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Seismic Wave Propagation in Fully Anisotropic Axisymmetric Media: Applications and Practical Considerations

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We present a numerical method to compute high-frequency 3D elastic waves in fully anisotropic axisymmetric media. The method is based on a decomposition of the wavefield into a series of uncoupled 2D equations, for which the dependence of the wavefield on the azimuth can be solved analytically. The remaining 2D problems are then solved using a spectral element method (AxiSEM). AxiSEM was recently published open-source (Nissen-Meyer et al. 2014) as a production ready code capable to compute global seismic wave propagation up to frequencies of $\sim$2Hz. It accurately models visco-elastic dissipation and anisotropy (van Driel et al., submitted to GJI) and runs efficiently on HPC resources using up to 10K cores.

At very short period, the Fresnel Zone of body waves is narrow and sensitivity is focused around the geometrical ray. In cases where the azimuthal variations of structural heterogeneity exhibit long spatial wavelengths, so called 2.5D simulations (3D wavefields in 2D models) provide a good approximation. In AxiSEM, twodimensional variations in the source-receiver plane are effectively modelled as ringlike structures extending in the out-of-plane direction. In contrast to ray-theory, which is widely used in high-frequency applications, AxiSEM provides complete waveforms, thus giving access to frequency dependency, amplitude variations, and peculiar wave effects such as diffraction and caustics.

Here we focus on the practical implications of the inherent axisymmetric geometry and show how the 2.5D-features of our method method can be used to model realistic anisotropic structures, by applying it to problems such as the D" region and the inner core.