Response to reviews for the manuscript titled “Spatiotemporal evaluation of Rayleigh surface wave estimated from roadside dark fiber DAS array and traffic noise”, R. Czarny, T. Zhu, J. Shen, submitted to Seismica

Summery from Nicola Piana Agostinetti (Handling Editor)

Dear Rafał Czarny,

I hope this email finds you well. I have reached a decision regarding your submission to Seismica, "Spatiotemporal evaluation of Rayleigh surface wave estimated from roadside dark fiber DAS array and traffic noise". Thank you once again for submitting your work to Seismica. The manuscript is suitable for publication in Seismica, but it needs substantial revisions.

I received three peer-review reports for your manuscript. The reviewers have quite different opinions about the manuscript. From the reading of the reviewer reports and my personal reading of the manuscript, I suggest (1) to extend the analysis to more time-windows (i.e. months) to show the variability of the signal individuated in May 2019; (2) to clarify the processing steps, adding a supplementary material section; and (3) to consider off-axis sources as suggested by Reviewer #2 to give a more comprehensive view of the use of DAS data in reconstructing Rayleigh Waves dispersion curves (highlighting potential and pitfalls). Regarding point (2), I found a similar publication from your research group (see below), which is not cited in the Reference List of the manuscript, reporting the processing steps for FORESEE DAS data. This publication should be correctly cited and the processing steps refereed.

Rafał Czarny and Tieyuan Zhu (2022) Estimating Rayleigh surface wave from ambient noise recorded by distributed acoustic sensing (DAS) dark fiber array in the city https://library.seg.org/doi/abs/10.1190/image2022-3750564.1

Authors response to Nicola Piana Agostinetti

A: Thank you, for this summary review. We have considered all reviews to improve the manuscript significantly. We have done more data processing i.e. extended the analysis from 1 to 5 months (end of September) and computed the spatial distribution of the noise source to see off-axis noise. New results give more insight into the topic and confirm previous conclusions.

Comments from Reviewer #1

Spatiotemporal evaluation of Rayleigh surface wave estimated from roadside dark fiber DAS array and traffic noise by Czarny & Zhu

In their study, the authors analyze distributed acoustic sensing (DAS) data from the FORESEE dark fiber deployment in the area of the Penn State University campus. They mainly use cross-correlation gathers on a 800 m long cable subsegment to analyze spatiotemporal evolution of coherent wave propagation along the deployment. Using the beampower of slant stacks of the cross-correlation gathers as coherence criterium, they present evidence that pedestrians and vehicles hitting road obstacles like speed bumps are the main source of local coherent wave propagation. Furthermore the manuscript discusses the imprint of precipitation and wind, which is seen on a few channels.

It is interesting to use dark fibers beneath cities for various purposes (subsurface imaging, traffic intensity tracking, etc) and the authors show that DAS may provide useful data in this regard. However, contentwise, the study lacks depth and it does not provide novel information. It has been shown by other DAS studies and it is not surprising, that traffic generates seismic waves. In addition, by lack of depth in content, I mean that the study only analyzes one month of a data set covering more than two years and that the selected representative signals for precipitation and rain are only visible on a few channels out of several thousand channels. Furthermore, while most of the methodology appears tenable (yet many formulations are unprecise and lack explanation), the analysis of attenuation is too simplistic and I cannot see evidence for the temporal change in attenuation as claimed in the manuscript (Fig. 6). Finally, I cannot see a clear motivation for the conducted study, which – togehter with the above mentioned issues – brings me to the conclusion, that the manuscript does not fulfil the scientific requirements of peer-reviewed journals like Seismica.

Authors response to REVIEWER #1

A: Thank you for your comment. We have done our best to improve the manuscript to fit the scientific requirements of peer-reviewed journals. We have rewritten the discussion section and highlighted the benefits of our research. We extend the analysis to 5 months and clarify the processing steps. According to the attenuation analysis, we want to stress that wave attenuation itself wasn't our goal in this paper. However, we addressed this analysis to scientists who would like to monitor subtly near-surface change with the use of high-frequency noise with DAS in urban areas. The changes in water saturation can lead to changes in the noise source distribution, which can mislead the analysis of kinematic and dynamic parameters in terms of subsurface changes.

Comments from Reviewer #2

This is a review of the manuscript "Spatiotemporal evaluation of Rayleigh surface wave estimated from roadside dark fiber DAS array and traffic noise". This paper studies the influence of ambient noise sources of Rayleigh waves on distributed acoustic sensing records. The authors first study the behavior of the ambient noise of local activity on the recordings.

The authors detail very precisely all effects observed which is very useful as data recorded in city is complex and should be understood to be used. I liked that the authors explored their data. However, it means that the article is very descriptive and the results section is quite heavy. It would be good to have a general summary about the most influential parameters and to compare these with other studies made with DAS data or high-density arrays. The section is called Results and discussion but the discussion portion is missing.

