

The article under review cover an interesting topic and present some unprecedentedly published results, for these reasons I would be in favour for publication. Unfortunately, the manuscript does not fit the standard for publication and It requires, in my opinion: a deep review for different reasons:

1. the text is in some part confuse, with a lot of repetitions and for the reader (at least for myself) it is difficult to distinguish between original results, hypothesis from the authors and previously published results. It emerges clearly that this is the manuscript from a newbie researcher and I would encourage him to rephrase many sentences and drain the text as much as possible, to ease the readability and comprehension.

Considering also the following points raised by the reviewer, we updated several instance in the manuscript trying to address the readability of the text.

2. a clear description of the methodology is missing. I understand that PSD is a standard but how PSDs were computed should be described, otherwise the results would be difficult to be reproducible. The authors do not mention is disturbances to the noise (e.g. earthquakes) are removed to the dataset.

We updated the Method section with the information that were missing as pointed out by the reviewer.

3. Section results does not analyse in depth the results, e.g. figure 3 that contains the substance of the paper (PSD for single station, difference between the different months and years but it is not discussed at all.

In Figure 3 only 20 stations out of 532 are presented to provide an overview of the behaviour of the noise over time. In the updated Figure 4 the overall noise levels of all stations are presented: the figure in the first version was a comparison figure for 6 periods instead of median vertical component noise maps of 9 different periods.

4. In Section Discussion I would suggest that the authors at first present their results and then they discuss them in the context of previous study. figures are difficult to be read. Italy is long and narrow and the authors are evaluating +500 stations that means +500 colored symbols placed in the map.

In the Discussion section we divide the results in 3 categories (low, medium, and long periods). For low and medium periods we discuss day-night and weekday-weekend variations; for the long periods we discuss seasonal variations. The structure is inspired by Anthony et al. (2022). The results are then compare with the ones from D'Alessandro et al. (2021). Since COVID-lockdown is an extraordinary event, we discuss its effect in a separate section. The Trieste case study and the vehicle noise are discussed separately in their dedicated sections as they analyze very short periods (i.e. high frequency) that would be difficult to merge inside the more general discussion the main Discussion section. However, if the reviewer thinks that the Discussion section needs to be reorganized we can reshape it as below:

5. Discussion

5.1 Low periods

5.1.1 Case study: stations located in Trieste

5.1.2 Vehicle noise

5.2 Medium range periods

5.3 Long range periods

5.4 COVID-19 lockdown

For better visualization we provide HTMLs with interactive features in our GitHub repository (<https://github.com/sffornasari/RAN-noise>).

We are at the end of 2022 and the authors during the review phase will have the full 2022 year available. I encourage them to use that dataset to provide a much comprehensive analyse for a complete year for which a lot of stations should be available. and eventually to consider the option of dropping data from 2019 that could become less relevant.

We agree that adding 2022 would increase the quality of the paper. Right now, we are considering to do this. In the meantime we would like to wait for the response of the second reviewer before making such a major change in the paper.

