Air Pollution Event Report

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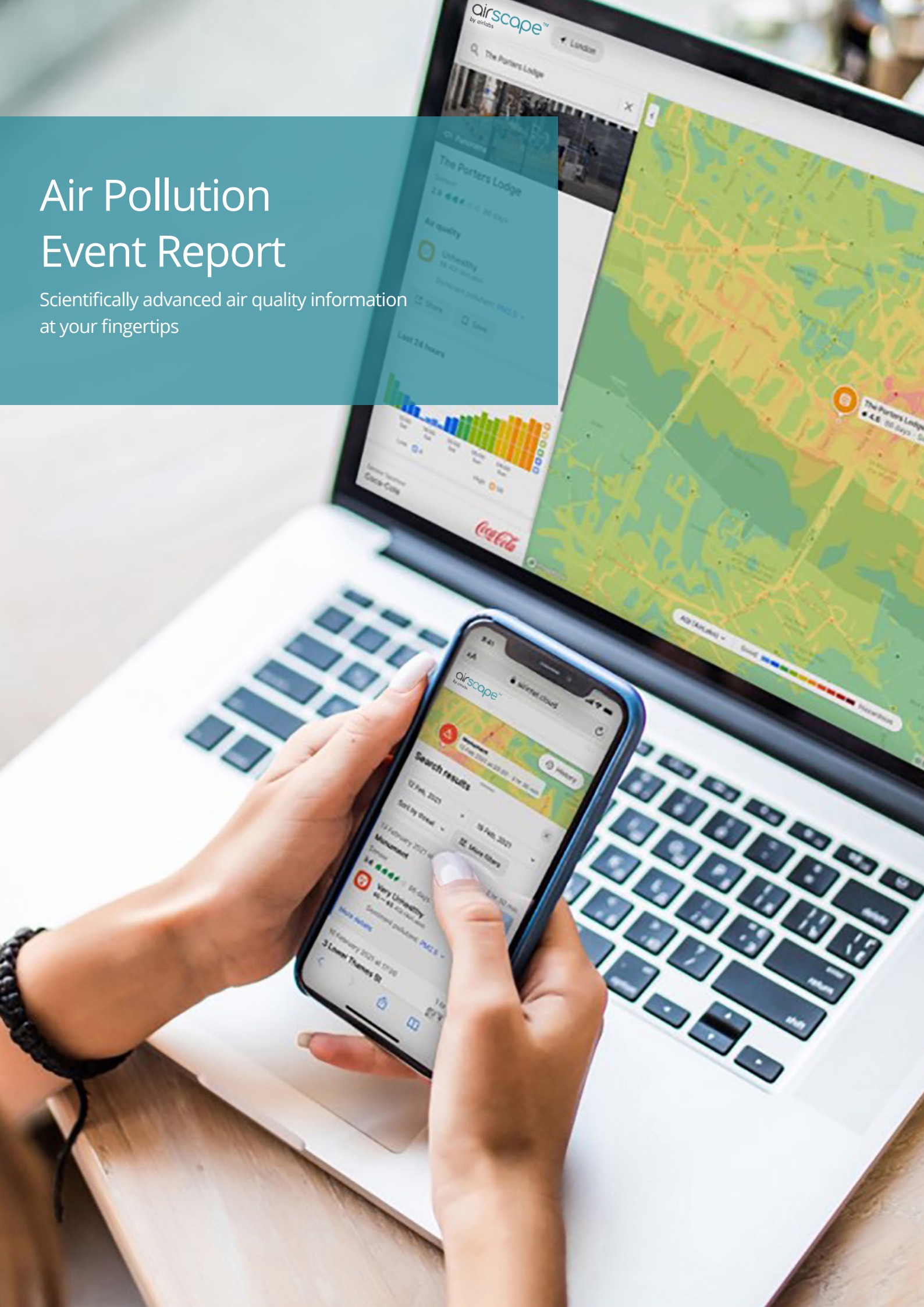

Camden, London December 2022

Title	Camden pollution events report (December 2022)
Report no	TR006
Report type	Event Assessment
Description	Report on recent pollution events in Camden, London
Authors	Szymon Kwiatkowski, Ruta Romero
Reviewers	Matthew S. Johnson
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Background

This document is an analysis of pollution patterns during December 2022 over a sensor network in Camden, London. For this report a representative sample of 80 nodes (1/3 of the whole network) was analysed based on hourly average of the following pollutants: $PM_{2.5}$, O_3 and NO_2. The pollutant concentrations were also compared to previous months and the findings are presented in this report.

