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Tomographic Reflected-Wave FWI Using Time Lag

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ABSTRACT

Accurate long-wavelength velocity model is needed for improving RTM image quality and building good initial model for conventional FWI. Ray-based refraction/reflection tomography methods are commonly used to obtain long-wavelength velocity model. However, ray theory does not properly describe wave propagation in the case of complex heterogeneities such as a low-velocity anomaly. So velocity model from ray-based traveltime tomography might not be reliable to be used for RTM or serve as a starting model for FWI. To mitigate the limitation of ray-based tomography methods, various wave-equation-based traveltime inversion methods or finite-frequency tomography methods have been developed in exploration geophysics and global seismology. Most of wave-equation traveltime inversion methods is restricted to invert refracted waves or turning waves. Due to limited offset and signal-to-noise level, the recorded refracted waves travel only through the shallow part of model. In addition, the gradient of refracted waves has poor lateral sensitivity since their wave path is mostly horizontal. Therefore, wave-equation traveltime inversion using reflected waves is needed to obtain better long-wavelength velocity model in both the shallow and deeper part of model.

Reflected-wave wave-equation traveltime inversion can be done in either image domain or data domains. In this study, we choose to stay in the data-domain. For developing an efficient wave-equation traveltime inversion for reflected wave, the main challenges include high computation costs in full wavefield modeling, cycle-skipping issues, the separation of the long- and short-wavelength subsurface structures, the simulation of reflected wave using smooth velocity model and migration image, the estimation of temporal-varying/offset-varying time lag between observed reflection and predicted reflection. In this presentation, I will present our understanding of these challenging issues,
the corresponding solutions and preliminary synthetic examples.