Moreover,

1. L.20 To complete the though I would suggest to add that in this case earthquakes are considered as disturbances in the signal. ✓
2. L.21 Since the authors made a distinction, we now need a definition of what, for the case of this paper, is noise. ✓
3. L.25 I would suggest to add also the scattering at shallow layers that e.g. generates the so-called Newtonian Noise (e.g. Harms et al. 2009.) ✓
4. L42 “away from anthropogenic noises”, I would say “far from any source of noise”, usually seismometers are buried to prevent thermal fluctuation, and so on. ✓
5. L.44 Since the argument is faced in a general perspective, I would say that seismic stations are placed where it is appropriate for the purpose of the project itself. VBB stations are in remote places far from anything, accelerometer for site effects and strong motion are placed at the study site and so on.
We rephrase the paragraph highlighting the importance of the purpose of the network in the site selection criteria.
"Despite to optimize the quality of the recordings seismic stations should be installed away from any source of noise (e.g., roads, major cities, and factories), the selection of the “optimal” location to install a seismic station weights multiple parameters depending on the purpose of the specific network. The National Accelerometric Network (RAN) is established to monitor strong motions at a national level which is owned and managed by the Italian Civil Protection Department (DPC) gorini10,zambonelli11,coستا2022near. The integrated RAN network is the combination with the following networks; i) the Friuli Venezia Giulia Accelerometric Network (RAF, Rete Accelerometrica Friuli Venezia Giulia in Italian, costa10) in the North-East Italy, owned and managed by the University of Trieste (UniTS) ii) Irpinia Seismic Network (ISNet, weber07) in the South of Italy, owned and managed by Analysis and Monitoring of Environmental Risk society (AMRA). From now on the RAN networks refers the integrated RAN."
6. L.50 I would suggest to extend this sentence. It would be difficult to understand why pandemic reduced the noise. Eventually including the citation of some of the paper on this topic as Lecoqe et al, Piccinini et al, Poli et al. ✓
7. L.54 “section 3 section” is a mistake ✓
8. L.57 Please note that COVID and COVID-19 are the same thing, same for “COVID lockdown” and “COVID-19 lockdown”. please fix it using one name over the whole manuscript ✓
9. L.62 at line 46 RAN was called in a different manner “Integrated italian Accelerometric Network” In my view things should be called consistently along the manuscript
We rephrased the sentences introducing the integrated RAN (and its "sub-networks") deleting the definition given in Line 62.
10. L.63 At line 47 the contributors are differently described. If there is the need to repeat it, please be consistent.
We moved the description of the integrated RAN to the Introduction section.
11. L.65 “in the South” and “in the North East” please specify of what, South of Italy I suppose. ✓
12. L.66 I am getting confused, The authors use RAN as the acronym for the Integrated, then they write that the RAN is made by three networks. And one of the three is the RAN.
The integrated RAN network consists 3 different networks. We define what integrated RAN as shown above.
13. L.68 Again there is some redundancy in the description, the fact that some of them have been converted to continuous was already mentioned about. ✓
14. L.71 Third time the migration to continuous was mentioned.
We deleted the sentence.
15. L.73 at line 59, it is written that, for simplicity The authors will call it just lockdown. ✓
16. L.75 Piccinini et al, proved that this was not true at national scale.
In Figure 4 of Piccinini et al. paper there are several stations with almost no noise reduction. Stations such as RAVA (<https://goo.gl/maps/DdCY2eZuePPQkkMAA>) is located away from population centers as they also report in their paper. It is expected to have small to none noise difference during the lockdown since there are no anthropogenic noise sources nearby. We also reported several instances in our paper. However, we agree that the generalization that we made may not correct. Hence, we changed the end of the sentence to “[. . .] were reduced in many places”.

17. L.79 Question: data from 2021 would not be useful to integrate the dataset?
During 2021 different regional lockdown measures were activated by Italian authorities at different times. It would be hard to interpret the results. We decided to include on the data from 2019 and beginning of 2022 for this reason.
18. L.87 I would suggest to add a sentence describing the workflow to go from data (continuous time series) to PSD. e.g. data have been corrected for the response? How the spectrum was computed is not mentioned.
We added the details of the PSD calculation and the response removal process.
19. L.90 I am not English mother tongue, but I feel that it is more appropriate to write "data" in place of "the data". Please check. ✓
20. L.104 better to say "described" if the author extends it, as suggested above, to a full description. ✓
21. L.104-105 figure 3 is not discussed although it contains THE RESULTS of the analysis. The reader cannot understand where the considered few stations are located and why they differ in noise level.
Figure 3 shows a portion of the stations that we have analyzed in the paper. Hence, it provides an overview of how the noise levels change over the entire dates that we considered. In Figure 4 (the updated one that we present below), on the other hand, you can see the overall noise levels for all stations.
22. L.105 This sentence is not clear, results are shown in fig.3, what is then in fig.4?
We rephrased the sentence explicitly addressing Figure 4.
"The results obtained for few randomly selected stations applying the method described in Section 3 are shown in Figure 3 for the periods of interest, namely 0.1 s, 0.25 s, 0.5 s, 1 s, 2 s, and 5 s: this provides an overview of the behaviour of the noise at different timescales for different periods, as described in details afterwards (see Figure 1). The overall background noise levels for the all stations in RAN presented in Figure 4."
23. L.107 I am feeling pedant but is RAN stands for Rete Accelerometrica Nazionale, then it is not necessary to follow it by network. ✓
24. L.107-116 the authors move from periods to frequency and backward. I understand that this is a common practice but, in a paper it is more appropriate to stick on one choice, otherwise the reader gets confused.
We replaced "frequency" with "period" in Line 112 and Line 116.
25. L.120 RAN stations at touristic sites can experience the opposite, quiet in the weekdays and noise in the weekend. Anthropogenic noise is very local. Did the authors consider it?
We checked the 'anomalous' stations with noisier weekends but we did not see a pattern with the touristic activity around those stations. Some of them are in small towns and villages. We assume that those areas are not hosting major touristic activities.
26. L.122 this is a repetition of line 119
We changed the sentence: "We also studied the changes in the noise levels between weekdays and weekends and the general trend of noisier weekdays are observed Figure 7."
27. L.123 English unclear to me
We replaced "are used" with a comma.
28. L.125 "very long period" please give the period band since for some seismologists this would be tens and even hundreds of seconds
We explained what we mean by "very long period" (i.e., >5s).
29. L.133 Since the author proved that a seasonal variation and a weekday/weekend variation exist, I wonder if they considered it when comparing lockdown and no-lockdown. I mean that, to be consistent and to catch only the lockdown effect, the comparison should be done only with the same time span of 2019 and 2022.
We believe that in the lockdown period did not last enough to see any seasonal variations. We are in agreement with the reviewer about analyzing same time span to understand the exact effects of the COVID lockdown. However, for the sake of keeping the paper more compact, we did not include these analyses in it. But we decide to add them to the supplementary material and it can be seen in Figure S2. We also refer these figures in the paper.
30. L.140-143 Sentence is too vague
We changed the sentences:
"Table 1 shows the distribution of the stations according to the classification proposed by ISPRA. Despite most of the stations are located in urban areas, and then been potentially subjected to high levels of anthropogenic noise, this classification is too reductive (e.g., not considering the population density and the

