**Review of manuscript "Modal sensitivity of rock glaciers to elastic changes from spectral seismic noise monitoring and modeling"**

This is a very good and comprehensive study demonstrating the ability of passive seismic measurements for time-lapse monitoring of near-surface structures in combination with other geophysical methods which provide more high-resolution, but time-restricted information. The presented use of modal analysis in particular is a novel and promising approach for rock glacier monitoring. The results presented in this study support the capability if the method.

(1) I would be interested in a brief discussion on how the HVSR (Horizontal-to-Vertical Spectral Ratio) method is related to the modal analysis of single component seismic data. In case of HVSR, the argument often used is that normalizing the horizontal spectrum by the vertical will reduce the source effects and thus enhance the resonance spectrum of the site. HVSR peaks are interpreted either as SH wave resonance (see equation on Page 6, line 190) or maxima of the Rayleigh wave ellipticity in a layered medium. Would it make sense to present the results of this study as HVSR time-lapse spectra instead of single component spectra (assuming the three-component seismometer have been used)? I would expect to see the same temporal variability by potentially reducing at the same time some spectral peaks related to local sources. Is the 3D nature of the rock glacier the reason for not using spectral ratios?

(2) The ability of the HVSR method for time-lapse permafrost monitoring has been recently investigated in a few studies:

Abbott, R., Knox, H. A., James, S., Lee, R., and Cole, C.: Permafrost Active Layer Seismic Interferometry Experiment (PALSIE), Tech. rep., Sandia National Laboratories (SNL-NM), Albuquerque, NM (United States), available at: https://prod.sandia.gov/techlib/access-control.cgi/2016/160167.pdf (last access: 7 January 2019), 2016.

Kula, D., Olszewska, D., Dobiński, W., and Glazer, M.: Horizontal-to-vertical spectral ratio variability in the presence of permafrost, Geophys. J. Int., 214, 219–231, https://doi.org/10.1093/gji/ggy118, 2018.

Köhler, A. and Weidle, C.: Potentials and pitfalls of permafrost active layer monitoring using the HVSR method: a case study in Svalbard, Earth Surf. Dynam., 7, 1–16, https://doi.org/10.5194/esurf-7-1-2019 , 2019.

It might be useful to have a look at these studies. Please feel free to not cite them if they are not relevant for the current work (especially since a paper of mine is included).

(3) I miss a figure directly comparing the temporal evolution of the measured resonance frequencies with the modeled once for different states of thawing. Furthermore, a figure comparing the measured and modeled amplitudes spectrum for a particular time would be very useful (for example overlaying figure 2d). In my opinion such figures are more important for demonstrating the reliability of the method than showing the GPR and active seismic results in Fig 4,5 and 6. Those can be moved to the Appendix.

Minor comments:

General: Please check if all commas are needed.

The first sentence of the abstract and the Introduction are identical. Please consider rephrasing.

Line 42: highly challenging?

Line 49: Do you mean “coast-intensive”? Or “…remain cost-effective only when limited to one single …”?

Line 61: active permafrost layer

Line 73: Please explain “as a bending beam”

Line 76: “Our goal … of the rock glacier and the time variability of their resonance frequencies which gives hints …”

Line 78-79: “… are numerically modeled …”

Line 81: “In the second part, …”

Line 97: Something is wrong with formatting of exponents

Line 123: one bracket too much

Line 130: Are these three-component sensors? Was maintenance required during the measurements (releveling etc.)?

Line 140: I think the time-lapse resonance spectra of the other sensors should be included as supporting materials or in the appendix (do not need to be discussed)

Line 167: “Continuous seismic monitoring systems are composed …” (?)

Line 171: “… between several sensors and to monitor …”

Line 195: I suppose the vertical component is used?

Line 200: This is unclear. Please rephrase to describe how peaks are picked automatically.

Line 261: Just to avoid misunderstanding: Is the modelling of resonance frequencies done in full 3D, 2D or for a particular location and 1D model below?

Line 267: “cost-effective” See above.

Lines 376, 409, 449, and 452: paragraph/section numbers wrong

Line 476: “inter-annual climate variability” Is “climate” the right word here? I guess the constant climate at a particular site includes the inter-annual variability of temperatures.

Line 491: “observed gap” Do you mean “observed difference”?

Line 496: “in combination with”?

Line 498: Remove “Furthermore”

Line 515: Sentence “Frequency resonance focuses on …”: I am not sure if this is correctly formulated. The resonance frequency in general is also an effect of seismic waves propagating through the whole structure. It just depends on the considered frequency band. Here, I agree with your conclusion that resonance works well at high frequencies (and thus for shallower depths) where most of the changes occur, while noise correlation does not work so well due to lack of correlation at high frequencies if the inter-station distance is too large. So, the different sensitivities are mainly because of the nature of the ambient noise wavefield and the sensor network set-up, not because of the depth sensitivity of both methods as such. See for example the study of James et al, where noise correlation could be used to measure very shallow variability with closely located sensors.

Line 542: geophysical measurements

Appendix A: I am not sure if it necessary to include the results of earthquakes since the results are not much discussed. If they are included, one would like to know where the discrepancy compared to noise comes from.

Figure 2: Showing the noise waveform record is not necessary in my opinion. Instead, please also add a plot like (d) for Gugla.