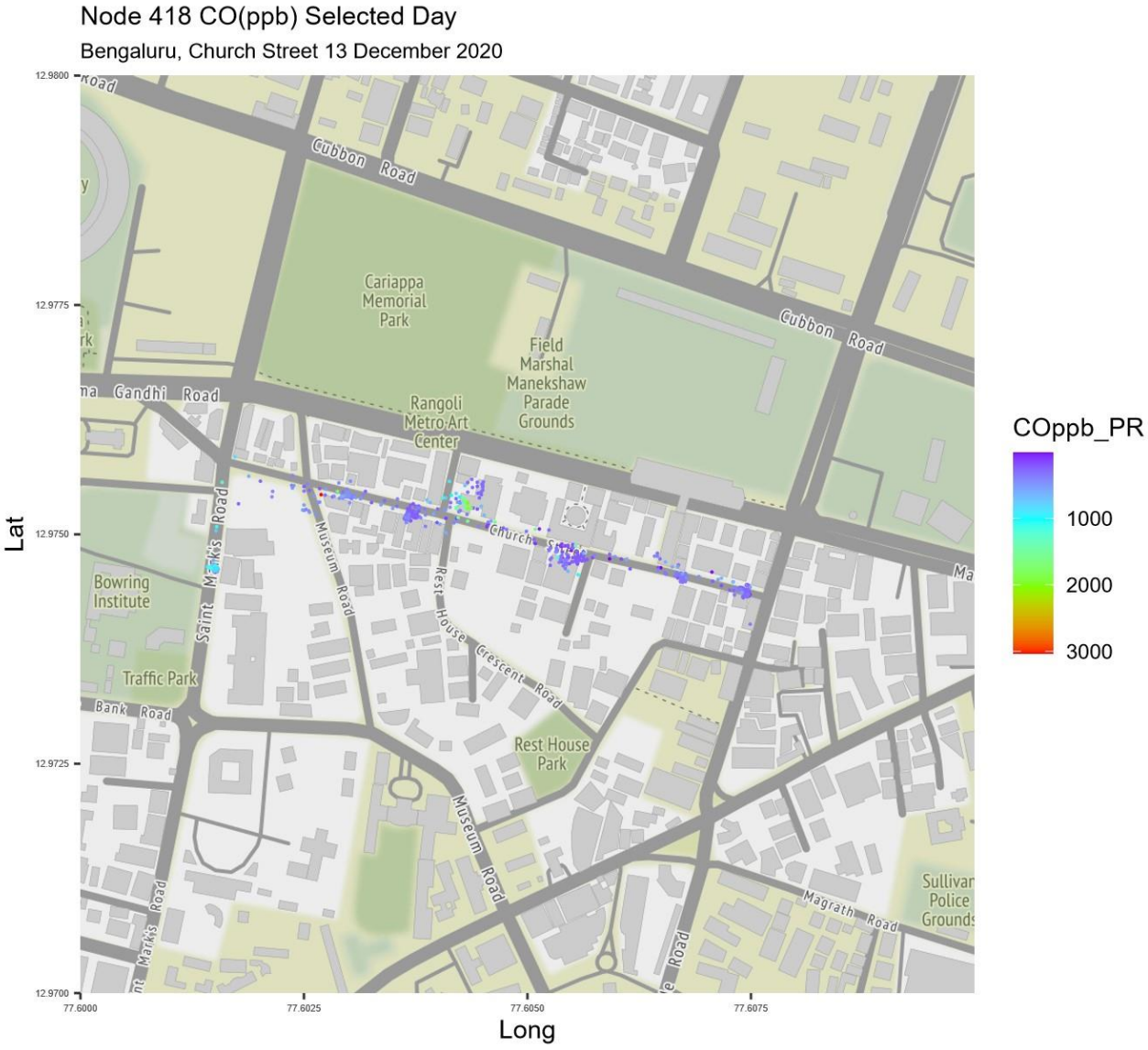

IfCA Technical Report

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Overview

Last year Atmospheric Sensors took part in a test programme in Bengaluru, India, part-sponsored by the CP Catapult. This allowed two local companies to deploy fixed air quality monitors, together with two of our Model 520 Personal Air Quality Monitors (PAMs), which gave a view of pollutants along all of the test street, together with data on the commutes of those wearing the PAMs.

The test street, Church Street, is a popular shopping area in the city centre and for the period of the trial had a weekend traffic ban. There was interest in observing the reduction of atmospheric pollution from the high levels set previously at the weekend.

After overcoming some logistical issues clearing Bengaluru airport customs, which caused a long delay, the units had to be deployed immediately. This gave no time to carry out the recommended commissioning and calibration tasks. An immediate problem was the failure to connect to the local cellular network, which was caused by incorrect information being supplied by our SIM provider. As there was no time to rectify this, it was decided to rely on the internal SD card that has sufficient capacity to record all of the data for the complete test, then analyse this at the end of the test.

The PAMs were supported during the trial by the IIS whose staff/students carried the units during the test.

Several attempts were made to activate the cellular communications, without success, and the PAMs collected data throughout.

At the end of the test the SD cards were removed locally, but unfortunately the correct shutdown procedure was not followed, resulting in corruption of the SD card. Because the PAM has a robust procedure when writing files it is always possible to recover data from this situation, but the SD cards have to be sent to a specialist company to extract the data, which required the units to be returned to the UK.

An extremely protracted period was required to get through local customs prior to export, which resulted in a long delay before the data could be looked at. This was further extended because the wrong address had been used for the return. Once back in the UK the SD cards were processed quickly by the recovery company and the data finally available for processing.

The data was in good order and capable of extensive analysis.

This short report presents the main findings, and demonstrates the benefit of having mobile, personal monitors to significantly open the window on the test area and beyond.

Description of Test

Two PAMs, were deployed, each allocated to a student/staff member for a period. The monitors ran for 24 hours a day and were charged at night in their basestations. The users were asked to carry the PAMs whenever they left the house, and in particular when they travelled in to the test area. The data collected therefore covers the participants homes, commuting and periods when they were on the test street, where they were encouraged to walk up and down during the test to allow the pollution along the whole street to be observed.

The variables recorded by the PAM include:

- Gas concentrations of NO_2, NO, CO and O_3, all measured down to low ppb levels.
- Particle densities recorded as PM 1, PM 2.5 and PM 10 values, together with bin counts for 24 different size particle ranges.
- Temperature and RH
- A measure of ambient sound level
- GPS-sourced latitude, longitude and altitude
- GPS-sourced accurate timestamp

The recordings were made every minute.

