

Seismic interferometry by crosscorrelation and by multi-dimensional deconvolution: a systematic comparison

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Seismic interferometry has a wide range of applications, ranging from surface wave tomography using ambient noise, to creating virtual sources for improved reflection seismology. Despite its successful applications, the standard crosscorrelation approach also has its limitations. The main underlying assumptions are that the medium is lossless and that the wave field is equipartitioned. These assumptions are in practice often violated: the medium of interest is often illuminated from one side only, the sources may be irregularly distributed, and, particularly for EM applications, losses may be significant. These limitations may be overcome by reformulating seismic interferometry as a multidimensional deconvolution (MDD) process. We present a systematic analysis of seismic interferometry by crosscorrelation and by MDD. We show that for the non-ideal situations mentioned above, the correlation function is proportional to a Green's function with a blurred source. The source blurring is quantified by a so-called point-spread function which, like the correlation function, can be derived from the observed data (i.e., without the need to know the sources and the medium). The source of the Green's function obtained by the correlation method can be deblurred by deconvolving the correlation function for the point-spread function. This is the essence of seismic interferometry by MDD. We illustrate the crosscorrelation and MDD methods for controlled-source and passive data applications with numerical examples and discuss the advantages and limitations of both methods.