Getting to the target with Marchenko-based virtual sources and receivers
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In many applications of seismic methods, a frequent issue is the presence of events that have scattered more than once in the subsurface, commonly referred to as internal multiples. The problem is that many methods cannot distinguish the internal multiples from the events that have scattered only once. This can cause artifacts in the final result of a method, especially for deep targets.

In recent years, the Marchenko method has been employed to deal with this kind of internal multiples. The method employs reflection data, which are data that are measured using active sources and receivers located at the surface of the Earth, to simulate sources and receivers in the subsurface. These simulated sources and receivers are referred to as virtual sources and receivers. In order to achieve this, the only information that is required is the first arriving event from the virtual source or receiver position in the subsurface to the Earth's surface. Such information can be obtained from a background velocity model. The main advantages of the method are that a virtual source or receiver can be created at any point in the subsurface without the need to resolve the overburden above the target. Other methods can achieve similar results for primaries, however the Marchenko method can handle the internal multiples properly.

We will present applications of seismic methods using the Marchenko method, namely the creation of virtual sources and receivers for the purpose of imaging the subsurface and monitoring wavefields in the subsurface. We will first demonstrate this on numerical data, using a model that contains an overburden with strong scatterers above a target with weak scattering energy. We will show the difference between the results achieved with the Marchenko method and achieved by a method that does not handle the internal multiples. We will show the application of these methods to field data, which have been pre-processed in order to apply the Marchenko method.

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