The units were deployed during December 2020, January and February 2021. After the test the two PAMs were co-located with an AQMesh fixed monitor, for comparison. This only had 15 minute data and no CO monitor, but was a useful exercise. Once the units were returned to the UK they were calibrated against a golden unit at Atmospheric Sensors. This had been previously calibrated against validated reference instruments. The results presented are processed with this calibration applied.

Data was also collected by fixed monitors from two local companies but we have not had access to this data. Participants also kept a written log, but again we have not seen these.

Whole month results

Figs 1-5 show the complete results for Unit 418 for December 2020 on a map of the city. These demonstrate the large variability across the city. The plots have all the points where GPS co-ordinates were available to this unit during December, with higher levels overwriting lower ones. This allows the potential problem areas to be identified.

The next plots 6-10 show the main pollutants when the unit was in the Church Street area for the same period, split into days. Data for other months and for the other unit is available on request.

These plots show that the Church Street area is generally a lower-pollution area compared with other sites in the city, particularly the main transit routes.

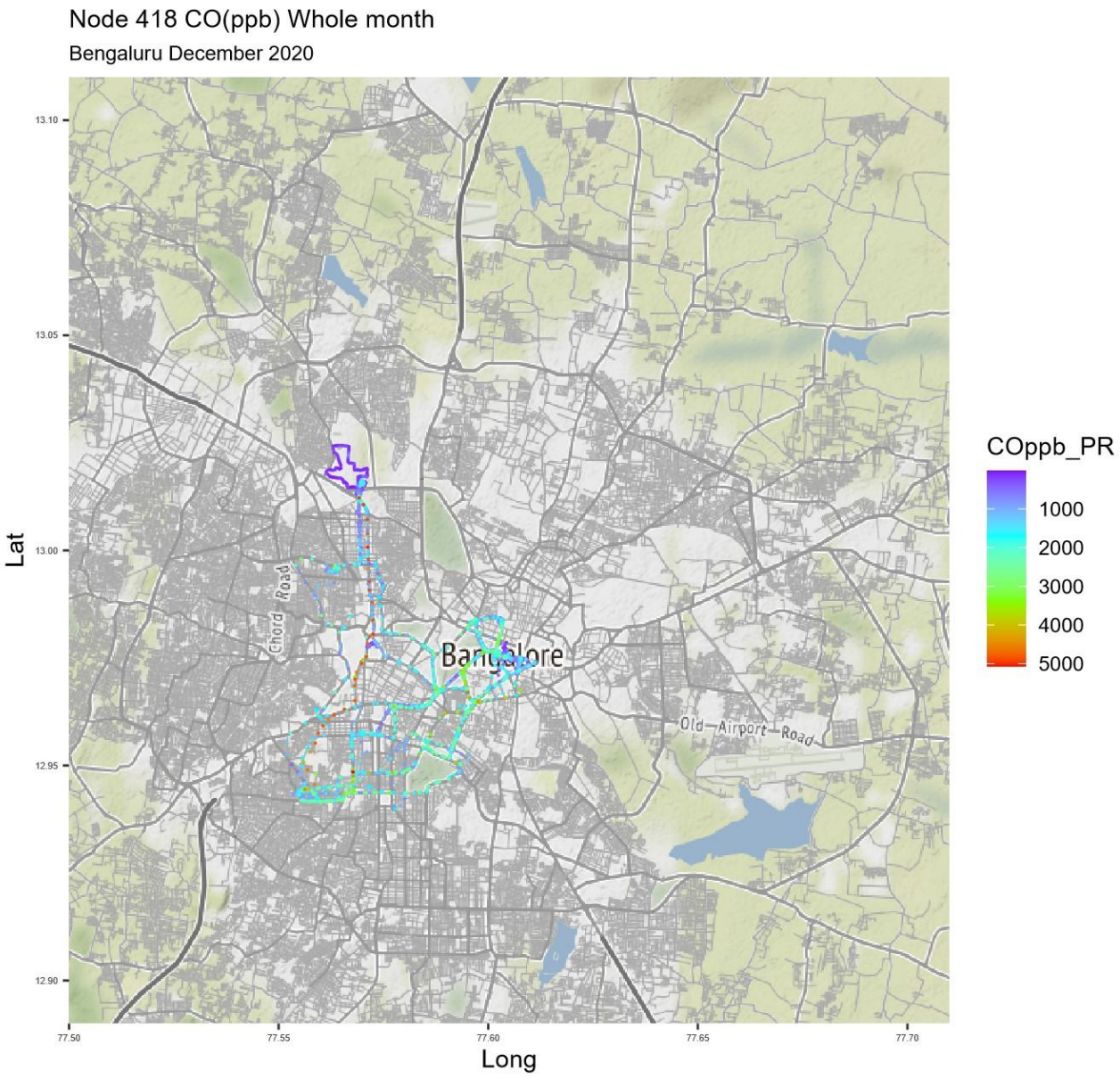


Figure 1

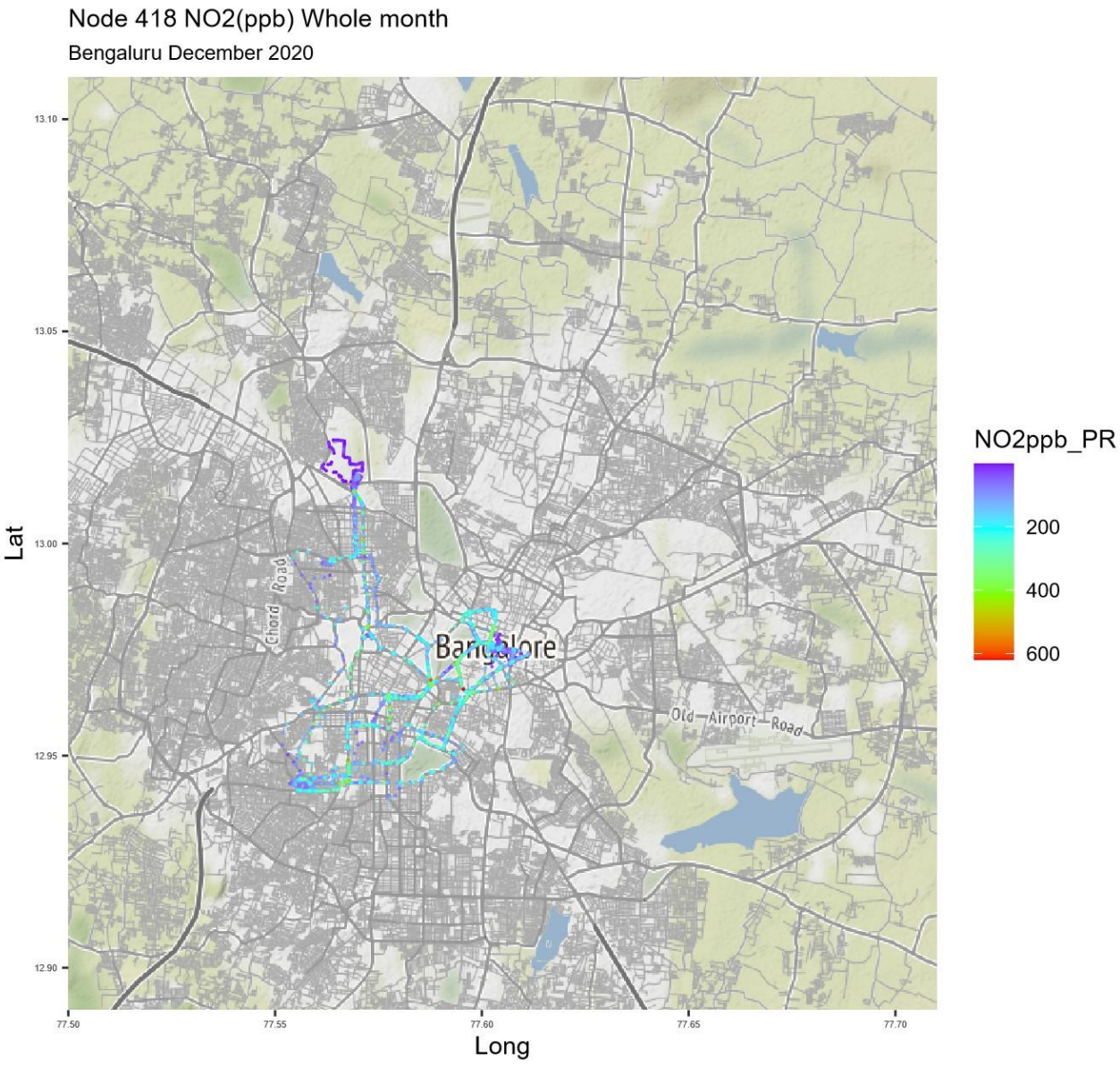
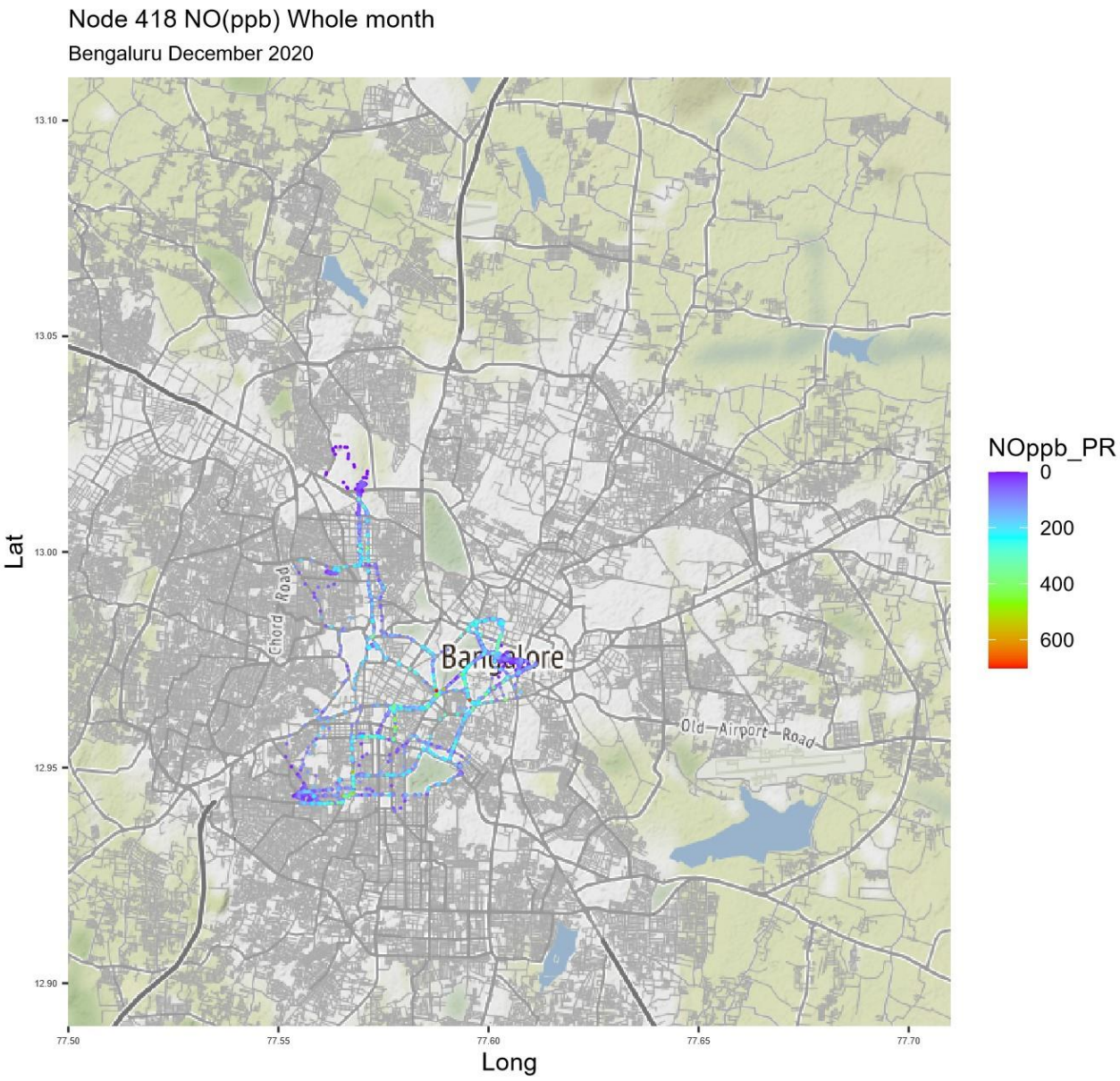


