

Interactive comment on “Glaciohydraulic seismic tremors on an Alpine glacier” by Fabian Lindner et al.

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Author comments to RC1 (anonymous reviewer)

Dear Reviewer, many thanks for your comments. In the following, we provide the corresponding author comments in a point-by-point style.

- page 2 line 10: rewrite this sentence to read something like "...these approaches have drawbacks, including: being expensive and laborious, providing subsurface images at only a few instances in time, and being isolated in location.
→ Thanks for the suggestion, we will implement these changes to improve the text flow.

C1

- page 2 line 19, I would “call out” (i) and (ii) as two indented short sentences in a list, then put the sentences that discuss them, e.g., “This configuration is expected...” which begins on line 20 in the rest of the paragraph that follows, and start the discussion sentences with “In the case of (i), this configuration is expected...In the case of (ii), These scaling relations...” etc. The way it reads now, the reader might not see the list of two end members in a simple way, because there is discussion involved in the definition of the list.

→ We will also work on this issue.

- page 3 around line 24 - can a description of how the lake levels were monitored and how draining was detected be added? Was this done using instrumentation (e.g., depth or pressure sensors in the water) or was it done via remote sensing? How accurately or frequently are water depth measurements made? Also, since power outages are referred to, at the end of the page, the type of power source (photovoltaic?) should be mentioned. On the next page in the paragraph starting on line 5, it might be worth mentioning the sample rate of the GPS units and also the sample rates of the various data sets associated with Lenk and Geopravent...

→ The lake level was monitored with a pressure sensor as indicated in Fig. 1. However, we will add information to answer the above questions since it does not seem to be clear from the current version.

- page 5 around line 20 - out of curiosity, do the Rayleigh wave polarizations conform roughly with direction of radiation and source location? Would polarizations be capable, in the absence of other analysis, of determining source location or at least source azimuth? How consistent would location and azimuth be if just Rayleigh wave polarization were used to determine phase velocity vectors?

C2

→ In principle, source azimuths can be determined from polarization analysis, as was e.g. done by Vore et al. (2018) for glaciohydraulic tremors. However, since we had arrays installed allowing for more accurate back azimuth / source locations, we didn't explore this option. A quick look into the polarization attributes revealed quite noisy data and showed that some more work would be required to obtain robust back azimuth measurements. But as stated by Koper Hawley (2010), the back azimuth θ_H in the polarization code we used is not well defined for strongly elliptical particle motion. We therefore refrain from a more detailed analysis of our polarization results.

Vore, M. E., Bartholomaus, T. C., Winberry, J. P., Walter, J. I., Amundson, J. M. (2019). Seismic Tremor Reveals Spatial Organization and Temporal Changes of Subglacial Water System. *Journal of Geophysical Research: Earth Surface*, 124(2), 427-446.

Koper, K. D., Hawley, V. L. (2010). Frequency dependent polarization analysis of ambient seismic noise recorded at a broadband seismometer in the central United States. *Earthquake Science*, 23(5), 439-447.

- equation 4: is it necessary to have two sets of absolute value or “norm” ($|.|$) signs, one on the denominator and one on the whole fraction of the right hand side?

→ Thanks for pointing this out, one is enough.

- page 9 line 27. I seem to have forgotten what a “Bartlett processor” refers to. Was this defined above? Maybe make a citation to equation 3 instead of just referring to the Bartlett processor..... Ditto with the term MVDR-Rayleigh results (a simple parenthetical with a equation number reference would be enough).

→ We will consider this suggestion in order to improve the text.

- page 10 line 7 - Can “spurious body wave contributions” be defined more precisely? Are they whole-ice-thickness modes of P or S where the wave vector is horizontal?

C3

→ Here, we intend to say that the measured seismic signal is not purely composed of Rayleigh waves but may also contain some body wave energy. The source of these body waves is unknown and might be turbulent water flow as well as anthropogenic activity.

- page 10 line 19 - has the term MVDR-grids been defined?

→ This simply refers to the spatial grid used in the MVDR beamforming. We will rephrase this expression.

C4