Reply to Martijn van der Ende

Thank you for your comments and suggestions.

1. General questions and comments

How often would false detections be produced by road traffic?

We did not run a continuous trigger algorithm over the whole dataset. Consequently, we cannot quantify the trigger efficiency as of now. However, comparing the confirmed avalanche signals with road traffic examples (individual cars and trucks, see attached image for comparison), simplified detectors will likely end up with false detections due to traffic. The noise situation is also changing with the season, so an optimization process to find the best trigger values would be required. In this paper, we did not aim for a robust and automatic detector to only trigger on avalanches and not on cars, so we did not further tune the parameters to avoid traffic triggers.

Does it help to stack the detection metric over e.g. 100m of cable?

In principle, spatial stacking of data over several traces should increase the signal to noise ratios, yes. However, we also observe that the noise is spatially correlated, sometimes over many traces as well. Below we show some of our trials on stacking for three different triggering algorithms (raw data, STA/LTA, Kurtosis), see Appendix 1. Stacking does not solve the problem, unfortunately. Although large events (like the avalanche from 10 April 2022) can be distinguished from road traffic, stacked detection metrics for smaller ones (like the one from 2 February 2024) lie in the same range as traffic.

Or apply a low-pass filter in space, given that the main avalanche signals have a spatial footprint that is larger than that of individual vehicles on the road?

The spatial footprint is not necessarily larger than that of individual vehicles – it can be similar when the avalanche event is not as large and more localized (see natural avalanche from 2 February 2024).

Or apply a basic FK-filter to remove the characteristic vehicle speeds?

We appreciate the constructive comments, and we will also investigate further in this direction of taking advantage of the high spatial resolution of the DAS data. We actually did apply and try quite a few different signal processing steps that unfortunately did not improve the results significantly above the STA/LTA approaches (semblance, semblance weighted, cross-correlation weighting, kurtosis/period,...). In the revised version we will include some of these approaches in the appendix.

Aside from this comment, I only have a few tiny suggestions for improvement:

- The authors use "spiky" to describe some of the more localised signals. Perhaps "impulsive" could be a more formal alternative description, but I leave this entirely up to the authors to consider.

  Adjusted as recommended.

- I think that the readability of Section 3.1 could improve by splitting the big paragraph (lines 101-138) into a few individual paragraphs.

  Adjusted as recommended.

- The reference to Xie et al. on line 210 is missing a date. Also, there are several papers that describe DAS-based vehicle detection that are already published, so I would suggest citing one or two of those in addition to this preprint.

  Fixed and additional reference was added.

- A suggestion for future work, if the authors intend to remove traffic signals from their data/detections: the traffic signals in the 0.5-5 Hz frequency band are very simple, as they basically represent the spatial footprint of a point load indenting a surface (which translates in time and space; see the Methods section of Jousset et al., 2018; https://www.nature.com/articles/s41467-018-04860-y). It is possible to deconvolve this characteristic signal from the data, which yields high-resolution detections of each vehicle on the road (https://dl.acm.org/doi/10.1109/TITS.2023.3322355; preprint: https://arxiv.org/abs/2212.03936). The authors could use this approach to exclude STA/LTA detections associated with traffic, or to mask portions of the data that coincide with traffic signals. This is merely a personal suggestion for future work, I don't expect the authors to expand on this for the present study.

  Thank you for the recommendation, this looks very interesting.