Analysis

For the comparison purposes the data of Camden AirNodes covers the last three months of 2022, nevertheless the focus is on December.

Based on the analysis of the NO_2 data from the representative Camden devices it can be seen that there are no big differences between the months and that the average monthly concentrations vary very little (Table 1, Fig. 1) suggesting a stable daily patterns for the pollutant formation.

One of the disparities can be noticed at the end of December (Fig. 2) which could be related to the increased ozone concentration over the area (this will be discussed later). There can be seen a drop in NO_2 concentrations since approx. mid December (Table 2, Fig. 2) by a third compared to the first part of the month.

Looking at the holiday period (between 24th of Dec 2022 and 2nd of Jan 2023) it could be seen that the usual daily pattern of NO_2 (morning and afternoon peaks) is not present on the 25th of December and the 1st of January (Fig. 3) which is related to decreased traffic.

Table 1: Monthly averages of observed pollutants

Month/Pollutant	NO2 in ug/m3	O3 in ug/m3	PM2.5 in ug/m3
October	31.6	28.6	4.9
November	35.2	27.9	6.7
December	36.6	25.7	11.6
3 months average	34.4 ± 2.6	28.6 ± 1.5	7.6 ± 3.5

Table 2: Change in concentration of observed pollutants between 1st (until 17th of December) and 2nd half of December 2022

Month/Pollutant	NO2 in ug/m3	O3 in ug/m3	PM2.5 in ug/m3
1st half of December	42.6	13.8	17.8
2nd half of December	30	35.5	5
Change in %	-30%	+257%	-70%

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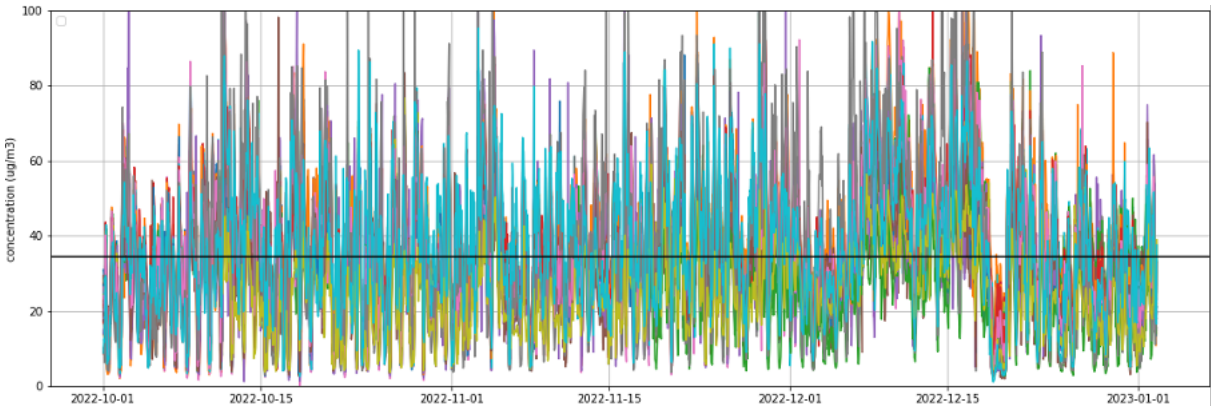

Fig. 1: NO_2 hourly average in October-December period.
The black horizontal line represents an average of AirNodes for that time period.

