Seismic interferometry and beyond

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The past decade has seen the conception and development of the field of seismic interferometry, which enables the creation of virtual seismic sources at positions where there are only receivers. Methodologies have been developed for controlled-source data as well as for passive measurements, such as ambient noise. Of course no new information is generated by seismic interferometry, but information hidden in noise or in a complex scattering coda, is reorganized into easy interpretable responses that can be further processed by standard tomographic inversion or reflection imaging methodologies. The main strength is that this "information unraveling" neither requires knowledge of the subsurface medium parameters nor of the positions or timing of the actual sources. Moreover, the processing consists of simple crosscorrelations and is almost entirely data-driven. The first part of the presentation will review the basic principles of seismic interferometry, illustrated with applications at different scales of the Earth's interior.

In all interferometric applications studied thus far, receivers are needed at the positions where virtual sources are created. Recently, the authors showed that it is possible to create the response to a virtual source inside the 3D Earth from reflection data acquired at the Earth's surface, hence, without needing a receiver at the position of the virtual source. This new methodology requires, apart from the reflection response, an estimate of the direct arrivals between the virtual source and the acquisition surface. A novel iterative scheme retrieves the full response to this virtual source (the Green's function), which consists of the direct wave and the correct multiple reflections. The second part of the presentation will discuss the principles of this new methodology and indicate the exciting applications in seismic imaging and monitoring.