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Seismic noise-based imaging and monitoring with the phase coherence approach

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Abstract

In the past 15 yr, seismic ambient noise studies for structural monitoring and imaging purposes have gained increasing importance in seismology and surrounding research fields. This is mainly due to the ubiquity of noise sources and recent advances on how to use the seismic noise wave field. All of these noise studies are based on interferometric principles in which empirical Green functions (EGFs) or robust seismic noise responses are extracted based on different signal processing strategies. These strategies mainly employ noise cross-correlations and subsequent correlogram stacking. Phase cross-correlations and phase weighted stacks, both based on the instantaneous phase coherence of analytic signals can be used in full analogy for an efficient signal extraction from ambient noise. During this presentation we will shortly revisit the phase coherence approach (phase weighted stacking and phase cross-correlation) to then discuss noise-based imaging and monitoring examples. We show that the phase auto/cross-correlation can robustly extract body waves, Rayleigh waves and normal modes because it is not biased by large amplitude signals (e.g., earthquakes). This is convenient because no data preprocessing (data selection or amplitude clipping) is required as usually employed for classical approaches. It also implies that the phase coherence approach takes advantage of the full data set and waveform information to achieve a high signal extraction convergence. The approach thus permits using small time windows to improve time resolution in monitoring studies. Among the examples, we show how we use noise autocorrelations to achieve an approximation of the zero-offset reflection response of the structure beneath seismic stations to finally map the Paleozoic basement of the Ebro Basin (North Spain), and how we detect structural variability before and during volcanic intrusions.

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