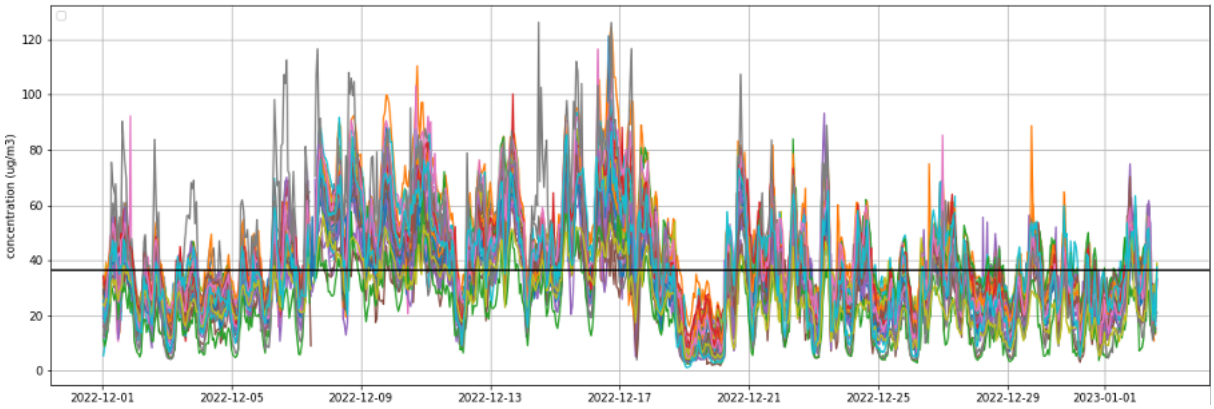

Fig. 2: NO_2 hourly average in December.
The black horizontal line represents an average of AirNodes for December.

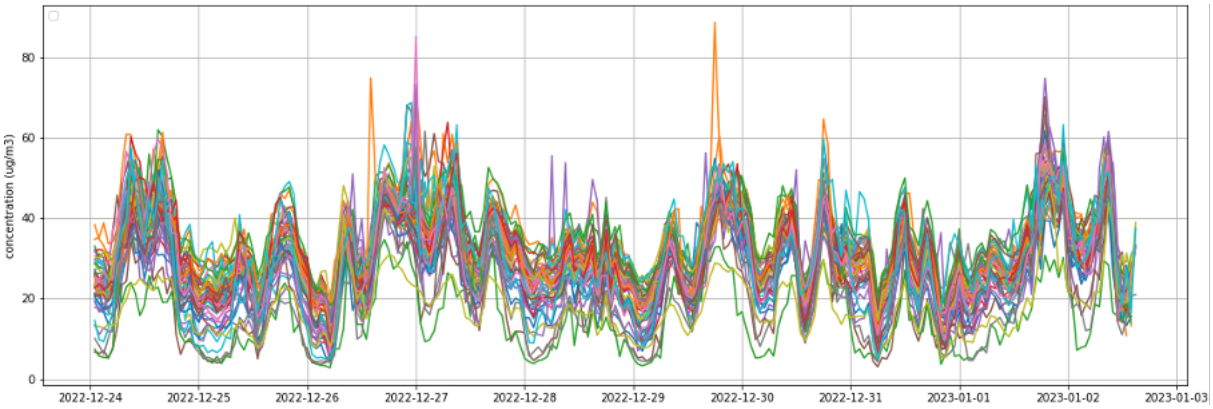

Fig. 3: NO_2 hourly average between Christmas and New Year's Eve.

