

The Cryosphere Discuss., author comment AC1
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Reply on RC1

Antoine Guillemot et al.

Author comment on "Effect of snowfall on changes in relative seismic velocity measured by ambient noise correlation" by Antoine Guillemot et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-108-AC1>, 2021

Referee 1 :

General Comments

The article identifies relative changes in subsoil stress caused by the snow cover in its fresh and dry state (when it is melting). The authors use ambient seismic noise to calculate these changes using coda DV/V wave interferometry. The hypothesis is that the melting snow can percolate through the soil surface and increase the pore pressure and density, leading to possible mass slips.

The article is well structured and adequately written. A significant contribution is that experimental results can be correlated with numerical simulations, which show that relative stress changes can be reproduced for the two physical states of the snow cover.

The article can be accepted with minor corrections.

I suggest a discussion of variations in dV/V estimation if **atmospheric effects** are taken into account.

- *Such atmospheric effect might probably influence the measured dV/V where atmospheric change occurs, but we expect its amplitude negligible for most cases, compared to other environmental influences (Le Breton et al., 2021; Hotovec & Ellis et al., 2014). The additional loading from the snow cover is much more important than atmospheric pressure variations. Then, following previous literature, we can argue that a dV/V variation less than 0,1 % for atmospheric changes (few kPa) is expected. We can add this discussion into the text.*

Also, the authors should include a **figure showing the correlations** obtained and indicating the part of the waveform in which the dV/V estimation is made.

- *Yes, we agree with this suggestion. Find the new figure in supplement materials (Figure 1) showing the entire correlogram from seismic data, including the part of the waveform from which dV/V is estimated.*

The authors assume that the **coda is mainly composed of surface waves** (not exist wave scattering). If this is not entirely true, then it should be discussed, as is the

confrontation conducted in the modeling (section 4.1), where results are generated for Rayleigh waves.

- *Although the coda is composed of both diffused surface and diffused body waves (see (Obermann et al., 2013)), we assumed that coda that we used for computing dV/V is mainly composed of diffused surface waves (early times of the coda, see Figure 1), that are most sensitive to shallow changes. This is an assumption, which we will explicitly mention in the revised version, that we used for modelling : actually we modelled Rayleigh wave velocity (diffusion is here not an issue). In fact, the energy partitioning dynamics favors Rayleigh waves in the early part of coda, when considering sensors and most of seismic noise sources being at (or almost) the surface (Obermann et al., 2013).*

Specific comments

Lines 80-90. For the reader to visualize how the influence of the snowpack will be modeled, the authors must make a **scheme** that illustrates this procedure.

- *Yes, we agree with this statement. We propose to add a scheme (shown Figure 2 in supplement) in the new version of manuscript (part Modelling) in order to explain how both snowpack and ground are modeled, for one snowfall event (Snowfall 2), as well as the schematic location of the seismometers.*

Line 150. Here's an error, the **depth of research in the refraction study** can't be the same as the length of the line.

- *The depth of refraction survey is of the order of 1/3 of the array aperture, say about 20m. The text was not clear and is now clarified -> "... a three layers model down to a depth of about 20m"*

Line 200. In this part, the authors consider dV/V calculations on **surface waves**, however. The previous section does not indicate if the analysis of dV/V involves direct surface waves or assumes that the correlograms' coda is composed purely of surface waves.

- *Direct surface waves are not used in the time window considered here : we process only the early part of the coda. In fact we assume that the part of the correlogram that we used for computing dV/V is mostly (not purely) dominated by diffused (not direct) surface waves. Since we use only vertical component geophones, we assimilate measured seismic wave velocity changes as Rayleigh wave velocities, rather than Love wave ones. We will indicate it in the new version.*

References

Hotovec□Ellis, A. J., Gomberg, J., Vidale, J. E., and Creager, K. C.: A continuous record of intereruption velocity change at Mount St. Helens from coda wave interferometry, 119, 2199–2214, <https://doi.org/10.1002/2013JB010742>, 2014.

Le Breton, M., Bontemps, N., Guillemot, A., Baillet, L., and Larose, É.: Landslide monitoring using seismic ambient noise correlation: challenges and applications, *Earth-Science Reviews*, 103518, <https://doi.org/10.1016/j.earscirev.2021.103518>, 2021.

Obermann, A., Planès, T., Larose, E., Sens-Schönfelder, C., and Campillo, M.: Depth sensitivity of seismic coda waves to velocity perturbations in an elastic heterogeneous

medium, *Geophys J Int*, 194, 372–382, <https://doi.org/10.1093/gji/ggt043>, 2013.

Please also note the supplement to this comment:

<https://tc.copernicus.org/preprints/tc-2021-108/tc-2021-108-AC1-supplement.pdf>