A: We have rewritten the result and discussion. We have divided this section into spatial and temporal SNR changes and extended our result analysis**.**

The authors mention in the abstract that they use 160 virtual sources. Since they insist on this number its choice should be discussed more clearly since this number feels qui small.
For example, line 150, I understand that only two wavenumbers are explored which confused me. Are these the two borders for the selected window in the f-k domain? In that case it is surprising to limit the analysis to the extremes. I may not have understood what the authors meant. Again, I may not be correct but I understood that the 80 virtual sources are along the fiber which seems quite limiting.

A: *We select a virtual source (VS) point every 10 m (5 channels) as an optimum value in terms of computational cost. This VS spatial resolution gives us the ability to characterize and identify the main noise source along the road (Section 4.2). Indeed, we constrain our analysis to the areas between 100 m/s and 5500 m/s. By doing that, we mitigate the impact of the off-axis noise. We also try to reduce the impact of the Love surface wave on the estimated Rayleigh surface wave. Following Martin et al., (2018) the sensitivity of the Love wave is the highest at 45 degrees.*

Indeed, sources off axis often have strong effects and can lead to misinterpretations of the signals. For a study on sources, it is too bad that these are not considered when there is a good chance that a lot of sources are off axis. As it is, the authors show which portions of the fiber are influenced by noise but not the noise sources themselves.

A: We have analyzed the noise source distribution along the fiber and identify some off-axis noise is section 4.2.

A check for English would be helpful because I sometimes did not understand what the authors meant. Consequently, some of my comments may be out of context when I did not understant correctly.

A: We have made grammar correction.

Specific comments:
- Line 94: I interpret "longest lasting" to be about length duration but the following sentence mentions spatial length. Is this "longest lasting" in "the city" (and what is this city) or do the

authors mean on that campus? If it is on that campus, it does not really seem necessary to mention it. Or is it supposed to be more general? In that case I would rephrase and check other recordings. The recordings on Stanford campus lasted for quite a while I believe.

A: We have rewritten this sentence. We agree that the Stanford experiment last also comparable long.

- Line 106: The frequency band chosen made me wonder about the choices of sampling. The authors insist on showing that they do measurements at different frequencies, a discussion of the reasons would be useful, since the analysis is limited to lower frequencies.

A: We agree with reviewer. We have added one more frequency range 20-50 Hz and improve the figure to emphasize the PSD changes.

- Line 107: The use of the word "relates" feels weird to me here, but I am not an English native so it should be checked.

A: We have rewritten this sentence.

- Lines 112-115: I would invert the two sentences since the day/night variation is the most obvious.

A: We have rewritten this sentence.

- Line 127: I am not sure the word route exist in English to say road.

A: We have changed this word.

- Line 127: I am not sure that "stuck" is the best word

A: We have changed this word.

- Line 128-129: The authors should detail this sentence and explain the reasons using references.

A: We have rewritten this sentence.

- Figure 3: It would be nice to add a length scale and not just write the channel to apprehend these scales better.

A: We have added a distance scale.

- Lines 142-143: I read the sentence several times and do not understand what is meant here, are the recordings really separated in two, or are they processed in two separate ways. The second way makes more sense to me but I may not have understood as it is not what the sentence implies.

A: We have rewritten this sentence.

- Lines 145-147: The window of velocity is quite large and would not restrict the stationary phase region. This needs to be justified. Also, since the study is about source influence, should all the window be analyzed? I am not saying it has to be but the authors should justify their choices clearly. There has been a lot of work in that subject that could be used by the authors. Moreover, since the point of this paper is to study the sources, the authors should express their reason for lowering their influence. It has been shown that the pre-processing modifies how the sources are seen. Comparing this process with the "raw" correlations would be useful to understand these sources and the effects of processing.

A:. The parameters for f-k are optimum and were tested. We select such a wide range of velocities because we also apply a smoothing filter at the edges of the mask. The source code can be found on github. Our constrain and method with f-k help us improve the quality of the reconstructed wave from a signal minute to analyze its SNR. Moreover, by applying f-k, we can observe interesting attenuation of the far-field noise from the west due to water saturation. Finally, we agree with reviewers that because of f-k, we missed the opportunity to analyze noise off-axis noise. However, we included this analysis in this revision.

- Line 151: I am not sure "analogously" exists.

A: We have rewritten this sentence.

- Line 155: I am wondering why the authors use the term "vast", is it compared to other areas? If it is this point should be supported.

A: We have rewritten this sentence.

- Line 157: I am not sure the authors mean by quality. It looks like what the authors are looking at is signal to noise ratio. If they want to keep the word quality, I believe it should be defined. Indeed, studies have showed that a good SNR is not equal to quality.

A: We agree with the reviewer. We have removed the word "quality" and operated only with SNR.

- Line 185: The authors say "Probably" here. This is to me a very important question about signal sources and they seem to be overlooked. I think this point needs to be supported.