Figure 2



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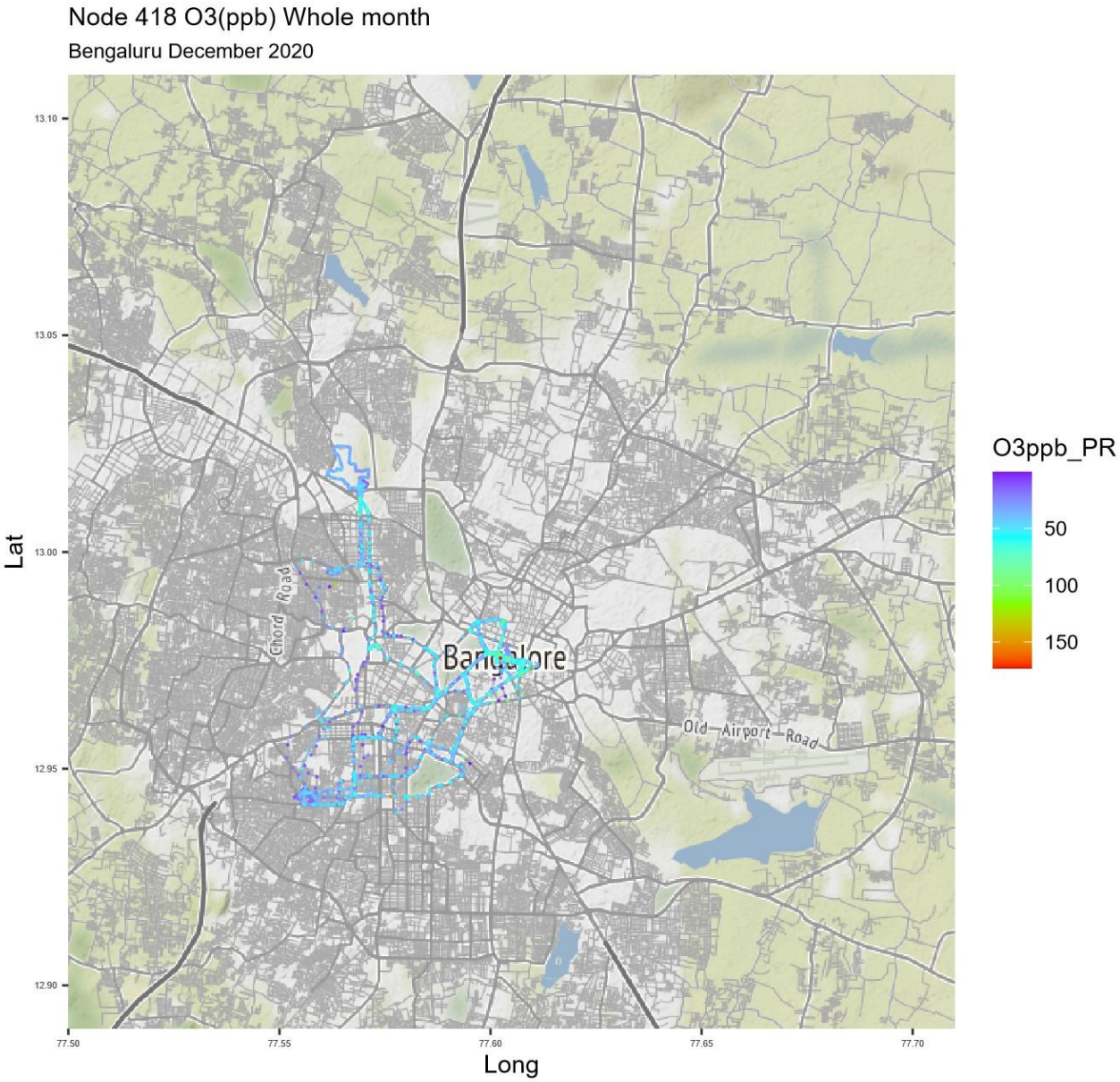

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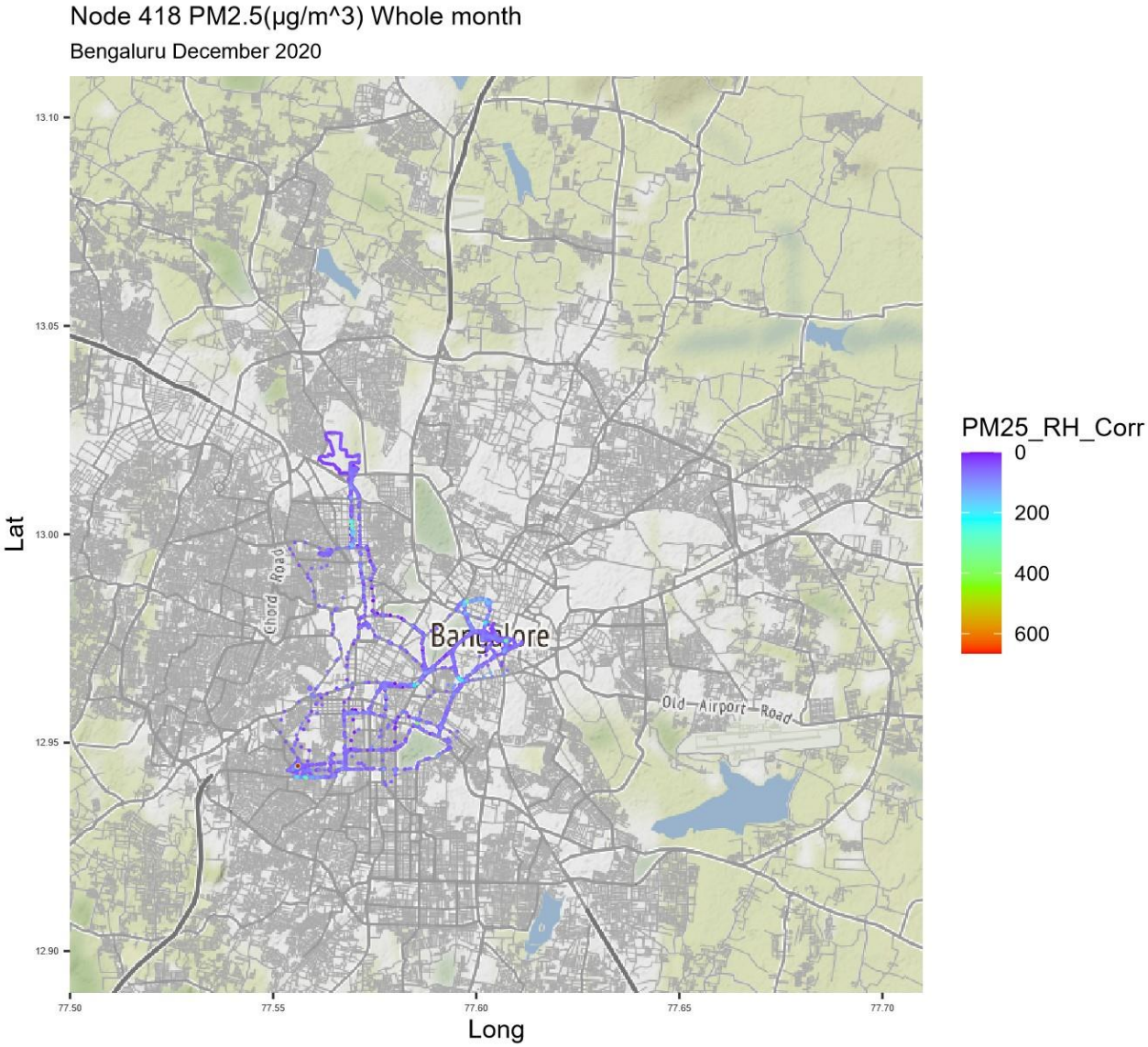

