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Local adaptive slant-stack filters in the time-scale domain

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The local adaptive slant-stack filters in the time-scale domain (TS-LSSF) was born as a combination of two frequently used tools in seismic data processing, the local slant-stack transform (LSST) and the Morlet wavelet transform (WT). The slope/slowness resolution of LSST is inversely proportional to frequency and stack length. LSST and WT merging enables an elegant adaptation of the slowness resolution at each scale/frequency depending on the problem constraints. But even more important, the high degree of freedom this combination provides sparks a relatively simple design method of high slowness resolution filters, unlikely to be achieved using LSST alone.

The main application of these filters is the estimation or attenuation of one or more coherent signals among coherent and non-coherent noise depending on their slowness; this makes them useful in many fields in geosciences, from surface seismics to global seismology. After some objective tests on synthetic data, we have applied TS-LSSF in wide-angle and on-land seismic profiles. In wide-angle data, we attenuate direct high-energy water reverberations with minimal distortion to crustal low-energy reflected/refracted waves; whereas, in on-land data, we separate high-energy dispersive surface waves from body waves.

The only information required for TS-LSSF configuration is a coarse location of the coherent signals and the coherent noise in the transformed domain. These locations are basic ingredients to design the optimum decomposition of each trace and to measure the degree of coherence for each sample in the time-scale-slowness domain. The coherence measure enables an accurate estimation of the instantaneous slowness of the main coherent events, from the coarse information provided in advance. Having good instantaneous slowness measures permits an automatic design of the filter in the transformed domain, an aspect of key importance in practice, considering the complexity of designing a local 4D filter. Once the filter has been applied, the filtered traces are synthesized back in the time domain with a simple 1D inverse wavelet transform.