Kind regards,

Martijn van den Ende

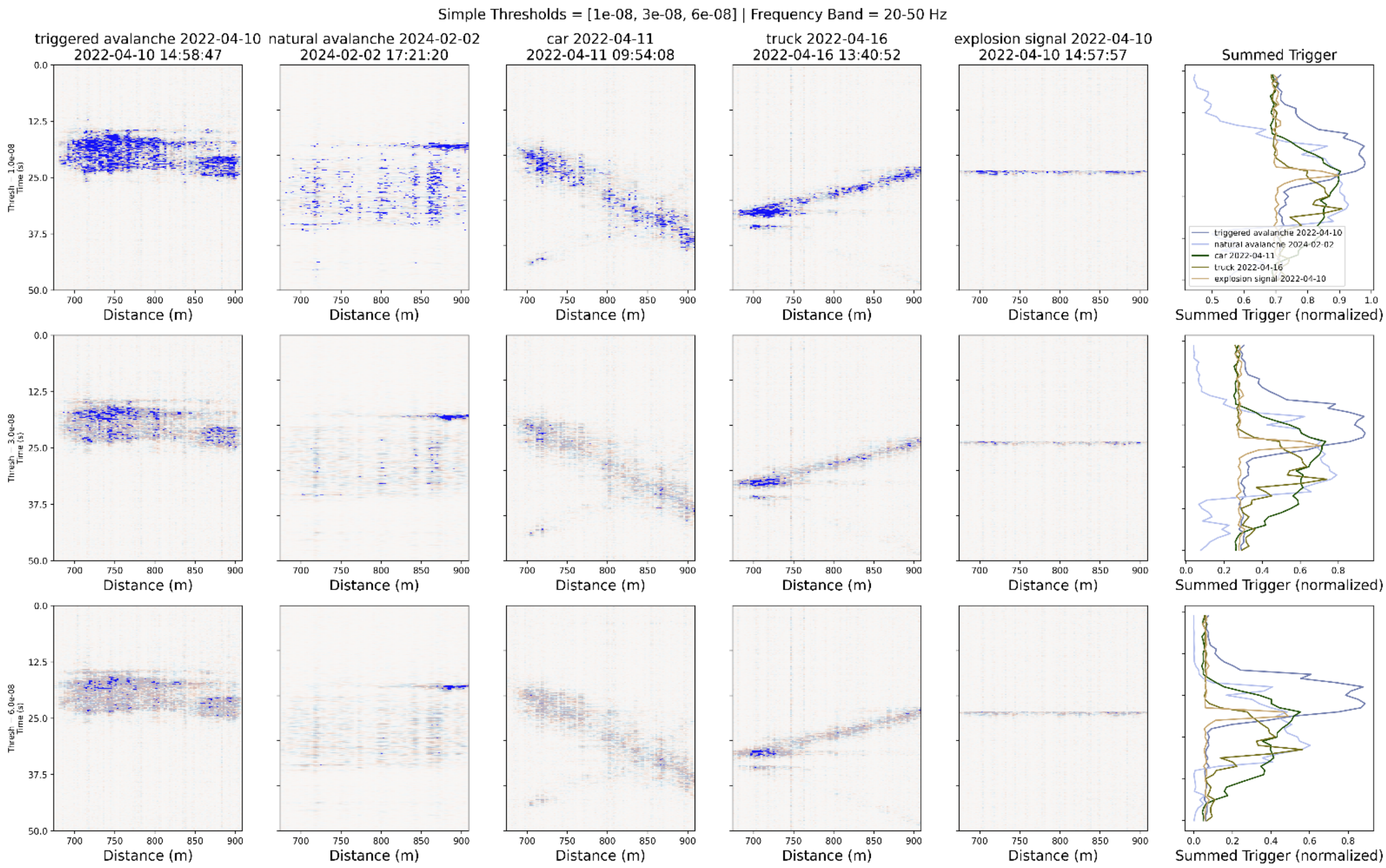
Attachements

1. Trigger comparison

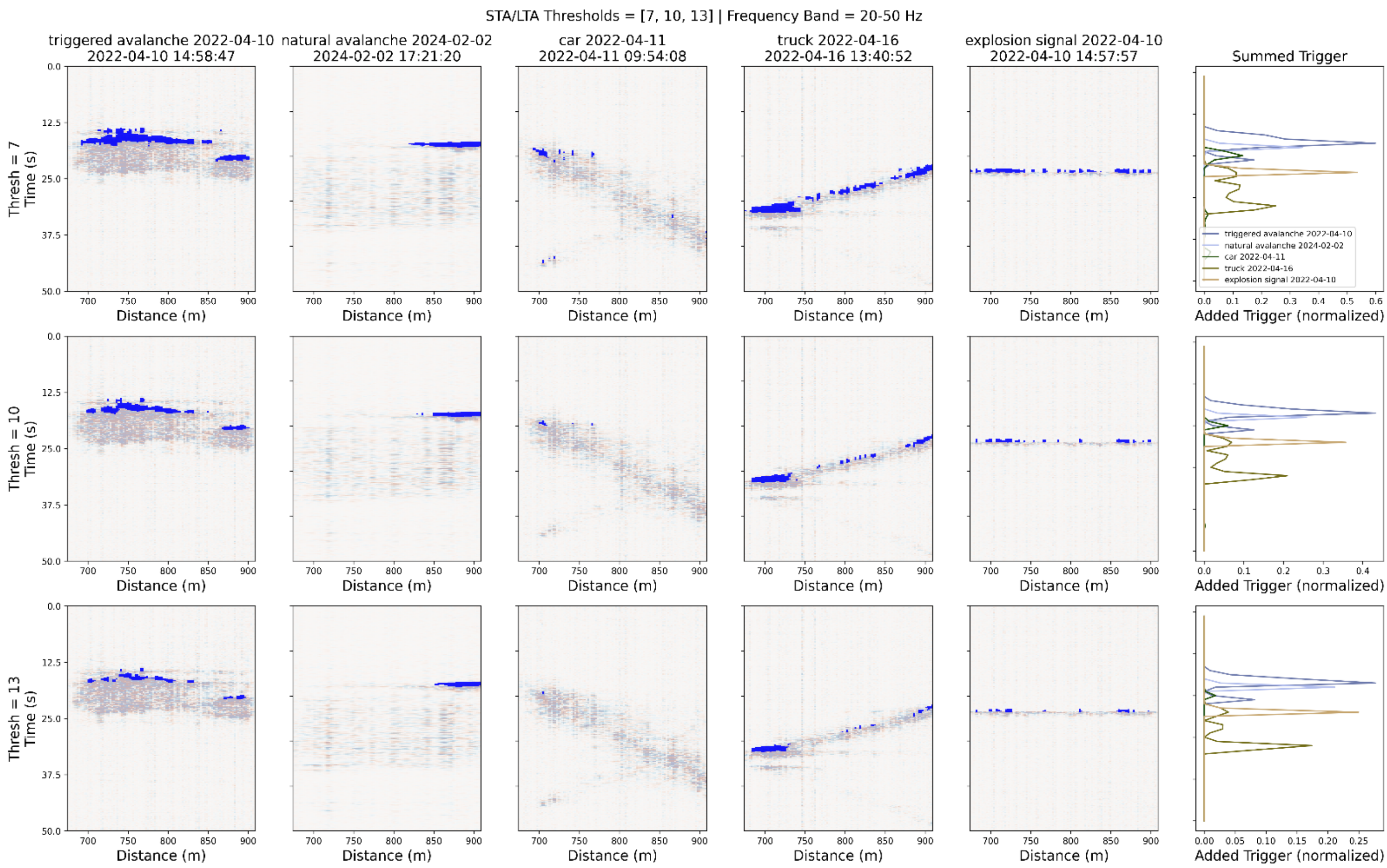
The following images display three different trigger mechanisms – simple threshold, STA/LTA and Kurtosis. The rightmost column shows the summed triggers for all events (summed in blocks of 1 s each). The triggered avalanche is

For each algorithm, three thresholds were tested (displayed in different rows).

