Investigating seismic velocity response to near-surface hydrological variations in Utah, United States

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Extensive drought and extreme weather events have become more common in recent years due to ongoing climate change. The increasing frequency and severity of droughts in semi-arid areas such as the western US could lead to enduring impacts on society and the environment. Understanding and monitoring the near-surface hydrological processes and groundwater resources are critical for resource management. Taking advantage of time-lapse seismic noise interferometry, investigating near-surface hydrological processes via seismic velocity changes (dv/v) is now possible. In this study, we apply a single-station cross-component correlation technique to determine the temporal dv/v evolutions of 23 permanent broadband stations across Utah between 2006 and 2022. Our dv/v results (in 1-5 Hz) reveal both seasonal and long-term variations at most stations. We compare the observed dv/v variations with the water storage model of SOPAC and the Great Salt Lake (GSL) water level. For seasonal variation, dv/v changes are overall in phase with GSL level, modeled soil moisture, and temperature variations. For long-term variation, dv/v changes are somewhat correlated with GSL level and modeled groundwater changes, particularly for stations in northern Utah. These results demonstrate the sensitivity of dv/v measurements to short- and long-term near-surface hydrological variation and show the potential of monitoring groundwater using passive seismic data.