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3D Seismic Wave Simulations of Mantle Heterogeneity and Shear Wave Splitting Phases

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Constraining the pattern and properties of seismic anisotropy in the Earth can help reveal relationships between mineral physics, mantle convection, and seismology. Sources of anisotropy in the lithosphere as frozen-in anisotropy, transition zone, and D" complicate shear wave splitting measurements, resulting in shear wave splitting that can differ from plate motion. If we better understand seismic anisotropy sourced in the lithosphere, we could also better constrain D" anisotropy, which requires correcting for the upper mantle to some extent. The goal of this work is to investigate the effect of 3D mantle and crustal structure on waveforms based on 3D wave simulations and adjoint data sensitivity kernels. We will explore the common phases (SKS, SKKS, S, ScS, PKS, etc.) and the common distance ranges used for mantle shear wave splitting with a resolution down to 9 s by conducting numerical simulations via 3D global wave propagation solver SPECFEM3D_GLOBE. We show results for a 1D mantle model (i.e., PREM [Dziewonski and Anderson, 1981]) and at least three 3D mantle models (S20RTS [Ritsema et al., 2011], GLAD-M15 [Bozdag et al., 2015], GLAD-M25 [Lei et al., 2020]). We calculate a number of data sensitivity kernels for travel time, amplitude, and anisotropy for our phases of interest over a variety of event depths and distance ranges. This work will help improve the measurements of shear wave splitting. The long-running goal is to use shear wave splitting in global full waveform inversion by addressing appropriate parameterization to describe body-wave anisotropy in the mantle during the inversion process. All simulations were conducted on a Research Allocation on the high-performance computing environment of XSEDE resources (TACC Stampede2).