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Temporal changes of crustal properties induced by the 2013 Ruisui earthquake and hydrological perturbations in eastern Taiwan revealed from seismic and strain ambient noise interferometry

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Coda wave interferometry is exploited to investigate the temporal changes of crustal properties preceding and following the Oct. 31, 2013 Mw 6.2 Ruisui Earthquake which struck the previously seismically quiet area in the northern segment of the Longitudinal Valley collision suture between the Eurasian and Philippine Sea Plate in eastern Taiwan. The coda is retrieved from the daily-stacked empirical Green's functions (EGFs) calculated by the correlations of continuous ambient noise recorded at three-component seismograph stations and volumetric strainmeters between 2013 and 2014. By comparing the time-lapse traveltime and waveform changes between the pre- and post-event coda arrivals at a wide frequency range of 0.05-8 Hz, we observe explicitly not only coseismic velocity reduction but also preceding decorrelation of waveforms in both the interferometric seismic and strain field. Considering the sensitivity of the observed coseismic velocity changes at frequencies of 0.1-0.9 Hz s to velocity perturbations at depth is dominated by surface wave sensitivity, their correlation with the changes of the volumetric strain at depths of 3-5 km induced by the earthquake slip indicates the static stress perturbations on the fault zone are the predominant cause. In addition, the quasi-periodic variation with a dominant cycle of about 4 months that appear only in the strain derived EGFs is correlated well with the fluctuation of the groundwater levels. During the yearly summer monsoon and typhoon seasons between July and October when the wind speed and the strength of noise source in Taiwan are relatively strong, the retrieved coda amplitudes are highly attenuated which lead to the abnormally large and random fluctuations in the estimated velocity perturbations and significant drop in waveform correlation. Such phenomena may be associated with the disturbance of subsurface structures by the increase in seasonal precipitation or hydrological extreme events such as floods and consequently rapid rise of groundwater levels. The use of the borehole seismometers and multiple-component EGFs can prevent this obstruction and obtain more stable and accurate estimates in the earthquake-induced perturbations.