presence or making a distinction between residential and industrial areas) to be associated to specific noise levels."

31. L.144 and following, Since the effect is local, did the authors consider the eventual presence of Wind Farms, or other facility that could produce anthropogenic noise at longer periods?
We did not analyze the effect of the wind farms since we do not have the list of wind farms in Italian territory.
32. L.149 "is assumed" It is not an assumption, it is an observation from data and from road traffic data, mobility from mobile phone records and so on. There is plenty of data showing that human activity is reduced. ✓
33. L.153 "trend" I would say pattern. ✓
34. L.153 "of" typo? ✓
35. L.155 "if a station is located in a settlement" I would expect that this is one of the result of this study, not and hypothesis within the discussion section. is this observed in data or not?
In the high frequency the sources of the noise are linked to the human related activity. Hence, we present a very straight-forward explanation to it. However, we do not analyze each factor that may play a role on the high frequency noise source. Because of that, we presented only a possible explanation for the low weekday- weekend difference in noise levels. Nevertheless we changed the sentence and deleted the parts where we address the sources of the noise specifically, referring them to human activities.
36. L.158-160 Again, do the authors observe what described by other authors in their analysis? This is not a review paper but a scientific one.
The cited studies provide a justification for the type of analyses that we performed and also identify the noise sources in the specific period range, which is beyond the scope of our paper. In the following sentences, we provide a description of the behaviour of the noise both daily and weekly.
37. L.169 "stations start". Start means that there is a variation to me, when do they start? No clear.
We changed the sentences: "Considering weekly variations, stations become noisier on weekends with decreasing power change."
38. L.175 If the last sentence applies, that implies that stations are blind in this range of period. I do not understand why discussing the source of noise when in this frequency band accelerometers just measure the self noise of the instrument. Moreover the self noise can be computed and measured. It is not a matter of believing. Am I wrong?
We agree the reviewer about the usage of the word "believe" and rephrased the sentence: "As indicated by Cauzzi et al. (2013) the main source of long period noises in the case of accelerometric recordings can be associated to the instrumental noise of the RAN stations."
39. L.179 Again the authors discuss something that they cannot observe. I suspect this depends on the fact that they are using accelerometers and D'alessandro et al. (2021) used velocimeters.
The two main factors that contribute to the different results with respect to D'Alessandro et al. are the different types of instruments used (we use accelerometers and they used velocimeters, BB?) and the position of the stations used over the territory (in settlements vs far away from them). We can specify this. That being said we believe it's a relevant result, especially considering that no previous studies have been carried out on continuous recordings from accelerometers (in Italy at least).
40. L.185 "period periods" repetition ✓
41. Lines 185-189, in summary:
 - (a) human activity dominate noise in this freq band.
 - (b) high noise can be linked to activities
 - (c) less human activities less noise.

