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Near offset data truncation in the Laplace-domain waveform inversion

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Full waveform inversion is a method to determine unknown subsurface parameters from seismograms, and it is usually performed in the time, frequency or Laplace domain. Laplace-domain waveform inversion can recover long-wavelength subsurface model from scratch.

Time or frequency domain waveform inversion requires the small grid spacing to avoid gird dispersion. For the large offset data to image up to the deep part of the subsurface model, the usage of small grid spacing causes large computational cost. On the other hand, the grid dispersion in the Laplace domain modeling is much less than that in the time or frequency domain. Therefore, Laplace-domain inversion can obtain macro subsurface model for the large offset data using the large grid spacing.

However, waveform inversion with the large grid spacing cannot assume the exact location of source and receiver depth. This problem causes the large misfit between observed and modeled data at the near offset, and the misfit at the near offset leads the inversion result to have incorrectly estimated parameters at shallow subsurface. To mitigate this problem, we truncated near offset data and employed only far offset data to back-propagate the residual for computing the gradient direction.

In addition, for the land data case, the waveform inversion using acoustic approximation should be performed after the muting of the Rayleigh waves. If we truncate the near offset data in the residual, the misfit between observed and modeled data at the near offset does not affect the inversion results.