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The time-scale phase-weighted stack for ambient noise applications

Sergi Ventosa (1), Martin Schimmel (1), and Eleonore Stutzmann (2)

(1) Institut de Ciències de la Terra Jaume Almera, CSIC, Barcelona, Spain (sventosa@ictja.csic.es), (2) Institut de Physique du Globe de Paris, Paris, France

The ubiquity of noise is making seismic ambient noise an excellent complement to earthquakes in local to global tomography and monitoring studies. The main applications of noise correlations, surface-wave tomography, monitoring and body-wave studies, usually demand big volumes of data to convergence to the empirical Green's function (EGF) or to a robust seismic response of the structure under consideration.
The time-frequency phase-weighted stack (tf-PWS) is a physically-intuitive non-linear denoising method that uses the phase coherence to improve convergence and quality of extracted signals when conventional linear averaging methods do not suffice. The high computational cost derived from a continuous approach to the time-frequency transformation is currently the main limitation in ambient noise studies which are requiring big data volumes. We introduce the time-scale phase-weighted stack (ts-PWS) as an alternative extension of phase-weighted stack that uses complex frames of wavelets to build a much more computational efficient transformation, preserving the performance and flexibility of tf-PWS. Then, we propose alternative filtering approaches based on an unbiased phase coherence further improving noise attenuation.
To conclude we compute stacks of correlograms of station pairs of several years of data from global networks with linear and non-linear methods showing minor- and major-arc Rayleigh wave from R1 to R4, to compare the quality of the signals extracted and their convergence speed. And finally, we show that ts-PWS is a much faster alternative to tf-PWS, typically limited by input/output operations, obtaining virtually identical results.