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Temporal Changes of anisotropy related to the Parkfield 2004, Mw 6.0 earthquake using continuous seismic noise records

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Measuring significant and systematic temporal variations of physical parameters is a major goal of seismologists for monitoring seismogenic zones, and eventually forecasting earthquakes. Seismic anisotropy, induced by the crack distribution within the continental crust, is very sensitive to stress field changes. To date, anisotropy has been investigated through Shear-Wave Splitting (SWS) measurements of local earthquakes. To avoid the erratic occurrence and spatial uncertainties of these events, we have measured the effects of anisotropy on surface waves recovered from the cross-correlation tensor of the ambient seismic noise.
Noise cross-correlation is applied to continuous data recorded by the High Resolution Seismic Network (HRSN) located around the San Andreas Fault (SAF), both in 2004, when the Parkfield earthquake occurred (28th September 2004, Mw 6.0), and in 2005, with no significant seismic activity. Focusing on the noise-extracted surface wave, we separate two main contributions to temporal changes, identified as (1) slow and weak variations due to seasonal changes of seismic noise incident direction and (2) strong and fast rotations of quasi-Rayleigh and quasi-Love wave polarization angles at the moment of the Parkfield event. After removing part (1), the strong polarization shift may be related to changes in crack properties induced by the co-seismic stress. Since a 30-day average is necessary to obtain stable correlation signals, it is not yet possible to detect precisely when changes occur. However significant jumps in polarization angles are observed before and after the Parkfield earthquake at some receiver pairs, in particular with pairs involving one of the closest seismic stations to the SAF. Contrarily to the SWS, polarization of surface waves is more sensitive to crack distribution rotation than travel-times or phase velocity. This new technique can be implemented on a routine basis for monitoring stress changes in seismogenic zones.

Keywords: anisotropy, seismic noise, monitoring, parkfield, temporal change, surface waves