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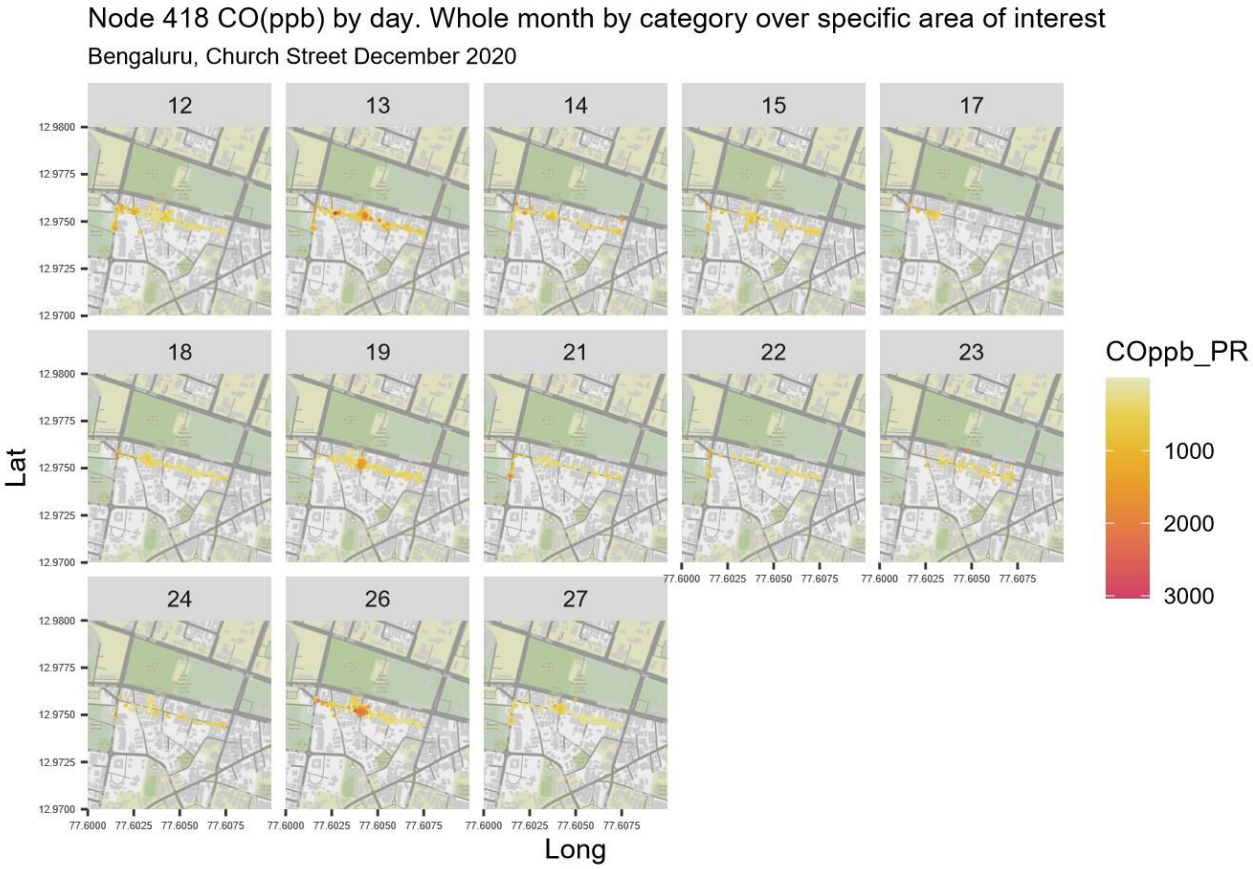
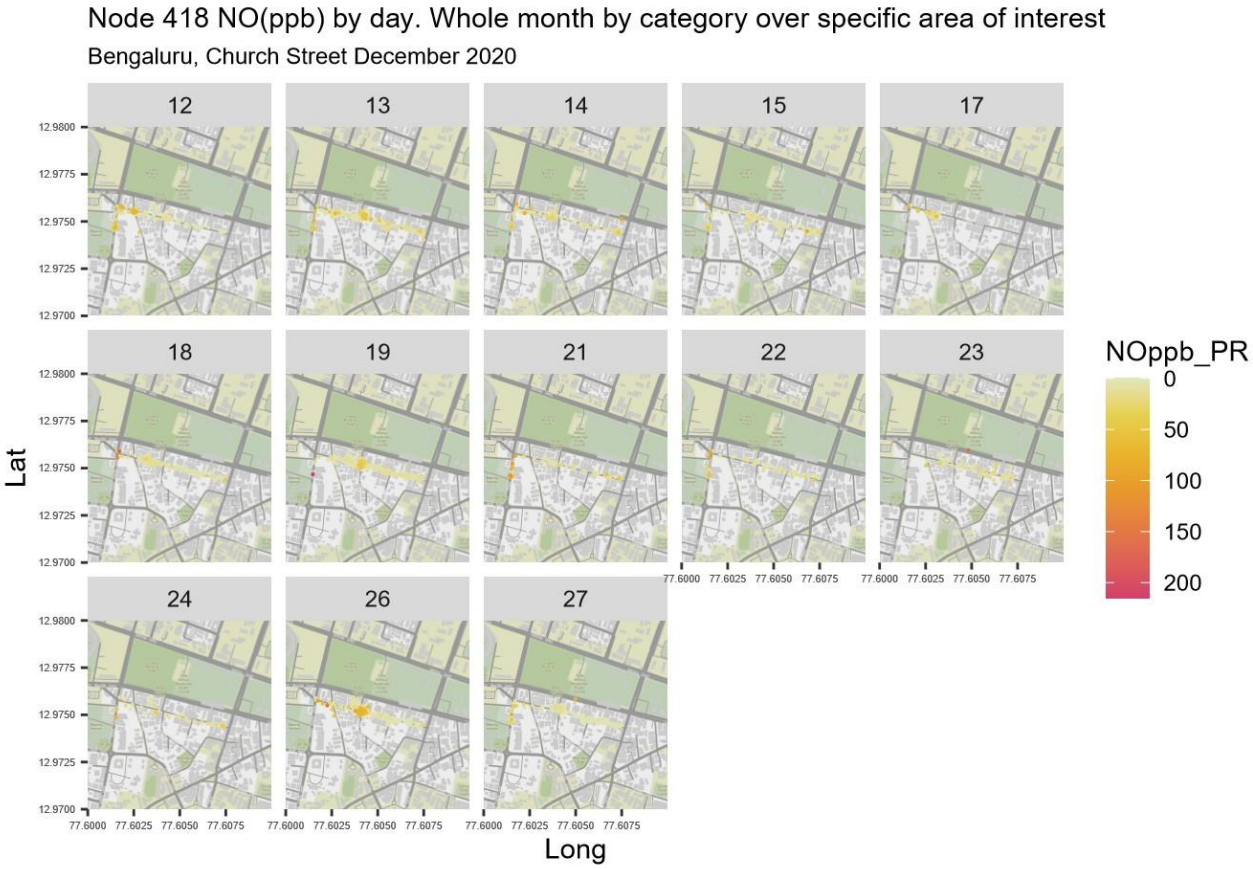