Do we need a scientific study and a paper to state this? Different is when this is a direct observation from data. but this is not what the authors write in these 2 sentences.

This is a direct observation from our data. This is the first time the integrated RAN's noise levels are presented. We would like to analyse its noise content even if some of the results may be guessed without even looking the actual data. By giving the noise level changes in day night and weekday weekend, we also present the contribution of human and/or other sources in the background noise levels of RAN.

42. L.190-194: COVID reduced human activity, ok. Human activity influence seismic noise. Noise is higher in populated areas and near buildings. A dozen of paper noted such a reduction. The authors too. OK, what is the added value of this study for the COVID-19 lockdown ? It is not clear to me.
We agree that there are numerous studies published specifically for the COVID-19 lockdown. We point out though that no other paper used the RAN data. Thanks to the idea behind the RAN, capturing ground motion information in the urban areas, study the COVID-19 lockdown allowed us to evaluate the background noise level of the network with reduced human related noise.
43. L.215 “are” should be “is” ✓
44. L.216 “at” should be “in” ✓
45. L.222 “dates” ??? I presume median of the PSD noise.
We changed the "dates" with "periods".
46. L.223 “are more dominant” could be “prevail”? ✓
47. L.233 I miss to understand how this paragraph, at the end of section discussion is linked to the rest of the study. It would make sense at the beginning of the analysis when authors tackle the problem of distinguishing between different source of noise and of characterize their frequency content.
We add a sentence to the Section 5.2 explaining the choice of the two particular situation: "The selection of these two particular stations is due to the extensive knowledge about their spatial and administrative information."
48. L.235-237 I suggest to rephrase the sentence. ✓
49. L.240 “manually” “by hand”, As I mentioned, I am not english mother tongue. But to me, this sentence means that somebody was checking the passage of cars using his own hands. Not that, as I suppose, somebody visually inspected seismic data and searched for the effect of the passage of the cars and manually marked it on the seismic trace.
We changed the sentence to "visually analyzing the data".
50. L.247 “is” should be “are” ✓
51. L.254 the assertion “capable of providing” Is a qualitative speculation not based on true values. can the authors give some estimate of the minimum magnitude that can be detected at local distance by high noise and normal noise accelerometric stations?
We choose the 10 most noisiest stations to understand their capabilities on P-wave corner frequencies defined by Brune (1970).
52. L.256 “. . . but also the small ones” This sounds a bit obvious and not very useful without, as above, an estimate of the detection capability. Big and small are always relative to something.
We agree with the reviewer that some of the sentences in that paragraph is unnecessary. Thus we modified it with the comparison with Brune’s model (1970).
53. L.258 “they” I cannot understand who is the subject: Selection criterion for what?
Here "they" is referred to median noise levels. The selection criterion depends on the nature of the study. For instance, one can exclude stations with high noise levels, if the research will be about small magnitude earthquakes. On contrary, noisy stations can be useful for benchmarking seismic denoising methods.
54. L.259 “Some of the stations” How many? again description of data and of result is too vague for a scientific paper
In total 81 of our stations are installed inside a building. We added the information to the paper.
55. L.260 “(528. . . .) whereas some of them” In the data description it is written that the study is based on 528 stations. If 528 are in settlement, how can be that some of them are away from settlement?
We modified the sentence by deleting this information.
56. L.263 “in the short period” could be “in the short period band”? ✓
57. L.273 and following. This is a repetition of line 172 and following
We modified the sentence.
58. L.281 “. . is applied” not clear
We modified the sentence: "During the COVID-19 lockdown in Italy (from March to May 2020), [. . .]".
59. L.296 Anthony et al 2021 was published in 2022. ✓