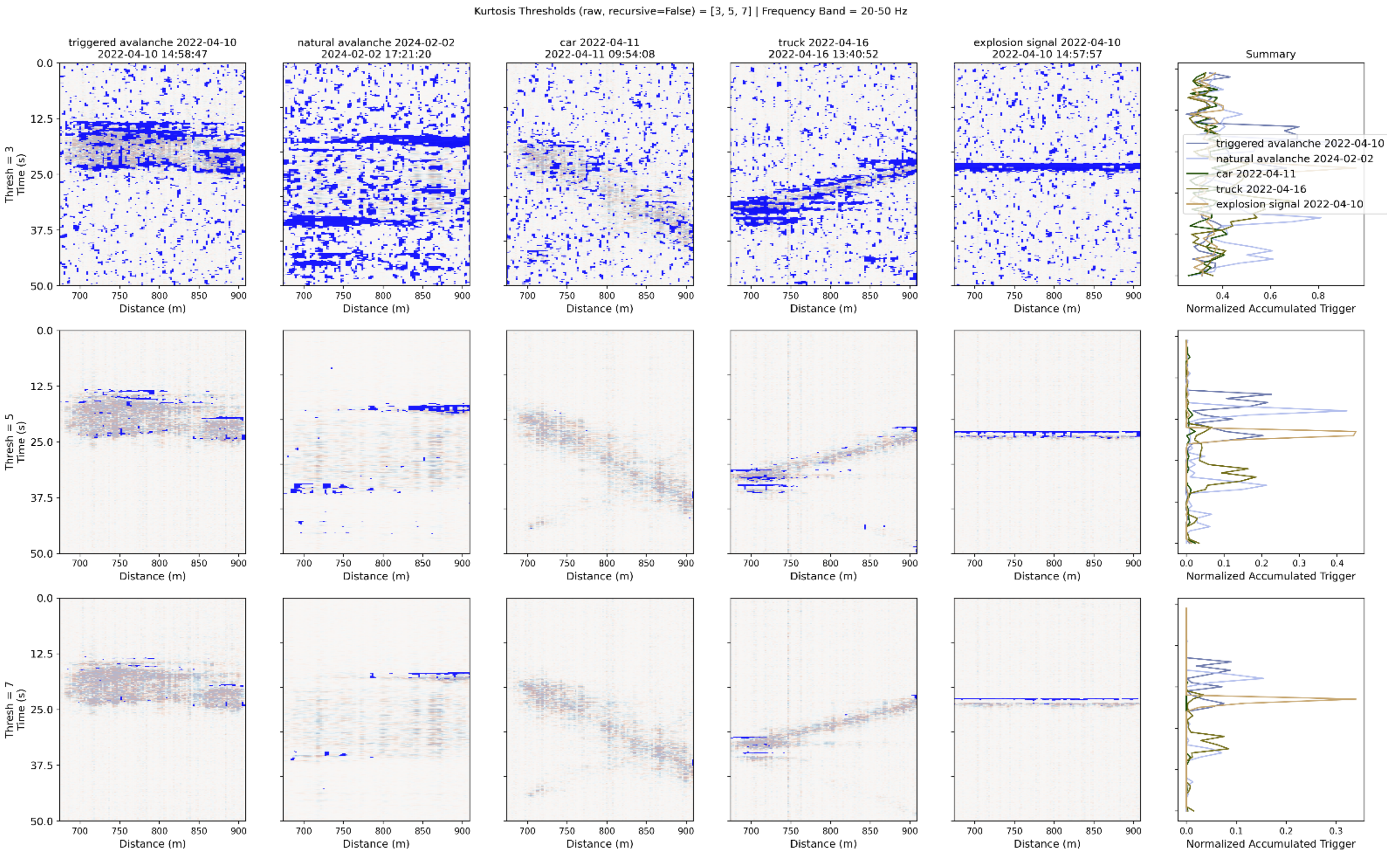
(a) Simple Threshold trigger


Simple Thresholds = [1e-08, 3e-08, 6e-08] | Frequency Band = 20-50 Hz
triggered avalanche 2022-04-10
2022-04-10 14:58:47
natural avalanche 2024-02-02
2024-02-02 17:21:20
car 2022-04-11
2022-04-11 09:54:08
truck 2022-04-16
2022-04-16 13:40:52
explosion signal 2022-04-10
2022-04-10 14:57:57
Summed Trigger
Thresh = 1.0e-08
Thresh = 3.0e-08
Thresh = 6.0e-08
Time (s)
Distance (m)
Summed Trigger (normalized)
triggered avalanche 2022-04-10
natural avalanche 2024-02-02
car 2022-04-11
truck 2022-04-16
explosion signal 2022-04-10

