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Monitoring surface process with ambient seismic noise: insights from Coda Wave Decorrelation and Locadiff methods

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Ambient seismic noise is now widely used to image the Earth, from global scales to local subsurface applications, and to monitor tiny mechanical changes [1]. Reproducibility turns this method into a robust technique for time-lapse probing the properties of the soil [2]. In most applications, we use Coda Wave Interferometry to estimate tiny relative velocity changes (dV/V) that are associated to evolutions of rigidity of the material and/or changes of density. Changes of density are in general smaller than rigidity changes priori to destabilization. Another idea is to evaluate, after correcting for the relative velocity change (by stretching the time-axis of the correlogram), the remnant decorrelation between the reference and the daily correlogram. If the decorrelation is zero, waveforms are matching and no structural changes occurred in the material. If the decorrelation is non-zero, some wavepaths (wave trajectories) have been modified in the material, indicating a structural change such as fluid injections, geometrical deformation, and crack developments… Using analogous ultrasonic experiments, we demonstrate the decorrelation due to fluid injection can be more significant than relative velocity changes (due to change of density or rigidity). In other words, decorrelation is more usefull than dV/V for practical applications at hich frequency seismic monitoring (say ten hertz and above), and for loose (unconsolidated) materials where the shear wave velocity is low. From a physical point of view, decorrelation can be more usefull than dV/V when the wavelength is not significantly larger than the macro-porosity of the material. We present practical applications, including in monitoring a rocky glacier (permafrost) in the swiss alps that show a paroxismic activity during snow melt.

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