A: We have rewritten this section and support this observation by back projection analysis.

- Lines 193-195: This sentence should be checked; the formulation does not seem to be correct.

A: We have rewritten this section

- Line 198: Again, it should be checked if the authors actually mean "quality".

A: We have removed the word "quality".

Comments from Reviewer #3

The work presented is a correct and detailed application of signal analysis techniques for ambient noise characterization. The analysis and the results are presented quite clearly, although some corrections are needed to clarify the paper. In the following, you can find the detailed revision.

Best Regards

General comments:

- In the procedure for calculating the cross-correlation, why did you not do a normalization in the time domain? Why only in the frequency domain?

A: We tested time domain normalization like 1bit, but we did not observe significant improvement in cross-correlation functions.

Revision and suggestions:
Paragraph 60 - change "which allow extracting " by "which allows extracting "

A: We have changed "which allow extracting " by "which allows extracting ".

Paragraph 60 - change "then excites it" by "then exciting it"

A: We have changed "then excites it" by "then exciting it".

Paragraph 60 - change "it towards receivers" by "it toward receivers"

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Paragraph 85 - change "analyze 160 virtual shot gathers" by "analyze 160 virtual shots gathers"

A: We have changed "analyze 160 virtual shot gathers" by "analyze 160 virtual shots gathers"

Paragraph 95 - change "with straight line geometry" by "with straight-line geometry"

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Paragraph 110 - change "the day and decays at night were" by "the day and decaying at night was"

A: We have changed "the day and decays at night were" by "the day and decaying at night was".

Paragraph 160 - change "different phase-shits in frequency domain" by "different phase-shifts in the frequency domain"

A: We have changed "the day and decays at night were" by "the day and decaying at night was".

Paragraph 200 - change "characterize different wavefield behavior." by "characterize different wavefield behaviour."

A: We have rewritten this section.

Paragraph 210 - change "marked as Segment C and D, respectively." by "marked as Segments C and D, respectively."

A: We have rewritten this section.

Paragraph 215 - change "high-frequency ambient noise behavior." by "high-frequency ambient noise behaviour."

A: We have rewritten this section.

Paragraph 220 - change "activities because of the day of week (similar behavior as we see between Segments A and B). " by "activities because of the day of the week (similar behaviour as we see between Segments A and B). "

A: We have rewritten this section.

Paragraph 225 - change "Due to strong contamination of other seismic noise to selected wavefield we examine only near field around the bump" by "Due to the strong contamination of other seismic noise to the selected wavefield, we examine only the near field around the bump. "

A: We have rewritten this section.

Paragraph 230 - change "We suppose that water due to lower temperature" by "We suppose that water due to the lower temperature"

A: We have rewritten this section.

FIGURES
Figure 5: change "ambient noise behaviors during " by "ambient noise behaviours during"

A: We have rewritten this section.

Dear Rafał Czarny,

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Please find here the reviewer reports here for references.

I look forward with interest to receipt of the modified version. You should explain how and where each point of the reviewers' comments has been incorporated. For this, please upload:
-A 'cleaned' version of the revised manuscript, without any markup/changes highlighted.
-A version of the revised manuscript clearly highlighting changes/markup/edits.
-A 'response-to-reviewers' letter that shows your response to each of the reviewers' points, together with a summary of the resulting changes made to the manuscript.

Please strictly follow the formatting requirements as presented in the Guide for Authors.

Please note that Seismica does not have any strict deadlines for submitting revisions, but naturally, it is likely to be in your best interest to submit these fairly promptly, and please let me know of any expected delays. Once I have read your revised manuscript and rebuttal,I will then decide whether the manuscript either needs to be sent to reviewers again, requires further minor changes, or can be accepted.I wish you the best with working on the revisions. Please don't hesitate to contact me with any questions or comments about your submission, or if you have any feedback about your experience with Seismica.

REVIEWER #1

Spatiotemporal evaluation of Rayleigh surface wave estimated from roadside dark fiber DAS array and traffic noise

by Czarny & Zhu

In their study, the authors analyze distributed acoustic sensing (DAS) data from the FORESEE dark fiber deployment in the area of the Penn State University campus. They mainly use cross-correlation gathers on a 800 m long cable subsegment to analyze spatiotemporal evolution of coherent wave propagation along the deployment. Using the beampower of slant stacks of the cross-correlation gathers as coherence criterium, they present evidence that pedestrians and vehicles hitting road obstacles like speed bumps are the main source of local coherent wave propagation. Furthermore the manuscript discusses the imprint of precipitation and wind, which is seen on a few channels.

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Again, I may not be correct but I understood that the 80 virtual sources are along the fiber which seems quite limiting. Indeed, sources off axis often have strong effects and can lead to misinterpretations of the signals. For a study on sources, it is too bad that these are not considered when there is a good chance that a lot of sources are off axis. As it is, the authors show which portions of the fiber are influenced by noise but not the noise sources themselves.

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