JOINT INVERSION OF NORMAL-MODE AND FINITE-FREQUENCY BODY-WAVE DATA USING AN IRREGULAR TOMOGRAPHIC GRID

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Global-scale tomographic models should aim at satisfying the full seismic spectrum. For this purpose, and to better constrain isotropic 3-D variations of shear velocities in the mantle, we tackle a joint inversion of spheroidal normal-mode structure coefficients and multiple-frequency *S*-wave delay-times.

In all previous studies for which normal modes were jointly inverted for, with body and/or surface waves, the mantle was laterally parametrized with uniform basis functions, such as spherical harmonics, equal-area blocks, and evenly spaced spherical splines. In particular, spherical harmonics naturally appear when considering the Earth's free oscillations. However, progress towards higher resolution joint tomography requires a movement away from such uniform parametrization, to overcome its computational inefficiency to adapt to local variations in resolution.

The main goal of this study is to include normal modes into a joint inversion based upon a non-uniform parametrization, that is adapted to the spatially varying smallest resolving-length of the data. Thus, we perform the first joint inversion of normal-mode and body-wave data using an irregular tomographic grid, optimized according to ray density (Fig. 1, right). We show how to compute the projection of 3-D sensitivity kernels for both data sets onto our parametrization made up of spherical layers spanned with irregular Delaunay triangulations. This approach, computationally efficient, allows us to map into the joint model multi-scale structural informations from data including periods in the 10–51 s range for body waves and 332–2134 s for normal modes.

Tomographic results are focussed on the 400–2110 km depth range, where our data coverage is the most relevant. We discuss the potential of a better resolution where the grid is fine, compared to spherical harmonics up to degree 40, as the number of model parameters is similar. Our joint model seems to contain coherent structural components beyond degree 40, such as those related to the Farallon subduction (Fig. 1, left). Assessing their robustness is postponed to a future work. A wider application of this tomographic workflow [1], holding promise to better understand mantle dynamics at various spatial scales, should primarily consist in adding surface-wave data and extending our sets of normal-mode and body-wave data.

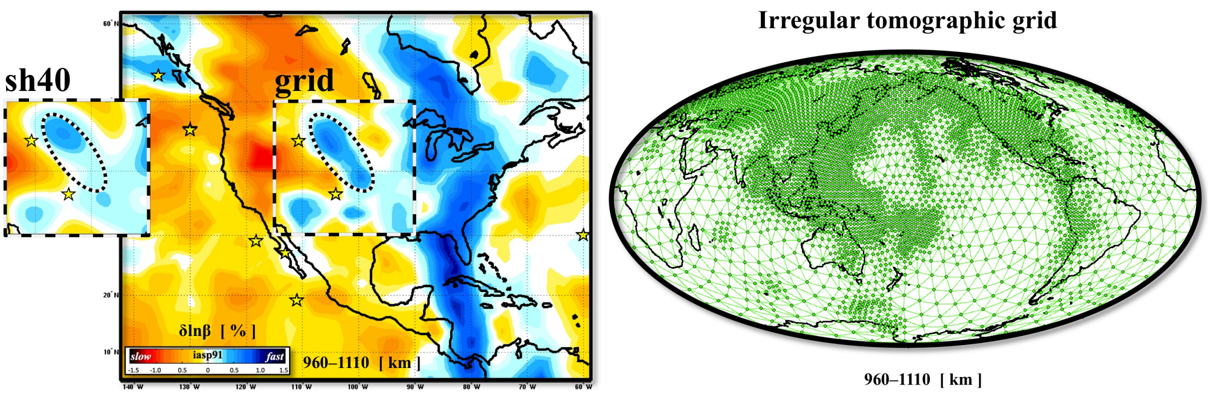

Figure 1. Zoom-in on the 3-D shear-velocity variations ($\delta \ln \beta$) related to the complex Farallon subduction system at 960–1110 km depth (left), as imaged in our joint model that was obtained using an irregular tomographic grid (right). Inset frame, on the left-hand side, shows the corresponding model from which all the spherical-harmonic components of degree greater than 40 have been filtered out. Note that our joint model seems to contain some coherent structural components well beyond degree 40.

References

[1] Zaroli, C., Lambotte, S., and Lévêque, J.-J., 2015. Joint inversion of normal-mode and finite-frequency *S*-wave data using an irregular tomographic grid, Geophysical Journal International, 203 (3): 1665-1681. doi: 10.1093/gji/ggv388