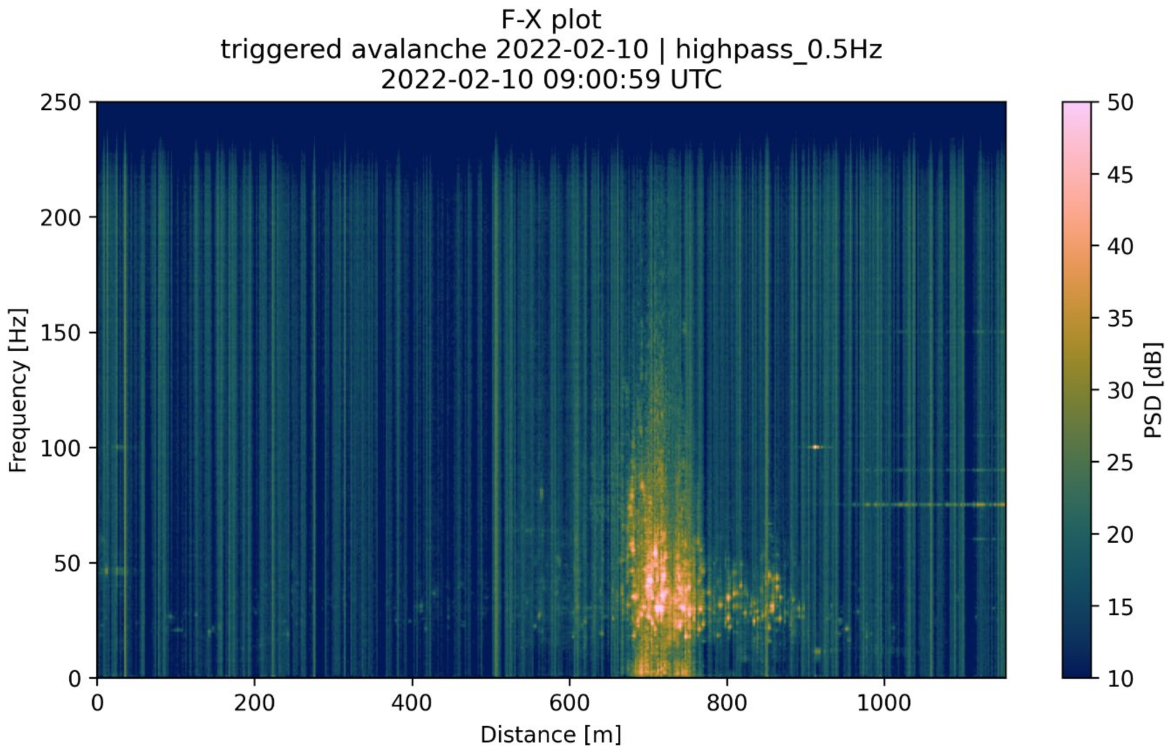
(b) STA/LTA

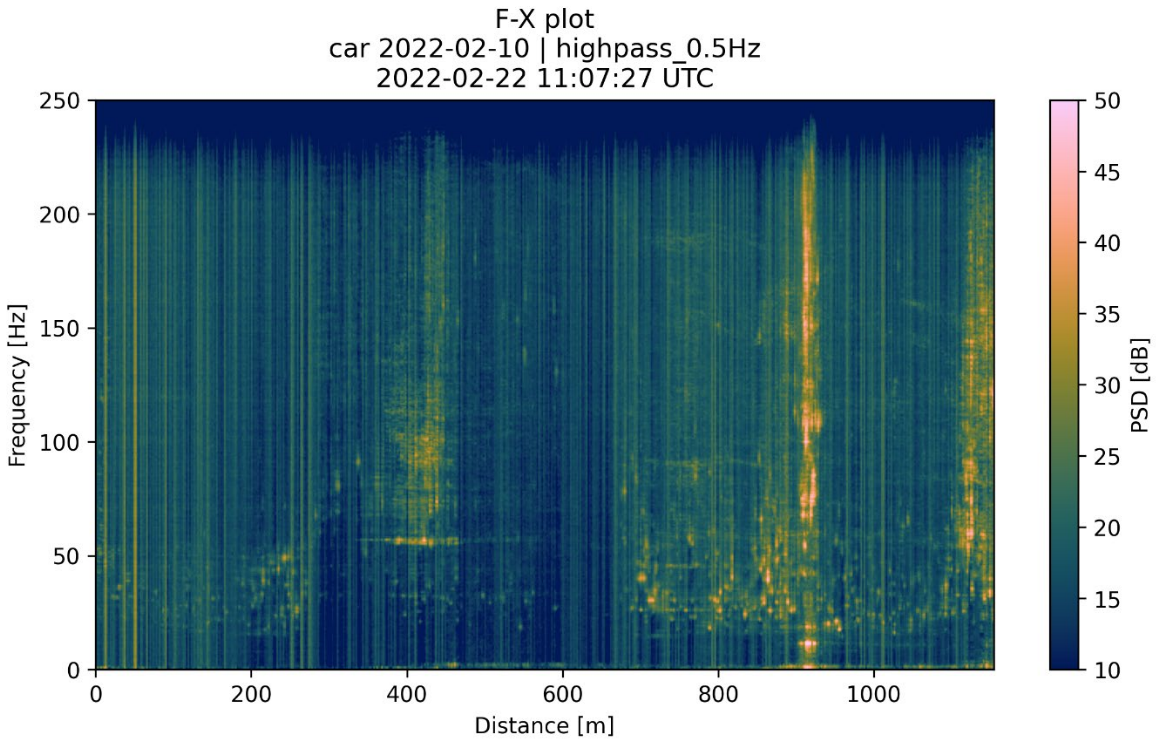

STA/LTA Thresholds = [7, 10, 13] | Frequency Band = 20-50 Hz
triggered avalanche 2022-04-10
2022-04-10 14:58:47
natural avalanche 2024-02-02
2024-02-02 17:21:20
car 2022-04-11
2022-04-11 09:54:08
truck 2022-04-16
2022-04-16 13:40:52
explosion signal 2022-04-10
2022-04-10 14:57:57
Summed Trigger
Thresh = 7
Thresh = 10
Thresh = 13
Time (s)
Distance (m)
Added Trigger (normalized)
triggered avalanche 2022-04-10
