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Backus-Gilbert style inversions for mantle anisotropy using normal mode data

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Seismic tomography is essential for imaging the Earth's interior in order to better understand the dynamic processes at work. However, robust physical interpretation of tomographic images remain difficult as the inverse problem is under-determined, model amplitudes are biased and uncertainties are usually not quantified.

Commonly-used techniques, such as damped least-square inversions, break the non-uniqueness of the model solution by adding a subjective, ad hoc, regularization, which can lead to biased amplitudes and potential physical misinterpretations. The SOLA method (Zaroli, 2016; Zaroli et al., 2017), based on a Backus-Gilbert approach, removes the non-uniquess by averaging, rather than introducing a subjective regularization. The method explicitly constrains the amplitudes to be unbiased and the computation of the model resolution and uncertainty is inherent and efficient. Instead of aiming to minimize the data fit, the SOLA approach aims to minimize the size of the averaging volume and the associated uncertainties.

We aim to build a new tomographic model of the Earth's mantle using the SOLA method. We focus our observations on normal mode data, the standing waves of the Earth observed after very large earthquakes, which are not affected by an uneven data distribution. As normal modes are sensitive to multiple seismic parameters, we treat the sensitivity to different parameters as so called "3D noise" within the SOLA framework. We are specifically interested in constraining seismic anisotropy, which provides more direct information on mantle flow.

Here, we report on some forward modelling results, fundamental to understanding normal mode sensitivity to seismic anisotropy at different depths and identifying which modes to focus on during inversions. We also show our initial work towards building a new tomography model, including the calculation of 3D noise and target kernels.