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Improved surface-wave response from ambient noise in Malargüe, Argentina, using seismic interferometry by multidimensional deconvolution

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Content
Generating new seismic responses from existing recordings is generally referred to as seismic interferometry (SI). Conventially, the new responses are retrieved by simple crosscorrelation of recordings made by separate receivers: a first receiver acts as `virtual source' whose response is retrieved at the other receivers. The newly retrieved responses can be used to extract receiver-receiver phase velocities, which often serve as input parameter for tomographic inverse problems, or which can be linked to temporally varying parameters such as hydrocarbon production and precipitation. For all applications, however, the accuracy of the retrieved responses is of great importance. In practice, this accuracy is often degraded by irregularities in the illumination pattern: correct response retrieval relies on a uniform illumination of the receivers. Reformulating the theory underlying seismic interferometry by crosscorrelation as a multidimensional deconvolution (MDD) process, allows for correction of these non-uniform illumination patterns by means of a so-called point-spread function (PSF).

We apply SI by MDD to surface-wave data recorded by the Malargüe seismic array in western Argentina. The aperture of the array is approximately 60 km and it is located on a plateau just east of the Andean mountain range. The array has a T-shape: the receivers along one of the two lines act as virtual sources whose responses are retrieved by the receivers along the other (perpendicular) line of receivers. Because SI by MDD relies on one-way wavefields, we select time windows dominated by surface-wave noise traveling in a favorable direction, that is, traversing the line of virtual sources before arriving at the receivers at which we aim to reconstruct the virtual-source responses. These time windows are selected through a frequency-dependent slowness analysis along the two receiver lines. From the selected time windows, virtual-source responses are retrieved by computation of ensemble-averaged crosscorrelations. Similarly, ensemble-averaged crosscorrelations between virtual sources are computed: the point-spread function. We use the PSF to deconvolve the effect of illumination irregularities and the source function from the virtual-source responses. The combined effect of time-window selection and MDD results in more accurate surface-wave responses.

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