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Global Adjoint Tomography: Next-Generation Models

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The first-generation global adjoint tomography model GLAD-M15 (Bozdag et al. 2016) is the result of 15 conjugate-gradient iterations based on GPU-accelerated spectral-element simulations of 3D wave propagation and Fréchet kernels. For simplicity, GLAD-M15 was constructed as an elastic model with transverse isotropy confined to the upper mantle. However, Earth's mantle and crust show significant evidence of anisotropy as a result of its composition and deformation. There may be different sources of seismic anisotropy affecting both body and surface waves. As a first attempt, we initially tackle with surface-wave anisotropy and proceed iterations using the same 253 earthquake data set used in GLAD-M15 with an emphasize on upper-mantle. Furthermore, we explore new misfits, such as double-difference measurements (Yuan et al. 2016), to better deal with the possible artifacts of the uneven distribution of seismic stations globally and minimize source uncertainties in structural inversions. We will present our observations with the initial results of azimuthally anisotropic inversions and also discuss the next generation global models with various parametrizations.

Meanwhile our goal is to use all available seismic data in imaging. This however requires a solid framework to perform iterative adjoint tomography workflows with big data on supercomputers. We will talk about developments in adjoint tomography workflow from the need of defining new seismic and computational data formats (e.g., ASDF by Krischer et al. 2016, ADIOS by Liu et al. 2011) to developing new pre- and post-processing tools together with experimenting workflow management tools, such as Pegasus (Deelman et al. 2015). All our simulations are performed on Oak Ridge National Laboratory's Cray XK7 "Titan" system. Our ultimate aim is to get ready to harness ORNL's next-generation supercomputer "Summit", an IBM with Power-9 CPUs and NVIDIA Volta GPU accelerators, to be ready by 2018 which will enable us to reduce the shortest period in our global simulations from 17 s to 9 s, and exascale systems will reduce this further to just a few seconds.