our INCITE allocations, we addressed bottlenecks in the FWI workflow, which mainly come from heavy I/O traffic during the simulation and processing stages.

To refine our model, we have increased the selection to 1,480 earthquakes. The large amount of computations mandates workflow automation to allow for better data management and some level of fault tolerance. This is being addressed by the Ensemble Toolkit project, a pilot-based approach allowing end-users to express dependencies between computational tasks. Efforts are also made to port the whole workflow, including SPECFEM3D\_GLOBE to Summit.