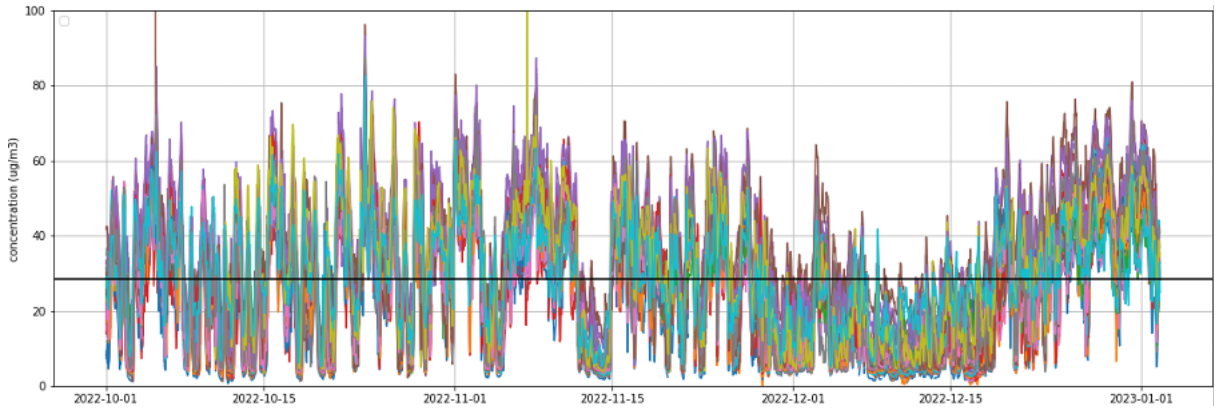

Fig. 4: O_3 hourly average in October-December period.
The black horizontal line represents an average of AirNodes for that time period.

As opposite to NO_2 relatively stable variation in monthly concentration, changes in ozone was more dynamic at the end of the year.

There was a decrease in ozone concentration in the beginning of the winter related to less sun and less photochemical reactions happening (Fig. 4). Nevertheless, the second part of December shows a significant rise again - more than 200% (Table 2, Fig. 5). This might seem unexpected at first glance knowing the formation of the ground level ozone. Yet a more detailed look at the intercontinental environmental conditions revealed that the stronger winds from the south west (or continental Europe, Fig. 11) could have brought more ozone with it to London.

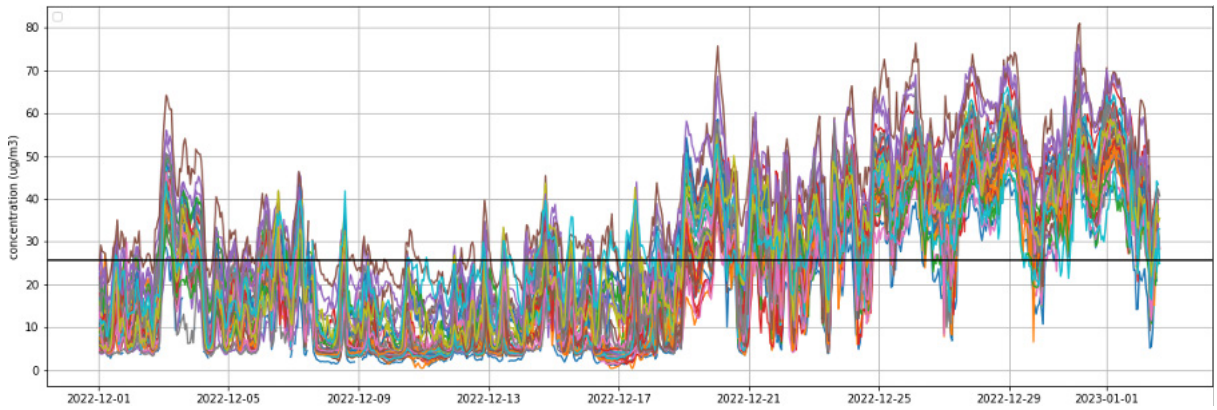

Fig. 5: O_3 hourly average in December.
The black horizontal line represents an average of AirNodes for December.

The $PM_{2.5}$ data shows a great increase (over 200%) in PM concentration in December compared to earlier months (Fig. 6, Table 1). The increase in PM concentration is more visible in the 1st half of December (Table 2, Fig. 7), especially between 8th and 17th of December when average temperature oscillated around 0 °C. The $PM_{2.5}$ pollution in that period was almost four times higher (21.4 ug/m3) than the average