60. Figure 1, I was surprised to see that Anthony et al. (2021, actually 2022) report info for only such narrow band and I checked the paper where for example I read (last paragraph, second column, pag 648) that noise in the band 0.0625-1 second contains cultural noise. So the narrow band should be as large as covering the entire band. Please check also the other.
In Anthony et al 2022, the interpretation of their results are done for very narrow frequency bands (shown in Figure 1 of their paper). However, as reviewer mentioned, they also provide frequency ranges from various noise types. We updated our figure accordingly.
61. Figure 2a, by placing the closeup box over Sardinia, the reader misses to appreciate the network coverage in that portion of the study area that is the whole Italian country.
The placement of the closeup box over Sardinia doesn't affect the visualization of the network coverage as there are no station there.
62. Figure 2, I wonder if there is a reason to plot stations with reverse triangles while in Figure 4 are not.
In Figure 2 all networks have their dedicated markers whereas rest of the figures have triangles for all stations. As reviewer said triangle marker for IT network may create misunderstanding. Hence, we changed the marker type for IT to diamond.
63. Figure 2 caption, the color coding of the figures is not descriptor. Moreover I do not understand what (RF) stands for.
The colorbar provides the information about the data completeness that are shown in the 3 subfigures. Subfigures are for 2019, 2020, and 2022. In subfigure a) and b) we zoom in several parts of Italy to show ISNet (IX) and RAF (RF) networks which are part of the integrated RAN. Definition of RAF has been provided in line 48. However, we acknowledge the fact that, the figure is complex and we did not provide all necessary information in the original caption. Therefore, we update the caption of the figure to : "Data availability of the stations in a) 2019, b) lockdown period, and c) 2022. In a) the close up box highlights ISNet (IX) and in b) the close up box highlights RAF (RF). Basemap data are retrieved from © Stamen Design."
64. Figure 2 palette: I read PSD database completeness does this means that the authors counted the expected number of PSD for e complete time-series and then computed the ration of available ones?
As said by the reviewer, the completeness is referred to the number of computed PSDs with respect to the theoretical total number for the specific time range.
65. Figure 3, caption says "several stations" while in the manuscript I read few stations and actually there are a very small fraction of 528.
We specify the number of stations in Figure 3 (which is 20).
66. Figure 4, in the caption the authors use "Power Change" while in the caption and at line 113 I read "noise". Since "power change" is introduced in the discussion and not in the caption I do not understand what figure 4 display.
In Figure 4, the wrong figure was presented by mistake. We changed the figure and it can be seen in the updated version of the paper. We also put the same figure below

