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Numerical Simulation of Reciprocity for Combining Onshore-offshore Seismic Survey

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The reciprocity is contributing in a lot of data processing tools in the seismic surveys. If geometric symmetry can be achieved between offshore source and onshore receiver, or between onshore source and offshore receiver, data can be created in areas of sparse source or receiver intervals by interpolation on the basis of reciprocity. Further, application of the reciprocity principle may allow the use of advanced processing methods (e.g., velocity filtering of common receiver gathers). Normally, velocity (or acceleration) is recorded onshore and pressure offshore. And, vibrator and dynamite sources are used onshore and airgun source is used offshore. The differences of source and receiver component prevent us from directly using the processing tools described above, because we could not find any appropriate article in terms of practical use of reciprocity.
The purpose of this study is to obtain the reciprocity for combining onshore-offshore seismic survey. We then compared following three cases;

1. Onshore geophone record from an offshore airgun source and offshore hydrophone record from onshore vibrator source,
2. Onshore geophone from an offshore airgun source and offshore hydrophone record from onshore dynamite source (in this case, multicomponent geophones distributed in a wide array are needed to derive dilatancy),
3. In the case of 2, subsurface waveform is reconstructed from surface records by using the reverse-time FD method.

Using the finite-difference (FD) method, elastic wavefields are computed and we compared offshore-record from onshore-source and onshore-record from offshore source. In all cases, it is found that reciprocity can be obtained in terms of the arrival time and phase. The amplitude is also corresponding in case of 2 and 3.

Keywords: reciprocity, Numerical simulation, onshore-offshore seismic survey