



EGUsphere, author comment AC2  
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## Reply on RC2

Louise Bøge Frederickson et al.

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Author comment on "Are dense networks of low-cost nodes really useful for monitoring air pollution? A case study in Staffordshire" by Louise Bøge Frederickson et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-407-AC2>, 2022

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**Thank you very much for your comments and please find our replies below.**

### General Comments

Frederickson et al., presented results of a one-year measurement campaign with 18 low-cost sensors measuring NO<sub>2</sub> and PM<sub>2.5</sub> measurements in Newcastle-under-Lyme, Staffordshire, UK. They describe a remote calibration strategy for electrochemical NO<sub>2</sub> measurements that accounts for the temperature-dependent response of the sensors used. They use spectral analysis to identify different frequencies in the PM and NO<sub>2</sub> time series and allocate PM<sub>2.5</sub> and NO<sub>2</sub> to local, urban, and regional sources based on 3-defined periodicity ranges. In all, this paper highlights a successful measurement campaign and an insightful method for source attribution. This manuscript may be accepted for publication after addressing the following comments:

### Specific Comments

- This paper does not claim to validate the results, but a brief comparison to modeled NO<sub>2</sub> and PM<sub>2.5</sub> concentrations would significantly strengthen the findings and the claim that low-cost sensor networks offer additional benefits and insights beyond the ability of AQMs or expensive sensors. This could also be addressed by simply comparing the results of the Fourier Transform with an emission inventory for the area. Does this result tell us something new about the sources of NO<sub>2</sub> and PM<sub>2.5</sub> or does it validate the inventory?

**Reply:** Thank you for the comment. The main focus of the paper is to demonstrate that additional useful information can be obtained from low cost sensors, and we have validated the analysis to the extent possible. Unfortunately there is not a detailed emissions inventory for the study location. We have added the following in the Introduction to address the larger question: 'This paper does not attempt to demonstrate that the low-cost air pollution sensors meet specific air quality monitoring standards. Rather, we argue that data obtained from such a network is able to provide useful additional information about local air pollution that extends what can be learned from conventional air quality monitoring stations. The data obtained from the low-cost air pollution sensor network is used for time series analysis in the frequency domain to obtain information on the variability of air pollution concentrations and to distinguish local sources from regional. The network, together with the analysis approach, has allowed

pollutant emissions attributable solely to the local sources to be distinguished from other regional or long-range transport sources. The approach of frequency domain analysis will be further evaluated in subsequent studies.'

- Please comment on the remote NO<sub>2</sub> sensitivity correction using the monitoring station at Stoke -on-Trent Centre, why do we expect the same variation at this reference site as in Newcastle-under-Lyme? Particularly given the difference in source apportionment between the AirNodes and this reference site seen in Figure 11, is this a reasonable assumption?

**Reply:** Even though they do not have the same variation (which can be seen in Figures 3 and 11), the same correction is applied for all AirNodes, meaning their relative measurements will be useful for the Fourier transform. We have made use of all nearby monitoring stations and clearly, we do not expect, nor do we see, the same local variation due to the distance between the sites. Nonetheless valuable insight is obtained from the comparison.

- No correction used for SDS-011. Can you please comment on the validation of these sensors?

**Reply:** A paragraph has been added to the correction section, where it is explained why no correction is performed on the SDS-011 readings. However, the correlation between PM<sub>2.5</sub> measured by the AirNodes and the PM<sub>2.5</sub> measured by the reference are added in the correlation heatmap. 'Regarding the SDS-011 PM<sub>2.5</sub> readings, outliers were removed by removing all values exceeding 5 times the standard deviation. Scale and offset correction was performed for PM<sub>2.5</sub> similar to the one for the NO<sub>2</sub> readings. However, there was no significant difference between the corrected and uncorrected PM<sub>2.5</sub> readings since the PM<sub>2.5</sub> readings were already highly correlated (mean  $R^2 = 0.72$ ) with the reference readings from the Stoke-on-Trent Centre.'

- Please comment on the choice of <1 day and >3 days as the cutoffs for the regional or urban contribution frequencies.

**Reply:** This is added to the manuscript: "The local-cutoff is chosen based on the European Environment Agency's definition of local time scale.

...

The cutoff frequency for the regional contribution is based on the intercontinental transport, which occurs on timescales on the order of three days to one month".

- Line 255. Is the observed difference as expected? Is there a reason to expect the reference to peak 2 hours later in the morning?

**Reply:** It is hard to say exactly why the reference peaks later than what the AirNodes

recorded. As we write, the concentration of NO<sub>2</sub> can have different profiles at different locations, depending on the traffic modes and sources.

- Figure 3 and 5 show comparison of a single AirNode, are these data characteristic of all of the AirNodes?

**Reply:** Yes, and it is added to the manuscript now. 'All AirNodes have the same tendencies, so `\textbf{Figure \ref{fig:Corrected_data}}` is characteristic of all AirNodes.'

- Line 302 is misleading because the seasonal effect is likely still the dominant effect. Which months were impacted by lockdown strategies?

**Reply:** We can see how it is misleading and have decided to delete the passage about Covid-19. It did not contribute to the story.

- Line 245-252 Can you show more details on the performance of modeled temperature data? On "the correction methodology even with the modeled temperature data, yields corrected readings that follow expected trends, giving confidence in sensor accuracy." If some sensors are shaded and others are in full sun, the temperature inside the sensor package can vary dramatically from the outside temperature.

**Reply:** Thank you for the comment. It is an important concern. The correlation with the reference readings (4 km away) are added to the heat correlation matrices, and it is seen how the AirNode NO<sub>2</sub> readings slightly correlate with the reference data. It is true that the correction would have been more efficient if internal AirNode temperature had been measured.

### Technical Corrections

Line 175 missing a space: "Q0.25,AirNode"

Line 219 "a upper" -> "an upper"

Line 221 "on Figure 2" -> "in Figure 2"

Line 280 remove comma

Line 334 "speed" -> "speeds"

Line 380 "odccurs" -> "occurs"

**Reply:** Thanks. They are fixed.