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Data-driven synthesis of primary plane-wave responses

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Seismic images provided by standard Reverse Time Migration are usually contaminated by artefacts associated with the migration of multiples.

Multiples can corrupt seismic images by producing both false negatives, i.e. by destructively interfering with primaries, and false positives, i.e. by focusing energy at unphysical interfaces. Free-surface multiples particularly affect seismic images resulting from marine data, while internal multiples strongly contaminate both land and marine data. Multiple prediction / primary synthesis methods are usually designed to operate on point source gathers, and can therefore be computationally demanding when large problems, involving hundreds of gathers, are considered.

In this contribution, a new scheme for fully data-driven retrieval of primary responses of plane-wave sources is presented. The proposed scheme, based on convolutions and cross-correlations of the reflection response with itself, extends a recently devised Marchenko point-sources primary retrieval method for to plane-wave source data. As a result, the presented algorithm allows fully data-driven synthesis of primary reflections associated with plane-wave source data. Once primary plane-wave responses are estimated, they are used for multiple-free imaging via standard reverse time migration. Numerical tests of increasing complexity demonstrate the potential of the proposed algorithm to produce multiple-free images only involving the migration of few datasets.

The plane-wave source primary synthesis algorithm discussed in this contribution could then be used as an initial and unexpensive processing step, potentially guiding more expensive target imaging techniques. Moreover, the method could be applied to large 3D problems for which standard methods are prohibitively expensive from a computational point of view.