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Investigating trade-offs in anelastic full-waveform inversions for regional- to global-scale models

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Abstract Text:

The attenuation of seismic signals plays a crucial role in constraining water content, partial melting, and temperature variations in Earth's crust and mantle. That is, improving the resolution of seismic anelastic models is essential for better understanding the Earth's subsurface structure and its dynamics. However, attenuation tomography models are typically less resolved than seismic wavespeed models mainly due to amplitude measurements' complex nature, which are sensitive to scattering/defocusing, anelasticity, source radiation pattern, and scalar moment. Moreover, attenuation affects not only amplitudes but also seismic wavespeeds as it causes physical dispersion.

Taking the full 3D complexity of seismic wave propagation into account helps minimizing the bias from ignoring scattering/defocusing effects in classical anelastic models. Many synthetic tests have so far been performed to validate anelastic full-waveform inversions. However, the trade-off between the elastic and anelastic parameters, which may be highlighted more at the global scale because of the sparse data coverage, is not well investigated or understood in a full 3D setup.

Our goal is to test the resolution and trade-off between elastic and anelastic parameters by conducting a synthetic full-waveform benchmark targeting an existing global 3D attenuation model and starting from a 1D Q-model. Although we investigate whole mantle inversions down to the CMB together with the crust, our primary focus will be in the upper mantle where the low-Q layer in 1D Q-models located at around 200 km depth causes the main challenge, specifically in surface-wave propagation. Our measurement period range lies within 50 to 250 s for which the Cowling approximation to self-gravitation in the numerical wave propagation solver SPECFEM3D_GLOBE is still in good agreement. The aim is to assimilate both phase and amplitude pieces of information in our seismic inversions. The anelastic/elastic iterations are performed on PRACE's Marconi100 system, taking advantage of the GPU hardware accelerators. We present our benchmark results which will allow us to refine strategies for large-scale anelastic inversions.

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