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An efficient, complexity-driven approach towards global waveform tomography

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We are developing a fast and efficient method that allows to transform waveform tomography into a higher-frequency range with more data, particularly suited for using body waves for 3D models.

This project adds the inversion framework to compute sensitivity kernels with wavefields produced by AxiSEM3D, a new and powerful wave propagation code. This will allow to capture the full 3D sensitivity of seismograms to Earth's structure at a much reduced cost compared to conventional 3D discretizations as the computational speedup offered by AxiSEM3D is exploited during the computation of the kernels, thereby rendering it orders of magnitude faster than alternative approaches for global waveform tomography.

One limitation of AxiSEM3D in the light of waveform tomography is the requirement that the source be rotated to the axis of the Earth to capture full 3D structures, which means that the typically employed continuous adjoint method cannot be used to ignite multiple adjoint sources off-axis simultaneously. However, we use the discrete adjoint formulation as found in many fields in physics and engineering, which allows us to circumvent this limitation. The wavefields produced by AxiSEM3D with off-axis sources in the discrete adjoint framework are not physical, however the sensitivity kernels are accurate and only those ingredients are needed from the adjoint wavefield. This approach thus allows us to further cut the number of simulations N receivers times, and further explore computational shortcuts due to the chosen measurement.

We will present the basic idea behind this approach as well as first examples of sensitivity kernels.