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# Full Waveform Inversion of Diving & Reflected Waves based on Scale Separation for Velocity and Impedance Imaging

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Full Waveform Inversion (FWI) is an appealing method for quantitative high-resolution subsurface imaging (Virieux et al., 2009). For crustal-scales exploration from surface seismic, FWI generally succeeds in recovering a broadband of wavenumbers in the shallow part of the targeted medium taking advantage of the broad scattering-angle provided by both reflected and diving waves. In contrast, deeper targets are often only illuminated by short-spread reflections, which favor the reconstruction of the short wavelengths at the expense of the longer ones, leading to a possible notch in the intermediate part of the wavenumber spectrum.

To update the velocity macromodel from reflection data, image-domain strategies (e.g., Symes & Carazzone, 1991) aim to maximize a semblance criterion in the migrated domain. Alternatively, recent data-domain strategies (e.g., Xu et al., 2012, Ma & Hale, 2013, Brossier et al., 2014), called Reflection FWI (RFWI), inspired by Chavent et al. (1994), rely on a scale separation between the velocity macromodel and prior knowledge of the reflectivity to emphasize the transmission regime in the sensitivity kernel of the inversion. However, all these strategies focus on reflected waves only, discarding the low-wavenumber information carried out by diving waves.

With the current development of very long-offset and wide-azimuth acquisitions, a significant part of the recorded energy is provided by diving waves and subcritical reflections, and high-resolution tomographic methods should take advantage of all types of waves.

In this presentation, we will first review the issues of classical FWI when applied to reflected waves and how RFWI is able to retrieve the long wavelength of the model. We then propose a unified formulation of FWI (Zhou et al., 2014) to update the low wavenumbers of the velocity model by the joint inversion of diving and reflected arrivals, while the impedance model is updated thanks to reflected wave only. An alternate inversion of high wavenumber impedance model and low wavenumber velocity model is performed to iteratively improve subsurface models.

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