pollution (5.8 ug/m3) of the last two months (October and November). The increase can be probably attributed to an increase in wood burners usage or other ways of increasing temperature in residential areas. The high concentration of PM can be further explained with low precipitation and low wind speed during that period (Fig.11), which would enhance the polluting effect of local sources. Contrary to the 1st half of December the 2nd half saw a decrease in PM concentration. This might be an outcome of a combination of both higher temperatures (lesser usage of wood burners) and increased rainfall and wind speed. The effect of increased rainfall is especially visible during the New Year Eve event, where one would expect prolonged high PM concentration due to fireworks shows all over the city. However this was not the case in Camden (Fig. 8). Some AirNodes still observed very high $PM_{2.5}$ concentrations (over 100 ug/m3) around midnight (Fig. 9) and this could probably be explained with private firework parties that happened to take place in close proximity to a particular AirNode. Moreover, 30 minutes after midnight most of the AirNodes in Camden observed a 4-5 times increase of $PM_{2.5}$ concentration from the baseline (Fig. 10). However that meant an increase from 5 ug/m3 to 20-25 ug/m3 that lasted for ca 30 minutes and can be contributed to the plume of fireworks pollution slowly dispersing over London.The pollution from fireworks disperse rather quickly due to strong wind and wet conditions.

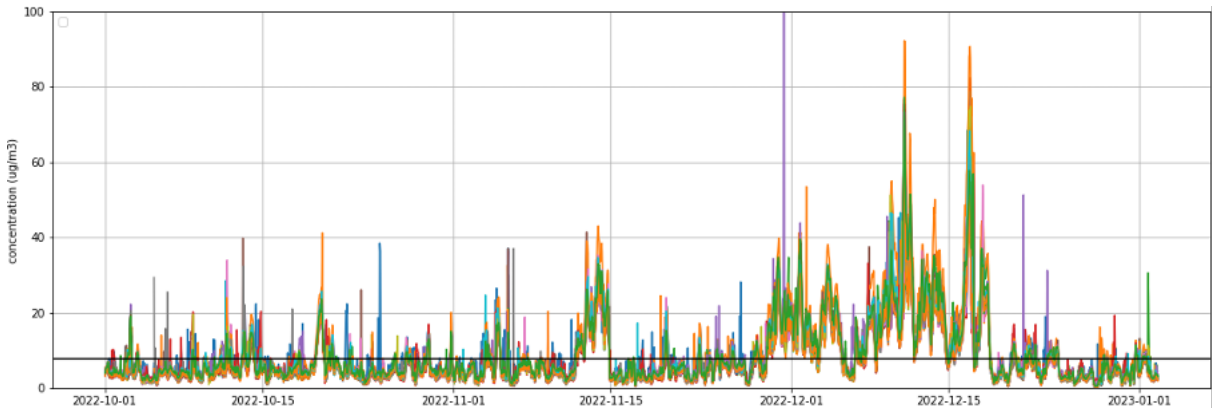

Fig. 6: $PM_{2.5}$ hourly average in October-December period.
The black horizontal line represents an average of AirNodes for that time period.

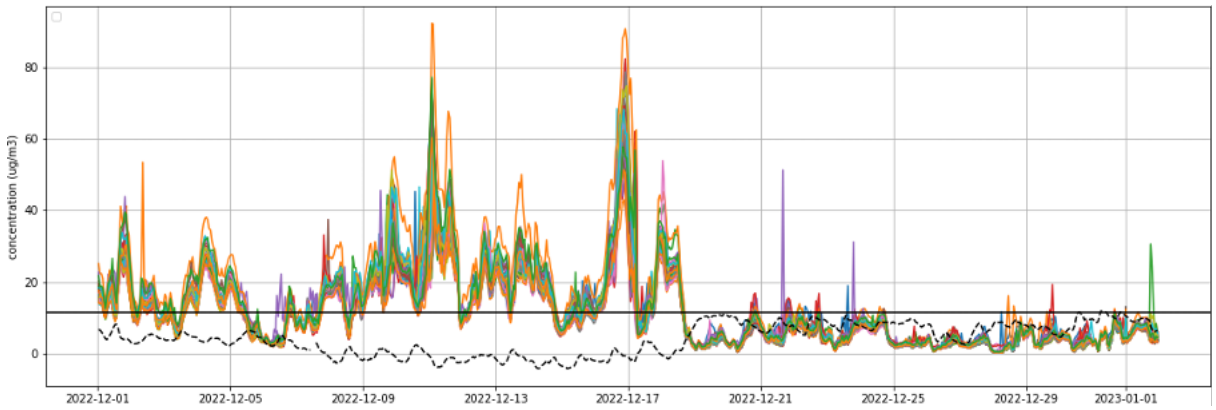

Fig. 7: $PM_{2.5}$ hourly average in December.
The black horizontal line represents an average of AirNodes for December.
The black dashed line represents temperature observed in the AirNode.

