Contribution ID: **14** Type: **Poster**

Adaptive denoising of acoustic noise injections

Friday, 12 April 2019 15:15 (5 minutes)

A tool for time series analysis based on adaptive methodologies such as Empirical Mode Decomposition (EMD) and its time varying version tvf-EMD, has been developed and applied to characterise seismometer data monitoring Virgo North End Building (NEB) recording during four different acoustic noise injections. The tool quantifies the trend/baseline wandering eventually present in the data and adaptively extract it removing the residual term of standard EMD. Furthermore, it extracts narrowband oscillatory modes which are possibly both nonlinear and/or nonstationary, using the tvf-EMD algorithm. Subsequently, the persistency of extracted modes is evaluated by means of Detrended Fluctuation Analysis (DFA), providing the Hurst exponent of each mode. Denoising can be then achieved by thresholding on the mode's Hurst exponent. Then, due to the completeness property, extracted modes quantitatively describe distinct bands of the Fourier spectra. The Hilbert-Huang transform can be obtained performing Hilbert Spectral Analysis on the obtained modes, providing a high resolution time frequency representation of the analysed data, capable of tracking nonlinearities and nonstationarities.
The induced seismic perturbation can be separated from the underlying nonlinear nonstationary seismic noise. Adaptive methodologies such as tvf-EMD should be employed for site characterization studies of underground detectors such as the Einstein Telescope.

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Session Classification: Poster Session

Track Classification: ET technology