Seismo-acoustic monitoring of surface processes across scales

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Many surface processes suffer from data scarcity, leading to a scalability gap between observations and predictions at the event scale versus landscape scale. The broad, continuous coverage and high resolution of seismo-acoustic data can provide valuable insights on these processes. In this talk, I will discuss two case studies in which seismo-acoustic methods are bridging observational scales to enable new insights on the coupling between surface or near-surface processes and environmental controls.

Fluvially generated seismo-acoustic waves provide a novel means of investigating otherwise hidden river processes, but signals from individual seismometers or hydrophones are challenging to interpret due to large-scale environmental heterogeneity and the integration of multiple signal sources. In results from the first in-stream distributed acoustic sensing (DAS) deployment, we show that meter-scale strain rate measurements along ~160 m of cable submerged in Clear Creek, Colorado provide a spatially continuous snapshot of the flow-generated hydroacoustic spectrum. This unprecedented spatial resolution enables clear attribution of detailed spectral characteristics to hydraulic features along the river, highlighting a potential new pathway for examining bed and turbulent flow dynamics at the grain to reach scales.

Conversely, transmission of wind energy by plant roots was recently shown to play an important role in the mechanics of rock fracture and soil production at the scale of individually instrumented trees, but has not been constrained over larger scales. We use data recorded by the US Transportable Array in Alaska to explore the role of trees in moderating the relationship between wind speeds and seismic activity at regional scales. Our results suggest that seismic monitoring could open the door to studying how interactions between wind and vegetation impact rock weathering at scales relevant to human infrastructure, hazards and the global cycling of biogeochemical mass fluxes.