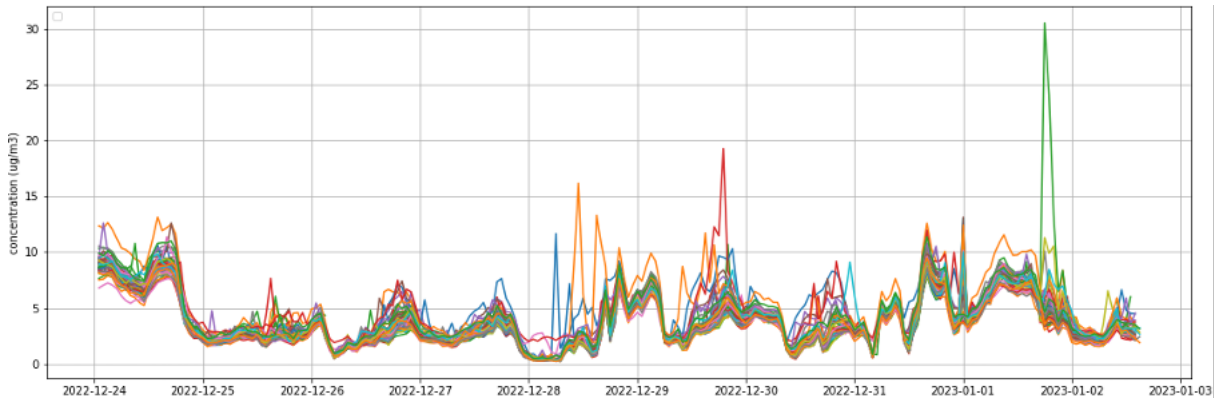

Fig. 8: $PM_{2.5}$ hourly average between Christmas and New Year's Eve.

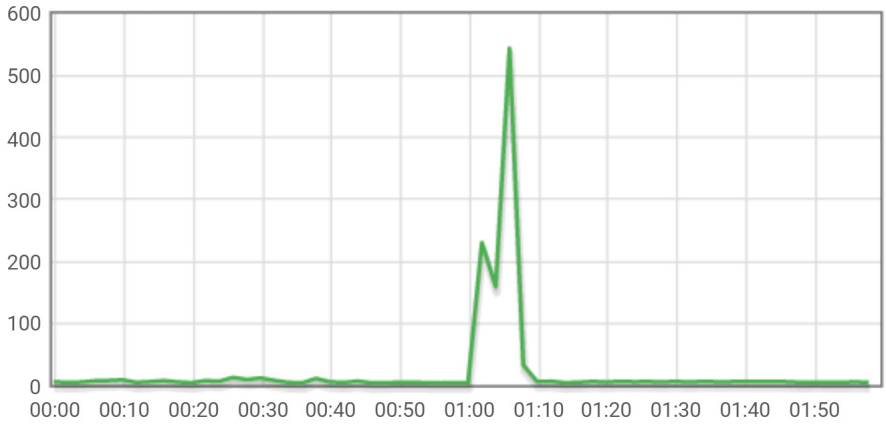

Fig. 9: $PM_{2.5}$ of one of the AirNodes on New Year's Eve. The time axis is in CET.

Fig. 10: $PM_{2.5}$ of one of the AirNodes on New Year's Eve. The time axis is in CET.

