Statement on the Revision of manuscript #2713

Pitter, patter, gurgle, burble: measuring the acoustics of rainfall using DAS in urban environments

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Dear Editor and Reviewers,

This document describes our revisions to the manuscript "Pitter, patter, gurgle, burble: measuring the acoustics of rainfall using DAS in urban environments" (#2713), based on the received comments. We appreciate your honest feedback and constructive comments and suggestions. We have implemented the required corrections and believe that they have helped to improve the presentation of our method and the results. In response to the reviewers, we have addressed all the received comments. For the reviewers' convenience, we have highlighted changes in the revised manuscript in blue for added text and in red for removed text. The line numbers refer to the final (no tracked changes) version of the manuscript, unless stated otherwise. Please find below a full list of comments and our replies.

Response to the Associate Editor

> **Associate Editor Comment** — ... If you deem it appropriate, please check that the revised version of your manuscript recognises the work of the reviewers in the Acknowledgements section.

Reply — Thank you so much for your feedback. We have added a thank you note to the reviewers (lines 422-423).

Response to reviewer 1

> **Reviewer Comment 1.1**: 1, the manuscript occasionally overstates the current capability of DAS as a "distributed rain gauge." The presented results convincingly demonstrate rainfall detection and qualitative sensitivity to precipitation intensity, but the evidence for robust quantitative rain estimation remains limited. Correlations vary substantially across locations, and many cable sections remain insensitive. I suggest moderating some of the stronger claims regarding rainfall quantification and emphasizing more clearly that the observed sensitivity strongly depends on local infrastructure coupling conditions.

Reply — Thank you so much for your constructive comments. We agree that the word "gauging" can potentially be misinterpreted in some context. Therefore we have replaced it with more appropriate terms where needed (lines 14, 384). However, we would like to point that we do clearly state current limitations of the method, including those listed by the reviewer. In fact, several paragraphs in sections *Results* and *Conclusions* are dedicated to this topic (e.g., lines 363-373, 390-395, 406-411). In addition, we discuss that the quantitative rainfall estimates can be challenging due to varying seasonal sensitivity (lines 368-370). We have further highlighted this point in the *Results* and *Conclusions* sections (lines 372-373, 402) to improve clarity.

> **Reviewer Comment 1.2**: 2, the frequency-band selection for different interrogators (e.g., 80–250 Hz for Treble+ and 40–100 Hz for QuantX) should be discussed more carefully. It is currently unclear to what extent these differences are controlled by rainfall physics versus interrogator characteristics, gauge length, noise floor, or processing choices.

Reply — In the original manuscript we specify that *"The selected frequency band was driven by the dominant rain energy observed in the respective datasets"* (lines 207-209). This, in turn, was primarily driven by the interrogator characteristics. We have added a clarification in the manuscript (lines 207, 297-298). While we do not have access to full instrument response characteristics of either system, the Treble appears to have better performance in the higher frequency bands while the QuantX has an improved response at the lower end. While this is not an entirely satisfying answer, the issue of DAS response, a convolution of IU and cable properties, is an on-going community challenge.

> **Reviewer Comment 1.3**: 3, several figures (e.g., figure 5/9) are information-rich but somewhat difficult to compare quantitatively because different panels use different amplitude scales. A summary table listing deployment conditions, burial/coupling type, dominant frequency band, correlation Coefficients, and sensitivity characteristics for each analyzed location would improve readability and help synthesize the results.

Reply — We appreciate your suggestion, however, Seismica requires all tables to be placed in supplementary materials rather than in text. Therefore, we believe that such a table, when placed outside of the main manuscript, will not improve readability. In addition, at this stage our analysis mainly focuses on the qualitative analysis. The direct amplitude comparison between different locations (i.e., plotting all amplitudes at the same scale) will not bring any clarity as absolute amplitudes depend on many factors that we discuss in the text (IU, cable deployment conditions, surface conditions, etc.). The only easy to compare and relative to the discussion direct comparison of the amplitudes is for the same locations but during different seasons which are displayed in the figures. Also, the provided quantitative measure of the correlation between the precipitation rate and DAS amplitudes is displayed in each subplot for readers' convenience.

> **Reviewer Comment 1.4**: 4. There are still a number typos throughout the text. For example, phrases such as "direct rain signatures" should be revised to "direct rain signature", and "mean DAS aptitudes" likely should be "mean DAS amplitudes" or "spectrogram energy".

Reply — Many thanks for noting these errors. We have scrutinized the manuscript and corrected the grammar errors and typos.

> **Reviewer Comment 1.5**: 5. The terminology related to urban telecom infrastructure should be defined more clearly when first introduced. Terms such as "pull box", "slack zone", and "surface

> utilities controller" may not be familiar to all readers in the seismological community. To be honest, I had to spend some time on google to verify their meanings.

Reply — We provide a written description for all listed terms when we first introduce these terms (lines 171-177 in the original manuscript). We also have picture examples for two types of pull boxes and a surface utilities controller (Figures 2b and 2c). We have added a couple more sentences for a more detailed description (lines 173-182)

Response to reviewer 2

> **Reviewer Comment 2.1**: ... While I understand that sensitivity and correlation levels vary along the array, it seems likely that there is a minimum precipitation rate required to induce a detectable DAS signal. It would be useful if you could estimate or evaluate this minimum threshold, as it would help quantify the sensitivity level needed to observe rainfall-induced signals with DAS.

Reply — Thank you for your constructive feedback. We have estimated the average sensitivity threshold for the RSTF cable to be about 2.5 mm/hr (we have specified the cumulative precipitation threshold in the original manuscript and added the corresponding rate in current revision, line 230). Identifying an average sensitivity threshold for the HANA array is a tricky task. Lower intensity rains tend to generate less high frequency energy. At the same time lower frequencies are often dominated by other ambient noise sources (infrastructure, traffic, etc.). The actual bandwidth and intensity of this background noise varies drastically from one location to another even within short distances (e.g., see Figure 10). Therefore, different sensitive zones within the same cable might have substantially different sensitivity thresholds. Hence we have not provided such an estimate for the HANA array. We have added a comment on this topic in the revised manuscript (lines 299-302).

> **Reviewer Comment 2.2**: ... It would also be interesting to further evaluate the high-frequency response during rainfall events. For the QuantX system, you state that the data were recorded at 5 kHz. Showing a full-band spectrogram would allow readers to assess not only the response below 1 kHz, but also any signal content at higher frequencies. In particular, I wonder whether acoustic emissions from individual raindrop impacts could be detected. These high-frequency signals may be too weak to observe clearly, but demonstrating this would strengthen the interpretation.

Reply — Thank you for this noteworthy suggestion. Your comment brought to our attention the fact that we did not mention one detail in the original manuscript. The QuantX data sampling rate in *both* space and time was reduced shortly after the beginning of the data collection to improve data transfer, storage, and processing efficiency. We mentioned the change in space sampling but not in the time domain, our apologies for the confusion. We have added a correction to the manuscript (line 187). The reduced sampling rate led to the shorter bandwidth of the spectrograms presented in the data. In addition, individual raindrop detection would require disdrometer data to make a definitive DAS signal interpretation, which unfortunately was not available. However, this might be an interesting question to answer in a future experiment, particularly given our access to fit-for-purpose arrays on campus.