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Discrete Wavelets for the cross-correlation of ambient noise

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In recent years the development of techniques of seismic tomography using ambient seismic noise opened new possibilities in the field of scientific and industrial exploration of the Earth's crust. Not requiring active sources it provides a cheap and convenient technique which can be applied nearly everywhere, at arbitrary spatial scales. The major drawback of this technique is the need for long field surveys, with acquisition times usually spanning from a few weeks to a few months, depending on the specific case.
This technique essentially consists in retrieving empirical Green's functions (GFs) between pairs of stations by cross-correlating the background noise signals. Those cross-correlations can be used for different applications as the determination of surface waves dispersion curves to perform ambient noise tomography. Depending on the considered frequencies and the distances between the stations, the achievement of reliable GFs depends on the length and the quality of the considered signals. In practice a long recording is split into smaller windows, on which cross-correlations are computed. The resulting functions are then stacked, after removing noisy windows where transient signals may disrupt the retrieval of GFs.
In this work we show how the use of the Discrete Wavelet Transform (DWT) offers many benefits in the estimation of GFs. First of all it provides a natural signal separation in dyadic frequency bands, making superfluous the use of spectral normalization of the signals. Furthermore it allows a separate estimation of the GFs in each frequency band, optimizing the elimination of noisy windows and hence reducing the time required for the field surveys. A single processing run, can allow obtaining GFs already separated in different frequency bands. This can be useful for the application of multi-scale inverse method to model the data.
We propose a workflow starting from raw seismograms and leading to separate GFs for each frequency band. We test the proposed method on datasets acquired on Tenerife (Canary Islands) with the purpose of ambient noise tomography for geothermal exploration. We compare the retrieved results with those obtained with standard approaches.