Practical considerations for the creation of virtual sources and receivers in the 3D subsurface

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Title: Practical considerations for the creation of virtual sources and receivers in the 3D subsurface

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Abstract:
In recent years, progress has been made in the field of virtual seismology. Using the novel data-driven Marchenko method, virtual sources and receivers can be created in the subsurface using only reflection data at the surface of the Earth and a background velocity model of the subsurface. Extensive studies have been performed on the application of the Marchenko method to 2D reflection data. This includes both synthetic reflection data and field reflection data. These studies have shown the potential improvements of the method for applications such as hydrocarbon imaging and wavefield monitoring. In the case of wavefield monitoring, a network of virtual receivers can be created in the subsurface to monitor the wavefield response of a subsurface source. This source response can be directly measured in the field, or it can be created from the reflection data, making it a virtual source response. Sensitivity studies have been performed to consider the acquisition limitations of the reflection data, as well as the influence of complex source signatures. This showed the potential of applying the Marchenko method for objectives such as monitoring complex induced seismicity signals and forecasting the responses of induced earthquakes. In this paper, we wish to present further studies for the creation of virtual sources and receivers from 3D reflection data. Similar studies for the application of the Marchenko method for hydrocarbon imaging have been performed, however, in these prior studies, both the source and receiver were virtual. In this paper, we also consider the case that the source is not created from the reflection data, but rather is recorded, and the influence of these types of sources on the monitoring. Furthermore, the limitations of the acquisition setup in the 3rd dimension are considered.