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Monitoring temporal changes in the source region of large crustal earthquakes using Passive Image Interferometry

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Passive Image Interferometry is a technique to continuously monitor temporal variations of the mean shear wave velocity of the Earth's crust. In a first step, the elastic Green's tensor between two seismometers is computed from the cross-correlation of seismic noise recorded at the two sensors during a certain period. Alternatively, one can also compute the source-receiver co-located Green's function using the auto-correlation function of noise recorded at a single seismometer. In a second step we compare the constructed seismograms of different periods. To do so, we apply the technique of Coda Wave Interferometry, which is able to detect small time changes in the coda of similar seismograms and to convert it to a relative change in mean shear wave velocity. First applications of Passive Image Interferometry show, that using high frequencies (1-10 Hz) one obtains a resolution for relative changes in mean shear wave velocity of about 0.1 percent. In this frequency range one day of noise data is generally sufficient to estimate the source-receiver co-located Green's function, which leads to a temporal resolution of one day. Using lower frequencies (10-3 s), on the other hand, much longer noise time series are required to compute the Green's function. The advantage of using lower frequencies is that Green's functions for larger station distances can be computed, whereas for high frequencies due to the lack of coherence

in many cases only source-receiver co-located Green's functions can be constructed. In an application to the Earth's crust in the source region of the shallow 2004 Mw = 6.6 Mid-Niigata earthquake, we use ambient seismic noise recorded at 5 stations of Japanese Hi-net and 1 station of broadband F-net, all located in a distance of less than 20 km from the epicentre of the earthquake. Daily measurements during two months before and two months after the earthquake show a sudden decrease of mean shear wave velocity of some tenth of percent at the time of the Mid-Niigata earthquake. Possible interpretations of this velocity decrease are a decrease of crustal stress after the earthquake, a creation of a shallow damage zone by strong ground motion, or the creation of new fractures in the source area of the earthquake.