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3D anisotropy sensitivity kernels using adjoint methods

A. Sieminski (1), Q. Liu (2), J. Trampert (1), J. Tromp (2)

(1) Utrecht University, Netherlands, (2) Caltech Seimological Lab, USA, (anne@geo.uu.nl)

Anisotropy is necessary to explain many seismological observations, and imaging this property is potentially very useful to constrain mantle dynamics. While the 3D sensitivity of the usual seismic data to isotropic mantle structure has now been widely studied, relatively little is known about the sensitivity to anisotropy. Understanding how seismic waves "see" anisotropy is crucial to efficiently extract information about mantle anisotropy from seismograms. Adjoint methods are one of the most efficient tools for a thorough analysis of the 3D finite-frequency sensitivity of seismic data. Using this approach, we calculate numerically the sensitivity kernels for the "primary" 21 independent coefficients of the elastic tensor through the interaction between the forward wavefield, propagating from source to receiver, and an adjoint wavefield, propagating from receiver to source. The expression of the adjoint wavefield depends on the kind of data we consider. We compute the wavefields with a global spectral element method. The 21 primary kernels can then combined to calculate the sensitivity to any combination of anisotropic parameters. We analyze these more fundamental "secondary" kernels for transverse isotropic structure as well as to for azimuthal anisotropic parameters. The data we consider are traveltime anomalies of body waves and phase anomalies of surface waves. We will consider these results in the context of mantle imaging.