Monitoring changes inside subsurface layers using non-physical reflections retrieved from seismic interferometry

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Seismic interferometry (SI) is a principle for retrieving responses between two receivers using cross-correlation. After the retrieval, one of the receivers acts as a virtual seismic source whose response is retrieved at the second receiver. Correct response retrieval relies on assumptions, among other, of a lossless medium being illuminated homogeneously by sufficiently densely spaced sources (passive or active). When these assumptions are not met, non-physical reflections might appear in the results of SI due to insufficient destructive interference. These non-physical reflections are caused by internal reflections inside subsurface layers. However, the non-physical reflections could be used for monitoring changes in the subsurface layers that generate them.
We investigate utilization of non-physical reflections for monitoring velocity changes for purposes of the DeepNL programme. We simulate reflection experiments using an acoustic finite-difference modelling for a horizontally layered model and for a subsurface with inclined layers. We perform SI by autocorrelation and by cross-correlation. Comparing retrieved results with the directly modelled results, we confirm previous results that for a layered subsurface the retrieved ghost reflections can be used for multiple offsets. For inclined layers, zero-offset ghost reflections can be retrieved for the different receiver locations. Both types of non-physical reflections are sensitive to velocity change and thickness of the layer that cause them to appear in the SI results, so they can be used for monitoring purposes of the subsurface.

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