Revealing seasonal crustal seismic velocity variations in Taiwan with single-station cross-component analysis

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Ambient noise interferometry is a promising technique for studying crustal behaviors, providing continuous measurements of seismic velocity changes (dv/v) in relation to physical processes in the crust over time. In addition to the tectonic-driven dv/v changes, dv/v is also known to be affected by environmental factors through rainfall-induced pore-pressure changes, air pressure loading changes, thermoelastic effects, and so forth. In this study, benefiting from the long-term continuous data of Broadband Array in Taiwan for Seismology (BATS) that has been operated since 1994, we analyze continuous seismic data from 1998 to 2019 by applying single-station cross-component (SC) technique to investigate the temporal variations of crust on seismic velocity. We process the continuous waveforms of BATS stations, construct the empirical Green's functions, and compute daily seismic velocity changes by the stretching technique in a frequency band of 0.1 to 0.9 Hz. We observe co-seismic velocity drops associated with the inland moderate earthquakes. Furthermore, clear seasonal cycles, with a period of near one-year, are also revealed at most stations, but with different characteristics. Systematic spectral and time-series analyses with the weather data are conducted and show that the rainfall-induced pore-pressure change is likely the main cause to the seasonal variations with high correlations. The strong site-dependency of these seasonal variations also precludes air pressure and temperature which varies smoothly in space from being dominant sources and suggests spatially-varying complex hydro-mechanical interaction across the orogenic belt in Taiwan.