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Refinement of tomographic models in the Western Mediterranean region through full waveform inversion

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Accurate imaging of crustal structures necessitates sophisticated inverse modeling utilizing extensive waveform data, including high-frequency signals from minor seismic events, an aspect traditionally underused in full waveform inversion (FWI). Integrating these intricate elements into novel tomographic models using FWI for the Western Mediterranean region, we address the challenge of enhancing model resolution while acknowledging the increased computational demands associated with inversion, an endeavor made feasible only through High-Performance Computing (HPC).

This study incorporates new considerations by comparing diverse reference models and updating a substantial dataset of earthquakes spanning the time interval from 2007 to 2022. While station deployment in the Mediterranean region is notably dense, the uneven geographical distribution of ray coverage from far-field waveforms necessitates the inclusion of lower magnitude earthquakes (M<4.5). This demands the determination of additional moment tensor solutions not readily available in public databases, alongside efforts to enhance signal-to-noise ratios. Our approach employs an iterative multiscale FWI approach, initially prioritizing the inversion of lower frequencies (period band of 100-120 s), and as the model refines, higher frequencies are progressively incorporated. The final goal is targeting a minimum period of 12 seconds or less. This incremental strategy aims to continuously enhance waveform fitting throughout each iteration, facilitated by an intensive computational workflow.

This contribution centers on the technical construction of the model, primarily focusing on S-velocity, and provides a comprehensive discussion of the employed data processing methods. We address the benefits, limitations and uncertainties inherent in this approach. Recognizing the pivotal role of higher-resolution velocity models in precise forward waveform modeling, we anticipate that the advancement of these inversion strategies will also contribute to refining earthquake-induced shake maps at regional to local scales. This research is funded by the Horizon Europe Project DT-GEO: A Digital Twin for GEOphysical extremes (ID 101058129).