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Near subsurface density reconstruction by full waveform inversion in the frequency domain

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The work proposed in this presentation is part of a global project dealing with the characterisation of heterogeneous media by both electromagnetic and mechanical full waveform inversion. Indeed Full Waveform Inversion (FWI) of seismic reflection (SR) or Ground Penetrating Radar (GPR) data is an efficient approach to reconstruct subsurface physical parameters with high resolution. We focus here on the mechanical part and more specifically on quantitative imaging of nearsurface density in the context of water content characterization, as analogous to relative dielectric permittivity involved in the electromagnetical approach. Processing field data is challenging because the nature of the source and the sensors used impact the signal-to-noise ratio as well as the frequency range embedded in the recorded data. From then it becomes interesting to process the data in the frequency domain, by working on a few representative frequencies of the recorded temporal signal. Field data are simulated by noisy synthetic data. Different frequency strategies are used and their results are compared with each other. The inverse problem involved consists in assessing the density in the probed medium, from the data on the displacement field measured at the detectors. Such a problem is known to be nonlinear and ill-posed. It is solved iteratively by a regularized Gauss-Newton algorithm (RGN), which relies on the Fréchet derivative obtained through the generalized reciprocity principle which is equivalent to the well-known adjoint method. The numerical results obtained show an optimal strategy, for which the convergence rate and the computation time are reasonable, the spatial resolution is improved and the density is well reconstructed.

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