The present manuscript of Kleine et al. describes selected signals from avalanches recorded with the Distributed Acoustic Sensing (DAS) technology. The scientific question that the manuscript asks, is if DAS along telecommunication fibers paralleling mountain roads can be facilitated for avalanche detection and possible early warning to traffic related avalanche accidents. The presented dataset (3 full winter seasons) is to my knowledge to date one of the most comprehensive DAS data sets related to avalanche studies.

Overall, the manuscript is well written and should be accessible for the readership of NHESS that are not necessarily familiar with DAS. The used methods are standard and solid. The results are reasonable. Figures, language, and manuscript structure are in good shape. Concerning references, I personally would avoid citing conference abstracts, as they are not peer-reviewed.

What I am not so sure about, is to what extent the manuscript represents a substantial contribution to the understanding of natural hazards and their consequences. And here comes the crux. The present study is in many ways similar to Edme, P., Paitz, P., Walter, F., van Herwijnen, A., & Fichtner, A. (2023). Fiber-optic detection of snow avalanches using telecommunication infrastructure. *arXiv preprint arXiv:2302.12649*. However, that study is also still in the pre-print stage and therefore it is difficult for me to assess the novelty of the present manuscript. The significance of the present study lies in my opinion in the temporal extent of the data set and the scientific possibilities that come with it. The largest weakness of this study is in my opinion that this potential of the data is not being exploited, as only avalanche examples are presented and a more quantitative analysis is lacking.

In principle I recommend the present manuscript for publication in NHESS because 1) a to date novel data set is presented and 2) the avalanche observations are to my knowledge either first or second of its kind. However, in my opinion the potential of this study and especially of the data is much higher than it is presented currently. Therefore, I make some suggestions to the authors that would in my view substantially increase the comprehensibility to the reader as well as the relevance of this study.

I hope my review is helpful to the authors. I would be happy to discuss and respond to questions.

Best regards,
Dominik Gräff

General Comments:

Novelty: I would recommend making clearer what the novelty of the present manuscript is. The manuscript would benefit from emphasizing the main message. 'What do we learn?' was a question that I was asking myself throughout the manuscript.

Language: To me, the manuscript seems partially wordy and very descriptive (probably as my review. Sorry for that.). Whereas the descriptiveness is not necessarily bad, it is at times

difficult to filter out the relevant information and what the actual point of all the description is. Therefore, the manuscript could be more precise and concise. A few examples:
L131/132: ‘Note that the y-axis scaling varies in Figure 4 to improve visibility and accommodate small values.’ You can remove the entire sentence after ‘Figure 4’ without losing information. You save 50% of space, remove many unnecessary words, and therefore strengthen the important information.
Second example L154/155: ‘The onset of strong signals (M and S in Figure 5a) corresponds to a sudden increase in power …’ What strong signal in a PSD does not correspond to a strong power? The important part comes later in the sentence, namely that the frequency content is broadening.
Another example: L141-143: ‘In this section, we present a more detailed analysis … and Power Spectral Density (PSD).’ These two sentences are obsolete, because you repeat the exact same later. What would strengthen the section, would be to put the main finding up front in one sentence, or a sentence what the goal of the section is. This helps the reader to understand why you are doing the PSDs and the STA/LTA analysis.

Avoid using quantifying language without being precise. E.g. L192: ‘slightly different paths’. How slightly different? 1m, 10m 100m? There is literally no meaning in the word ‘slightly’ here. Be explicit: ‘…different paths by about 100m.’

Formatting: I highly recommend using ISO 8601 for the date and time format. For readability in the text, a form like ‘1 January 1970 00:00’ is usually chosen. Also, please also always include the time-zone or indicate ‘(UTC)’ after your time stamp. I could find four different formatting types for date and time throughout the manuscript. Please be concise.

Scientific Potential:
The present DAS data set has certainly a large scientific potential for comparing various avalanches, and possibly avalanche types, over multiple seasons and years. I appreciate the focus of this paper on the avalanche signal content. However, in my opinion the large benefit of DAS, namely the spatial resolution over large apertures, comes short in the manuscript. The avalanche frequency content spatially resolved may allow for further insights how the avalanche propagates. Beamforming might be used to track the avalanche path down the slope. As of now, waveforms are shown in Fig. 4, however, their interpretation is limited to the signals’ frequency content. Including a quantitative analysis, the ‘results’ section could be much stronger.

Specific Comments/Questions:

- Where is the interrogator located?
- What you are referring to as ‘PSDs’ in your manuscript, I would call ‘spectrograms’. Usually, such spectrograms show the Power Spectral Density if not noted differently on the color bar, such as: Amplitude Spectral Density.
- Frequency filtering in spectrograms does not make sense. You can simply cut off frequencies that are not of interest or saturate the color map.
- What strain-rate signals do you actually measure with your DAS setup. I presume that from the explosion you record Rayleigh waves. Do you also expect to see Rayleigh waves for the signal of the cone-impacts? What do you measure when the avalanche propagates across the road. You shortly mention the seismic (presumably

Rayleigh) waves from the avalanche propagation down the slope. I think this would be worth to elaborate more on, since this signal would be the relevant one for early warning.

- I do not understand why the STA/LTA is so prominent in the manuscript. Yes, it is a standard detection method, but in your case, it seems to me that it does not perform any better than simply thresholding the absolute strain-rate data.
- The diverging colormap for STA/LTA implies a triggering threshold at the center. Why not use a monochromatic color map, or center your colormap around your trigger threshold?
- I don't understand why the manuscript elaborates so extensively about the duration of the events, or signals. What do the different timings mean? Avalanche propagation; propagation over the cones; can information about the avalanche speed be derived from these timings? Can that be linked to snow conditions, size, path? That would tremendously increase the significance of the manuscript.