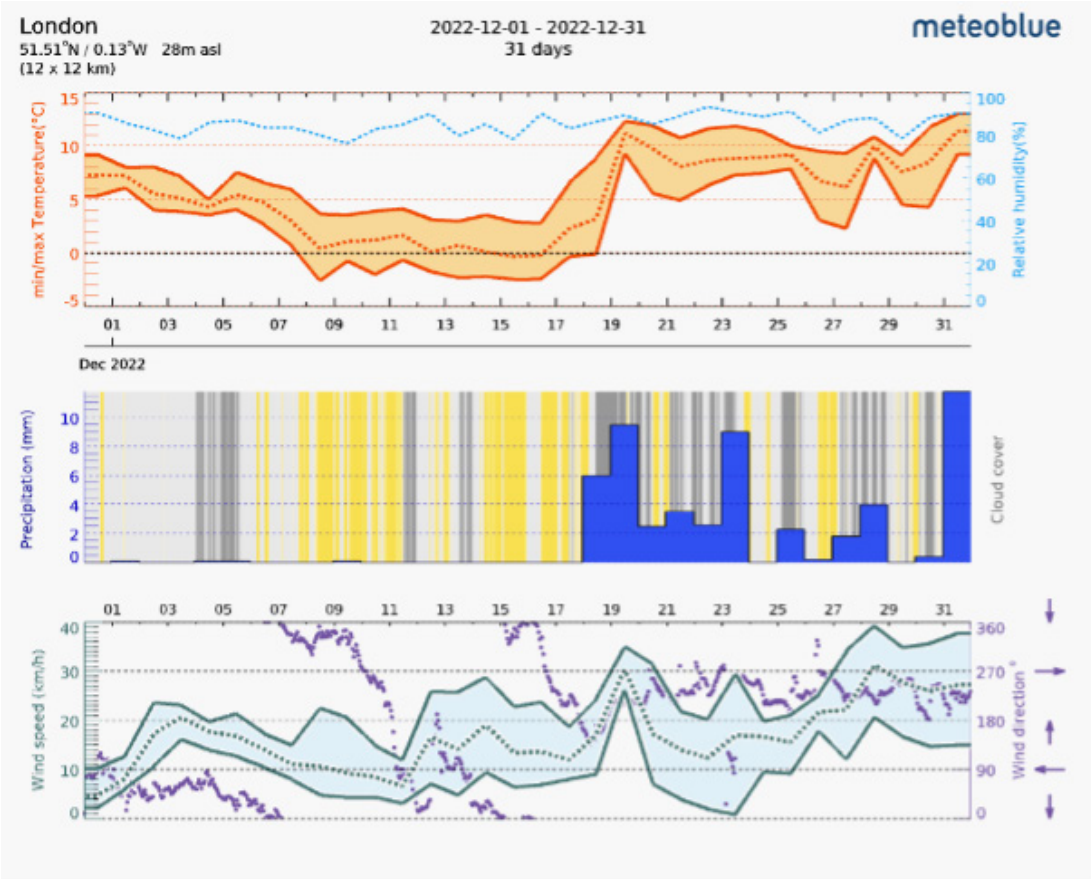

Fig. 11: Historical weather data from December 2022 (meteoblue.com)

Summary

Based on the data gathered by the Camden Network in London, December was quite an eventful month regarding air pollution.

- NO_2 data suggest a slow down in traffic during the week between Chrismtas and NYE, which is in line with our predictions. Otherwise the NO_2 data exhibit a well described daily pattern of higher concentration during rush hours.
- Ozone data seem to tell a more interesting story. Decrease in Ozone concentration in the 1st half of December can be attributed to usual higher cloud coverage and less sunlight in winter time. This changed in the 2nd half of December when the stronger winds started to blow from continental Europe bringing more Ozone with them.
- PM data increased over two times in December compared to previous months and in the most polluted period (8th to 17th of December) the average concentration was nearly four times higher than the average over the previous two months. This can be attributed to more active use of wood burners or other means to heat the residential buildings during the cold snap in that time. In the 2nd half of December the temperature increased as well as wind speed and precipitation, which could explain the decrease in observed PM concentration.
- The New Year's Eve fireworks event can be seen in the network data, however on a much smaller scale than expected and this can also probably be attributed to wet weather and stronger winds that day.

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