natural avalanche 2024-02-02
car 2022-04-11
truck 2022-04-16
explosion signal 2022-04-10

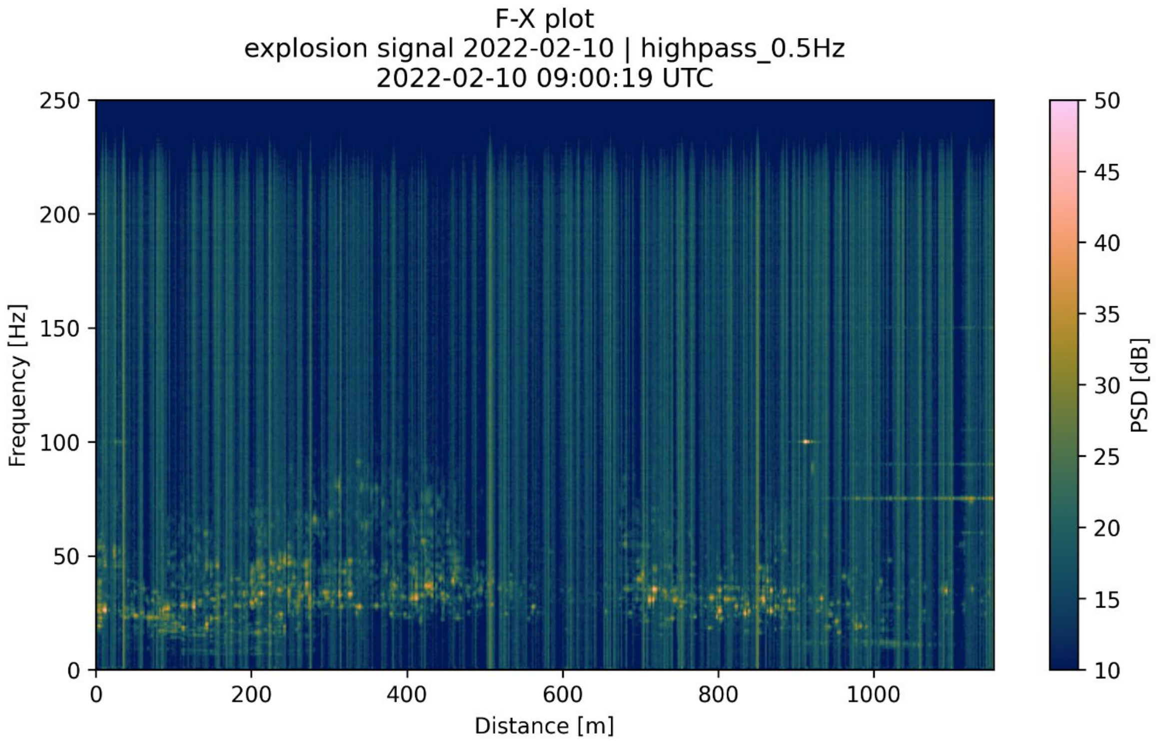
(c) Kurtosis



2. F-X Plots




F-X plot
car 2022-02-10 | highpass_0.5Hz
2022-02-22 11:07:27 UTC
Frequency [Hz]
Distance [m]
PSD [dB]
0
50
100
150
200
250
0
200
400
600
800
1000
10
15
20
25
30
35
40
45
50


F-X plot
explosion signal 2022-02-10 | highpass_0.5Hz
2022-02-10 09:00:19 UTC
Frequency [Hz]
Distance [m]
PSD [dB]
0
50
100
150
200
250
0
200
400
600
800
1000
10
15
20
25
30
35
40
45
50