Line-specific Comments/Questions:

Abstract:
L7: '… avalanches approach towards the fiber.'

1 Introduction:
L48: Typo: kHz instead of khZ
L59-61: Repetitive. I would recommend shortening or remove entirely.

2 Monitoring Site Description
L75ff: I get a bit lost reading all the slope aspects and must go forward and backward to Fig. 1 and within the paragraph. For me it would help labeling the slopes A,B,C or similar, if this is applicable. However, it looks like the paper only deals with avalanches from the easternmost slope. If so, is there a necessity to indicate the other slopes at all?

L92: Wordy. I would suggest: 'We recorded strain rate with an ANS OptoDAS interrogator with 2m channel spacing, variable gauge lengths between 3.1m and 5.1m and sampling rates of 250 and 500 Hz for different seasons.' Or something similar.

3 Signal Classification
3.1 Types of Signals

L101: Something is wrong with the wording of this sentence. Also, what makes a signal 'important'? Are these 4 signals most prominent or clean or representative?

L102ff: The timing information is missing. It would be great for reproducibility if the exact timing information in UTC is provided.

120: So why is the explosive signal not visible in Fig. 3a? What is the timing between the explosive signal and the avalanche signal. Are different frequency filters applied to a) and d)? - Note: This becomes clear later in the manuscript. However, it may be worth mentioning here.

L125: Some wording seems odd here.

L134/135: I don't understand that reasoning. A broad frequency content comes from a short signal. That fits well into your theory of an impulsive impact at the cones.

3.2 Signal evolution

L148: What is being stacked for the PSDs? The waveforms before calculating the PSDs? Or the PSDs of individual channels? In this case, the latter would be the appropriate way to avoid negative interference. Also, what you call PSDs, I would call 'spectrograms'. Of course, each spectrogram time segment represents the PSD.

L165: 'Due to the lack of additional data regarding the event, the reason for this extended duration remains unknown.' To me it's obvious that either one avalanche propagated faster than the other, or that the propagated distance to the cones differs. Is that a wrong or unreasonable assumption?

L168ff: This is important and should be described more concise. I start to understand only at this point, what you measure, as here you describe that you sense the seismic wave arrivals. It is written a bit unclear, such that I thought the 'seismic noise' comes from the impact on the cones, which does not make sense, because of the timing. Make clear that the 'seismic noise' corresponds to the avalanche propagation before the avalanche front hits the cones. Also, I think you should avoid the term 'seismic noise'. It is a clear signal. Probably also with coherent arrivals along DAS channels. I would assume that this signal is comprised from Rayleigh waves.

4 Discussion

L175: Where is this shown? You don't show plots where it gets clear if the road is reached or not it is not clear to me what signal content corresponds to what size of avalanche and how it varies significantly.

L180: This sounds correct to me. It's much clearer than what is written in L168ff.

L192: Remove 'slightly'.

L193: 'Although this is not verified yet, we aim to investigate this further using avalanche simulations.' Where? If you don't present it, there is no point in writing this.

L216: 'We have made valuable observations…' I would suggest letting the reader decide if the observations are valuable.

L224: 'across the entire frequency spectrum' This should be more specific.

Figures:

General: The unit on any axis representing strain rate should be s^{-1}, not $d\epsilon/dt$, as $d\epsilon/dt$ is not a unit.

Fig. 1: I got confused by the zoomed inset map (rightmost). I'd recommend a map that also includes roads, in particular the road that represents your fiber route. I thought your study site is between Geiranger and Erdal. The star in that zoomed inset is south-east of Jostedalsbreen.

Fig. 2: I personally don't like having a 2d birds-eye view and a 3d view of the study region in the same manuscript, because it's repetitive. I'd say in this case it's ok. However, I personally would put a figure like this in the supplementary information, as it is not essential for the manuscript.

Fig. 3: I strongly recommend using ISO 8601 as an international standard of displaying date and time. In your notation implies the American format and will certainly lead to misunderstandings.

Fig. 4: I start wondering why you always show the 40s-time window for the explosion. I understand that you do it for consistency in Fig. 3. But this figure is really about the waveforms, correct? If the figure is only about the power per frequency interval, it would be much nicer to show a 'spatial spectrogram' with spectral power plotted versus DAS channels.

Fig. 5: It is unclear to me, if the for the stacked PSDs the DAS channel waveforms were stacked, or if the PSDs of individual DAS channels were stacked.

The upper row (a,b) has the time on the y-axis, whereas the lower row (c,d) has time on the x-axis. To me that's inconsistent, but not wrong. So it is your choice, but for future publications I recommend being consistent. For me, it helps understanding such multi-panel figures.

Figure label: A new date format again. I recommend using ISO 8601.

Fig. 6: Similar to Fig. 5

Figure A1: a) I see 4 diagonal lines. Therefore 4 vehicles, not 6. Am I overseeing something?

Figure A2: This is a great figure. We learn so much from it. There are coherent phase arrivals, you can fit a seismic wave speed (presumably a Rayleigh wave). As no information about the modeling is provided, I do not know what the amplitudes refer to. They also do not have a unit. In my opinion it is already enough to only have a constant velocity-travel time curve, i.e. a curved line representing the first arrival. Due to the steep topography, I think you should do it in 3D. This should result a longer distance traveled and therefore higher wave speed. I would expect a value between 2500-3300 m/s for Rayleigh waves.

Tables:

Table 1: I think this could go in the supplementary information as it is not essential to understand the manuscript.

Data availability.

This seems useless. In my opinion it is ok if the data is not publicly available. I know that this does not agree with some journal policies. I face similar problems as you do with my DAS data. I would simply write: 'At the moment, the DAS data of this study not publicly available. Access can be granted on individual request.'