Figure 6

Figure 7



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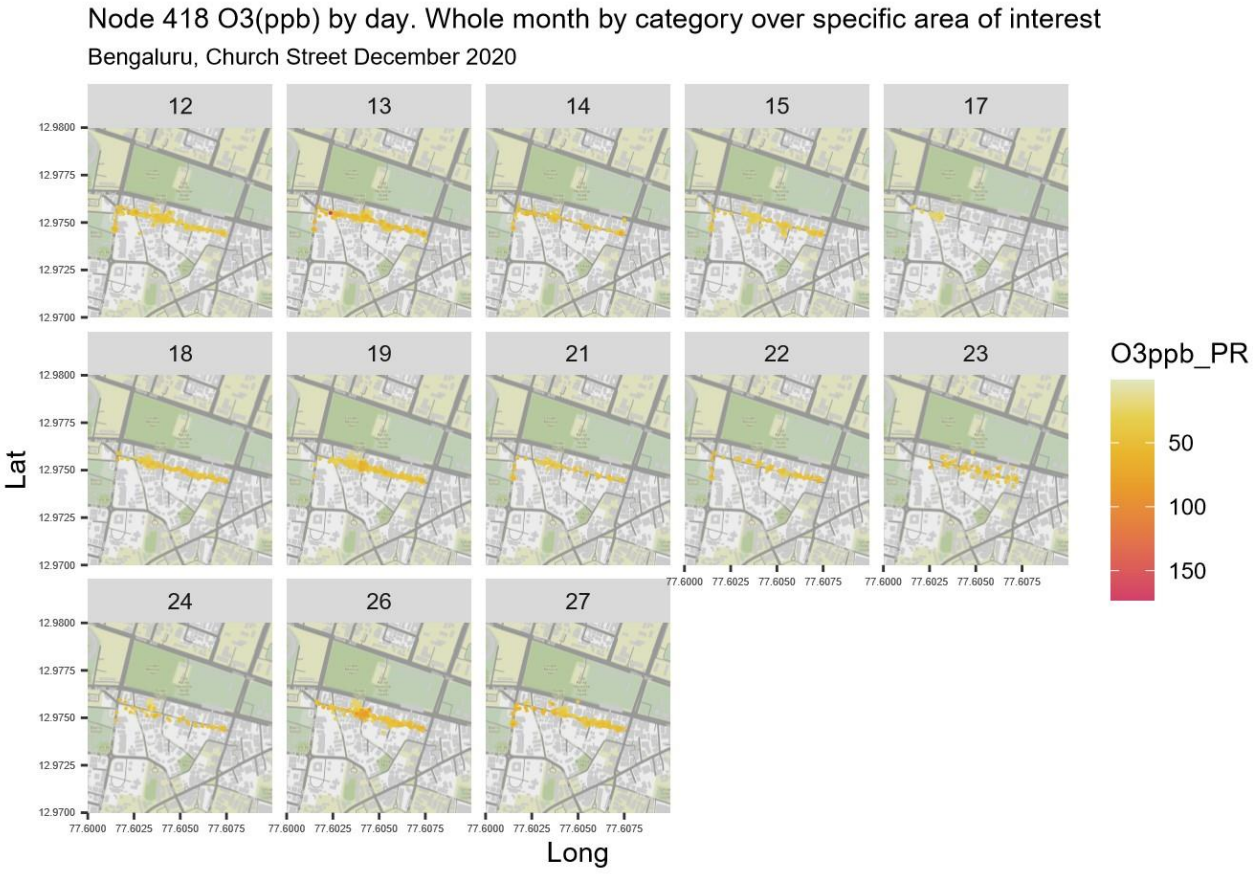


