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Solid Earth Discussions

Interactive comment on "Seismic monitoring of the Auckland Volcanic Field during New Zealand's COVID-19 lock-down" *by* Kasper van Wijk et al.

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I find this is a generally well-written manuscript and an interesting look into a unique period of seismic data.

Thank you, Reviewer 2.

I have two main suggestions for improvement that I think would strengthen this study's arguments significantly using the methods that they've already demonstrated. First, I think that discussion of changes in earthquake detection during COVID lock- downs would be benefitted by the further context of comparison with other changes in anthropogenic seismic noise

levels. Rather than only comparing lockdown to non-lockdown data, adding comparisons of night to day and weekend to weekday could give better insight into how anthropogenic noise affects event detection.

We agree, and analyse the (anthropogenic) noise by looking at day and night-time differences as well (see Figure 2, and 3, for example), as well as weekdays versus weekends.

The lockdown period is short enough (on the scale of earthquake occurrence rates) that I'm not fully convinced by the authors' claim that there was no change in detection rate during that period, so it would be helpful to back that up through comparison to other low-noise times for which more data exist.

Indeed, we did not find more earthquakes during the lockdown than in the time before and after the lockdown, and agree with the reviewer that more can be done to explain this. Now, whether this is also true for christmas periods, for example, is for a special issue on christmas-holiday seismology! All jokes aside: because our analysis focuses on the efficacy of the matched-filter method, the detectability is affected by the noise-level in the cross-correlation sum. To demonstrate that we would not expect a change in detection-rate during lockdown we computed and plotted (now included in a new appendix of our revised paper) the network cross-correlation sum for one template between February 29th 2020 and May 8th 2020, alongside the multi-tapered power spectrum for this time series. Plotting the full sample-rate correlation-sum shows little power outside the 2-15 Hz range used, however computing the hourly mean correlation-sum provides more useful information regarding the variability in noise in the correlation sum. In this hourly correlation sum, reductions should correspond to reduced noise in the correlation sum and hence enhanced detectability. We find clear daily variations (evidenced by a peak in the amplitude spectra at 24 hour periods), however there is no

clear reduction in background correlation values during lockdown. It is based on this evidence that we can be confident that there is no significant change in detectability during lockdown. Note also that our detection threshold is based on the daily median absolute deviation of the correlation sum which further smooths the daily variability in the correlation sum. The range of daily median absolute deviations upon which our threshold is based range from 0.234-0.254, with the lowest values falling outside the lockdown period.

Second, I believe that this study would be helped with further exploration (or at least explanation) into the frequency domain. The authors say that the 0.1–50 Hz range is of interest to volcano monitoring and contains anthropogenic seismic noise, but don't go into further detail and should at the very least provide more background on that choice of range and show a spectragram for at least one station. Dividing that range into a few smaller ranges and processing them individually would provide more information about the change in the seismic noise environment (e.g. deconvolving effects of changing wind and water vs changing anthropogenic activity), as well strengthen the authors' arguments regarding those noise levels' effects on event detection.

We agree that more details could be provided, and we have added spectragrams and text to further differentiate what we mean with anthropogenic noise, as well as our decision to treat these data mostly in one band, as the data frequency band for the different tasks of the AVSN (ie monitoring for impending volcanic unrest, as well as seismic imaging with local seismicity) overlap with the noise sources in question.

As for smaller technical corrections, the main things I found were: the authors need to ensure that all data in a figure is included in the one key (e.g. figure 7's key does not contain

a red line for wind speed, and figure 8 has two keys instead of one), decide whether to use "lock-down" or "lockdown", and ensure that figures are more colorblind-friendly (e.g. not using red and green for the two different lockdown levels).

We have fixed the lockdown/lock-down issue, and changed to line style for level 3 to distinguish it better from level 4. Figures 7 and 8 now have two keys (each), because there are two very distinct data sets displayed in these with separate y-axes.

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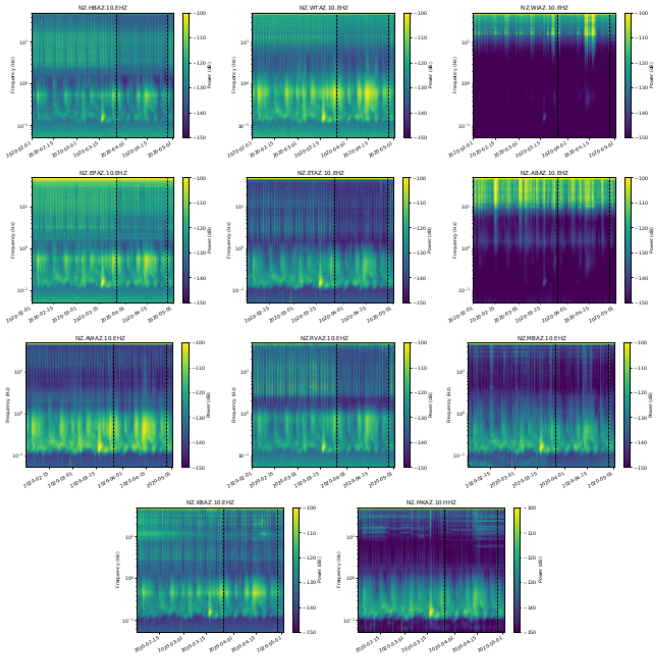

Figure A1. Spectrograms for the seismic data of the Auckland Volcanic Seismic Network. The vertical dashed lines indicate the start and end date of the COVID-19 lockdown in New Zealand.

Fig. 1.

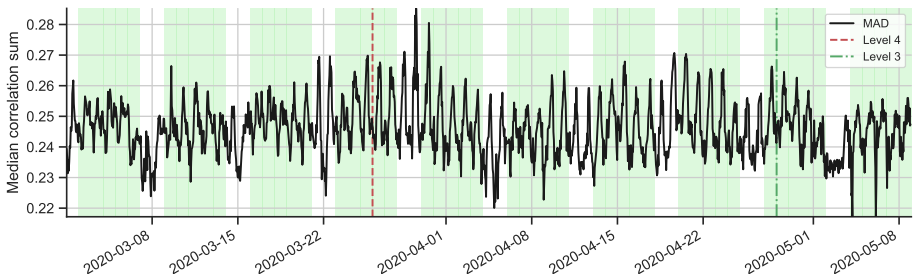

Fig. 2.

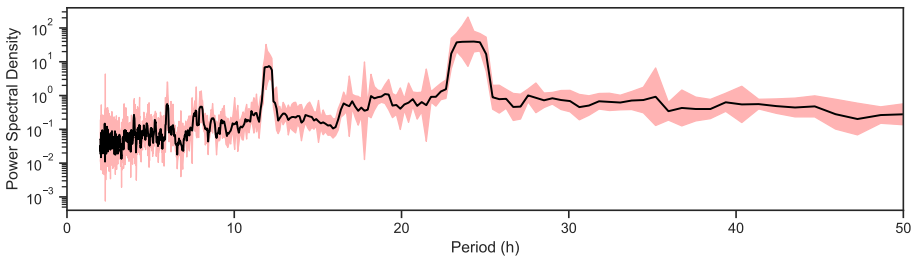
Power Spectral Density
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
0
10
20
30
40
50
Period (h)

Fig. 3.