

Separation of migration and tomography modes of full-waveform inversion in the plane-wave domain

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Full-waveform inversion (FWI) includes both migration and tomography modes. The migration mode acts like a non-linear least-squares migration to build the model interfaces with reflections while the tomography mode behaves as tomography to correct the background velocity. The migration mode is the main response of inverting reflections while the tomography mode exists in response to inverting both the reflections and refractions. To emphasize one of the two modes in FWI, especially for inverting reflections, the separation of the two modes in the gradient of FWI is required. Here, we will present a new method to achieve this separation by angle-dependent filtering in the plane-wave domain. Firstly, the source and residual wavefields are transformed into the plane-wave domain by Fourier transform; secondly, the tomography and migration components are distinguished by the opening angle between the plane-waves of the transformed source and residual wavefields. The opening angles close to 180° contribute to the tomography component while the others correspond to the migration component. This method is not affected by velocity variation, the dip angle of reflectors, the direction of wave propagation or anisotropy. It, therefore, is very effective and robust. This is demonstrated by theoretical analysis, synthetic and field data examples.

Keywords: full-waveform inversion, migration mode, tomographic mode, mode separation, plane wave domain, angle filtering

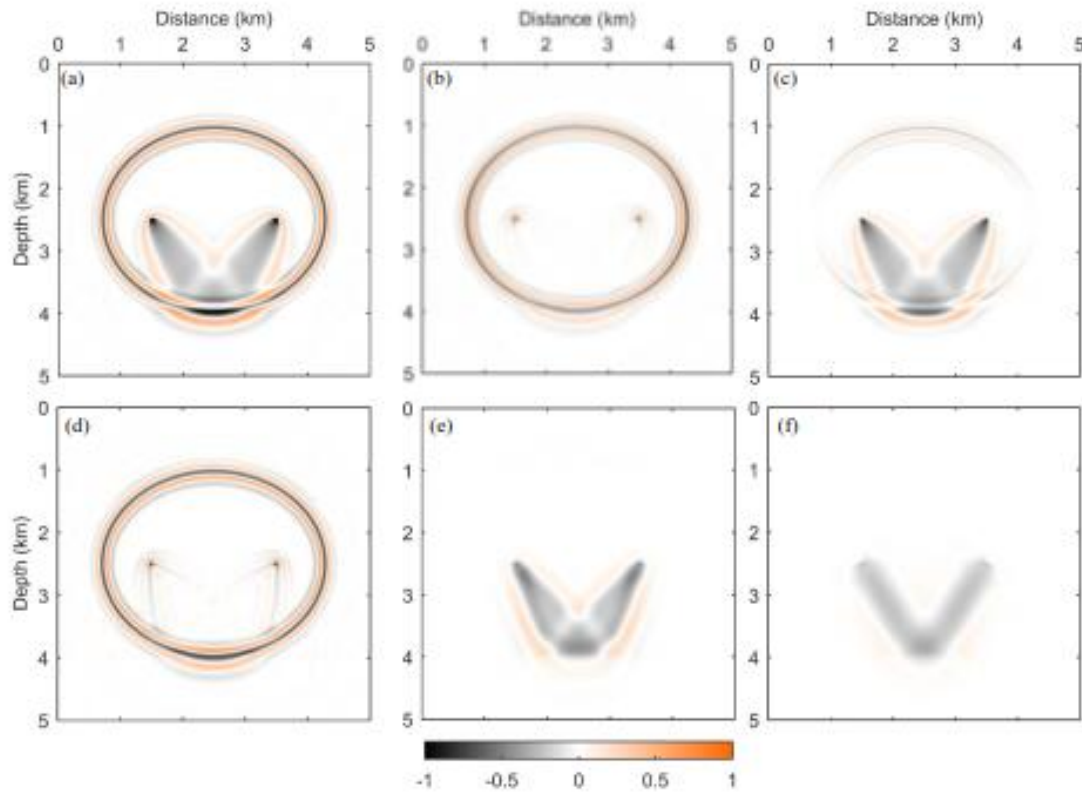


Figure 3 The mode separation of the gradient of the two-layer model with a one-source-one-receiver configuration shown in Figure 2. (a) The normal gradient. (b) Low-angle-pass filtered gradient with a transition band from 0° to 180° . (c) The high-angle-pass filtered counterpart of (b). (d) Low-angle-pass filtered gradient with a transition band from 100° to 120° . (e) High-angle-pass filtered gradient with a transition band from 120° to 140° . (f) High-angle-pass filtered gradient with a transition band from 140° to 170° . In the tests, the transition band has a shape of the square of cosine. Figures (b) and (d) show the migration component of the gradient while Figures (c), (e) and (f) show the tomography component of the gradient.