Figure 9

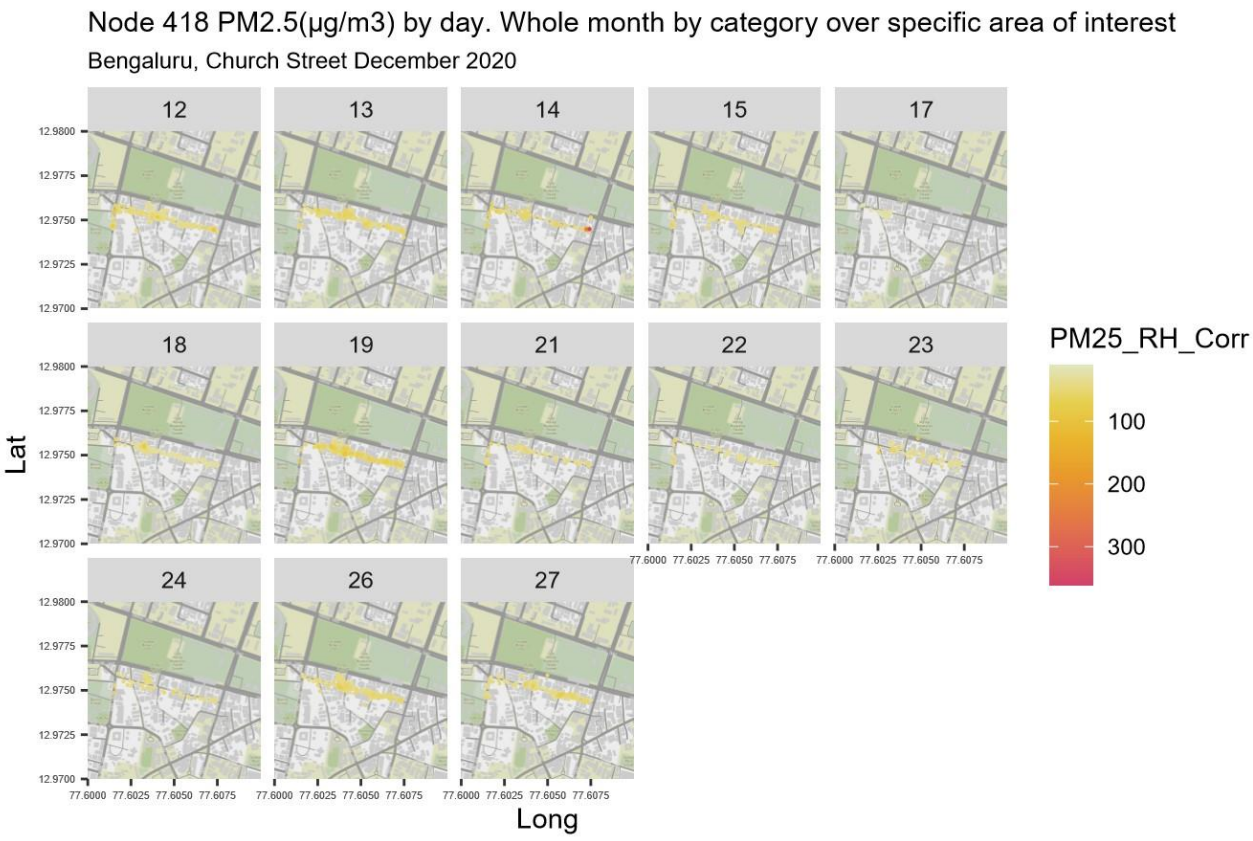


Figure 10

Detailed day plots of the Church Street area

To have a better look at individual days on full-size plots 2 days were selected and are presented in Figs 11-20. The results show that the differences between days are significant, but differences along the street are more significant. The difficulty of siting fixed monitors is also apparent from the results.

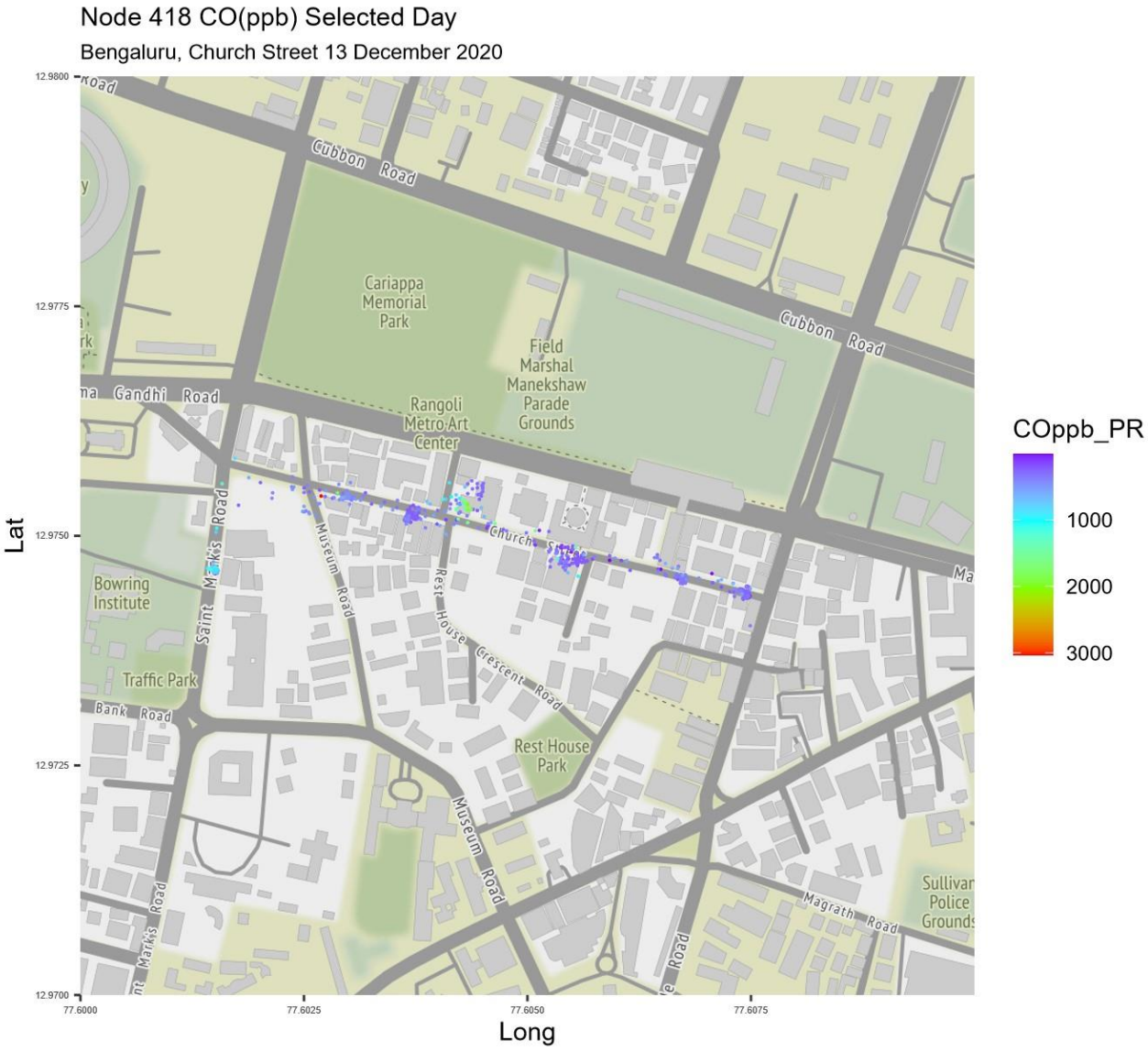
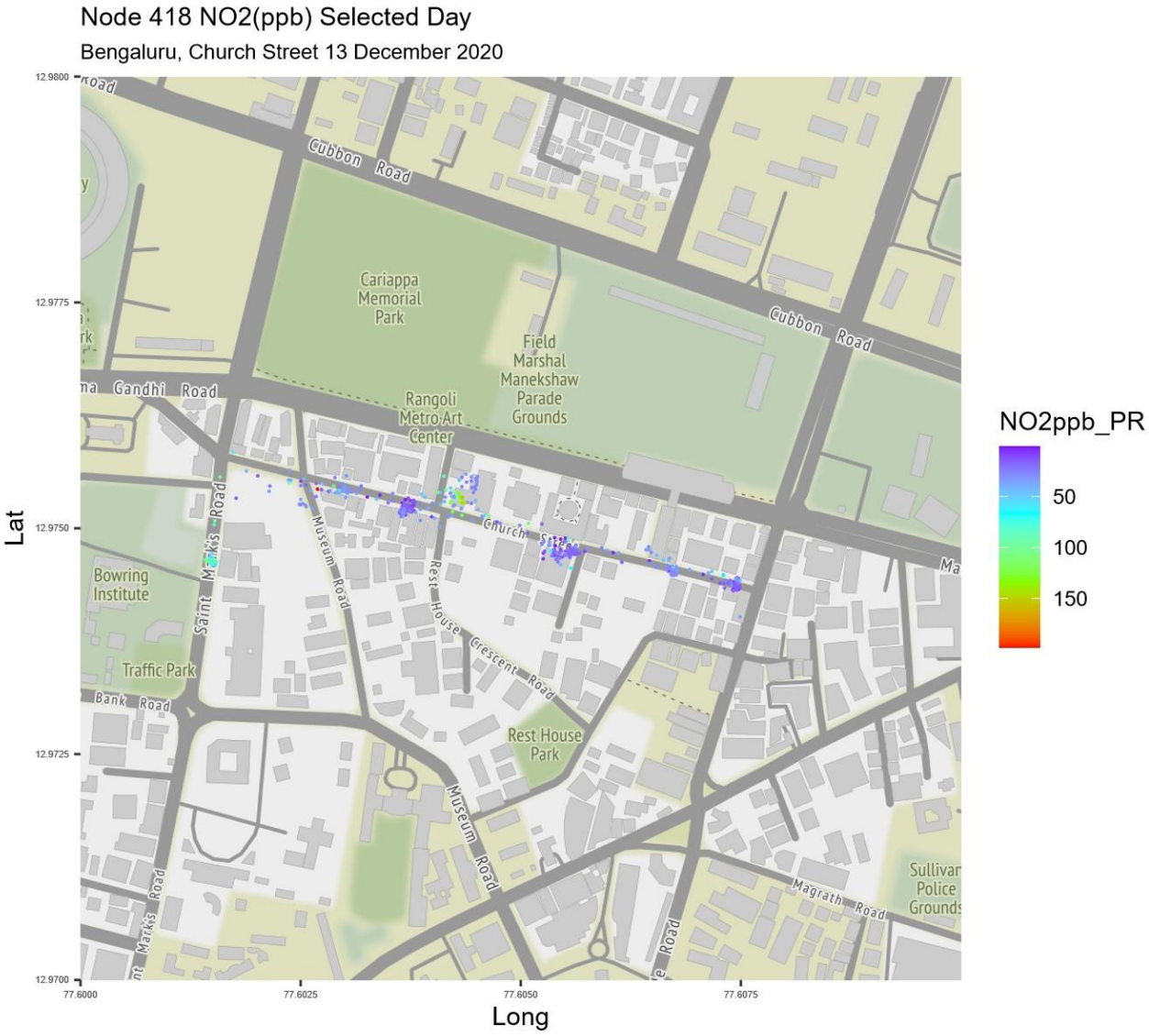


