Effect of snowfalls on relative seismic velocity changes measured by ambient noise correlation

Antoine Guillemot¹, Alec Van Herwijnen², Laurent Baillet¹, and Eric Larose¹
¹ISTerre, Grenoble Cedex 9, France (antoine.guillemot@univ-grenoble-alpes.fr)
²WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland

Seismic noise correlation is a broadly used method to monitor the subsurface, in order to detect physical processes into the surveyed medium such changes in rigidity, fluid injection or cracking (¹). The influence of several environmental variables on measured seismic observables were studied, such as temperature, groundwater level fluctuations, and freeze-thawing cycles (²). In mountainous, cold temperate and polar sites, the presence of a snowcover can also affect relative seismic velocity changes (dV/V), but this relation is relatively poorly documented and ambiguous (³⁴). In this study, we analyzed raw seismic recordings from a snowy flat field site located above Davos (Switzerland), during one entire winter season (from December 2018 to June 2019). Our goal was to better understand the effect of snowfall and snowmelt events on dV/V measurements through both seismic and meteorological instrumentation.

We identified three snowfall events with a substantial response of dV/V measurements (drops of several percent between 15 and 25 Hz), suggesting a detectable change in elastic properties of the medium due to the additional fresh snow.

To better interpret the measurements, we used a physical model to compute frequency dependent changes in the Rayleigh wave velocity computed before and after the events. Elastic parameters of the ground subsurface were obtained from a seismic refraction survey, whereas snow cover properties were obtained from the snow cover model SNOWPACK. The decrease in dV/V due to a snowfall were well reproduced, with the same order of magnitude than observed values, confirming the importance of the effect of fresh and dry snow on seismic measurements.

We also observed a decrease in dV/V with snowmelt periods, but we were not able to reproduce those changes with our model. Overall, our results highlight the effect of the snowcover on seismic measurements, but more work is needed to accurately model this response, in particular for the presence of liquid water in the snowcover.

References