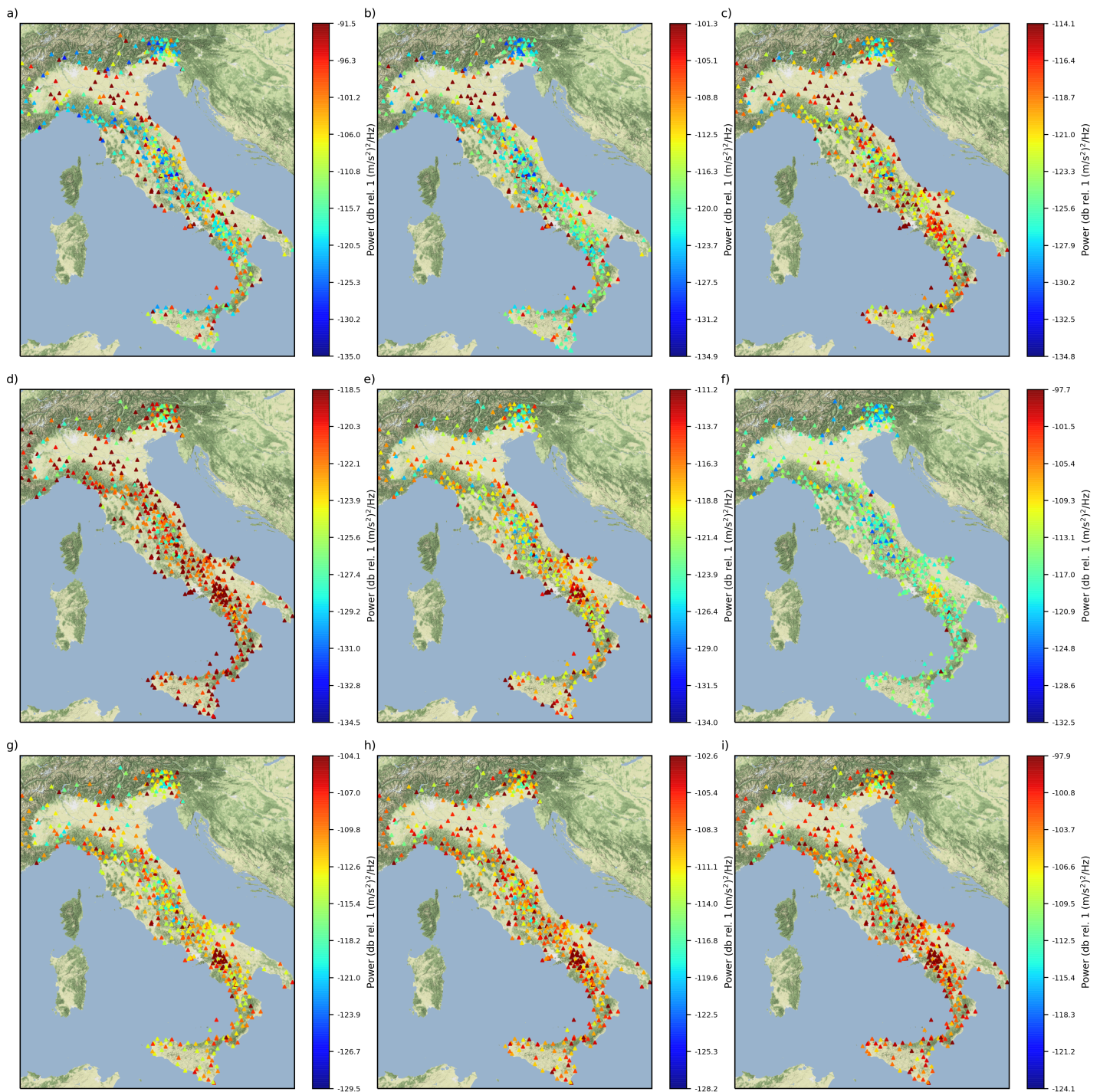


Figure 1: Median vertical component noise maps in one-third octave bands around a-g) 0.1 s, 0.25 s, 0.5 s, 1 s, 2 s, 5 s, 16 s, 32 s, and 80.6 s. Upper and lower limits of the color bar are defined by the model developed by cauzzi2013high. Vertical components are presented in the following figures and Electronic Supplement. Background noise levels of all calculated periods can be found in Figure S1.

67. Figure 8, seasonal variability. In the manuscript it is mentioned that: 1) seasonal variability is studied only for year 2019 and it makes sense since data coverage for 2022 is limited to January-April. It is also mentioned that data analysis is limited to stations with completeness above 90% and it also make sense. In figure 8 I see only two triangle in Pianura Padana and one of them in figure 2a is colored in green that means 40% to my understanding. Apparently something is not correct. I wonder is this applies also to other stations.

90% completeness is referred to the 90 minutes window used to compute the PSDs. However, as the reivewer mentioned, it is important to have sufficient amount of data to calculate seasonal variations. Hence, we introduce 50% completeness in the days that we have records. We updated Figure 8 accordingly and explain the procedure as: "Stations with more than 50 % of data for both summer and winter time periods are selected to analyze seasonal effects."

68. Figure 12, the authors did not provide indication of where Trieste is.

Figure of the left is the drawing of part of Trieste. Photo on the right panel shows a building in Trieste. The building hosts the CARC station which can be seen in Figure 11.

69. Figure 13, If I interpret correctly this figure line for 00:45 ± 45 (purple with dots) has high noise at .1 seconds, while line for 23:15 ± 45 (red without dots) has low noise. How can be midnight much noisier than 11pm? This contradicts expectation described in the manuscript. Am I wrong?
 CARC station (line with dots) has noise level around -95 dB (we add the label for y-axis) at 00:45 ± 45 whereas at 23:15 ± 45 it has noise level around -90 dB which means in 23:15 noise levels are higher than 00:45.
70. Figure 14, “demonstrated” better to say localized
 We changed the sentence.
71. Table 1, It confuses me. Since the total of stations gives 715 but the authors used only 528 of them. Is it relevant this table ?
 RAN network has 715 stations but only 532 were in continuous mode (including the ones converted from triggered to continuous recording between 2019-2022) which are eligible for our analysis. As this may create confusion, we reduced the information in Table 1 to the continuous station, i.e. the stations used for the current study.

Land Usage	Code	Stations
Settlements	SL	388
Annual Cropland	ACL	48
Permanent Cropland	PCL	12
Grassland	GL	39
Forest	FL	38
Other land	OL	7
Wetland	WL	0
Water	WT	0

Table 1: Land usage at the RAN stations (ISPRA).