Figure 11



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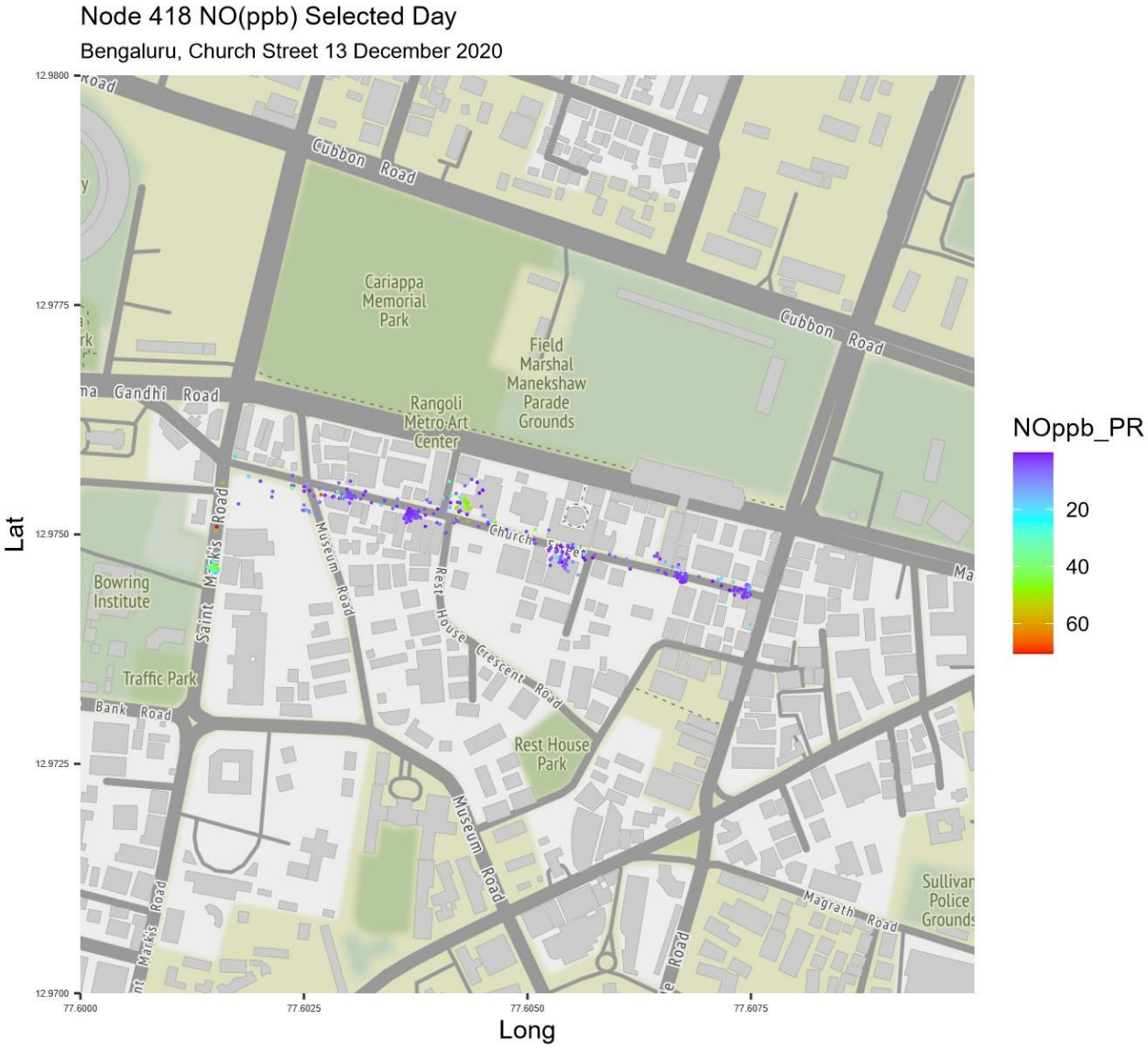

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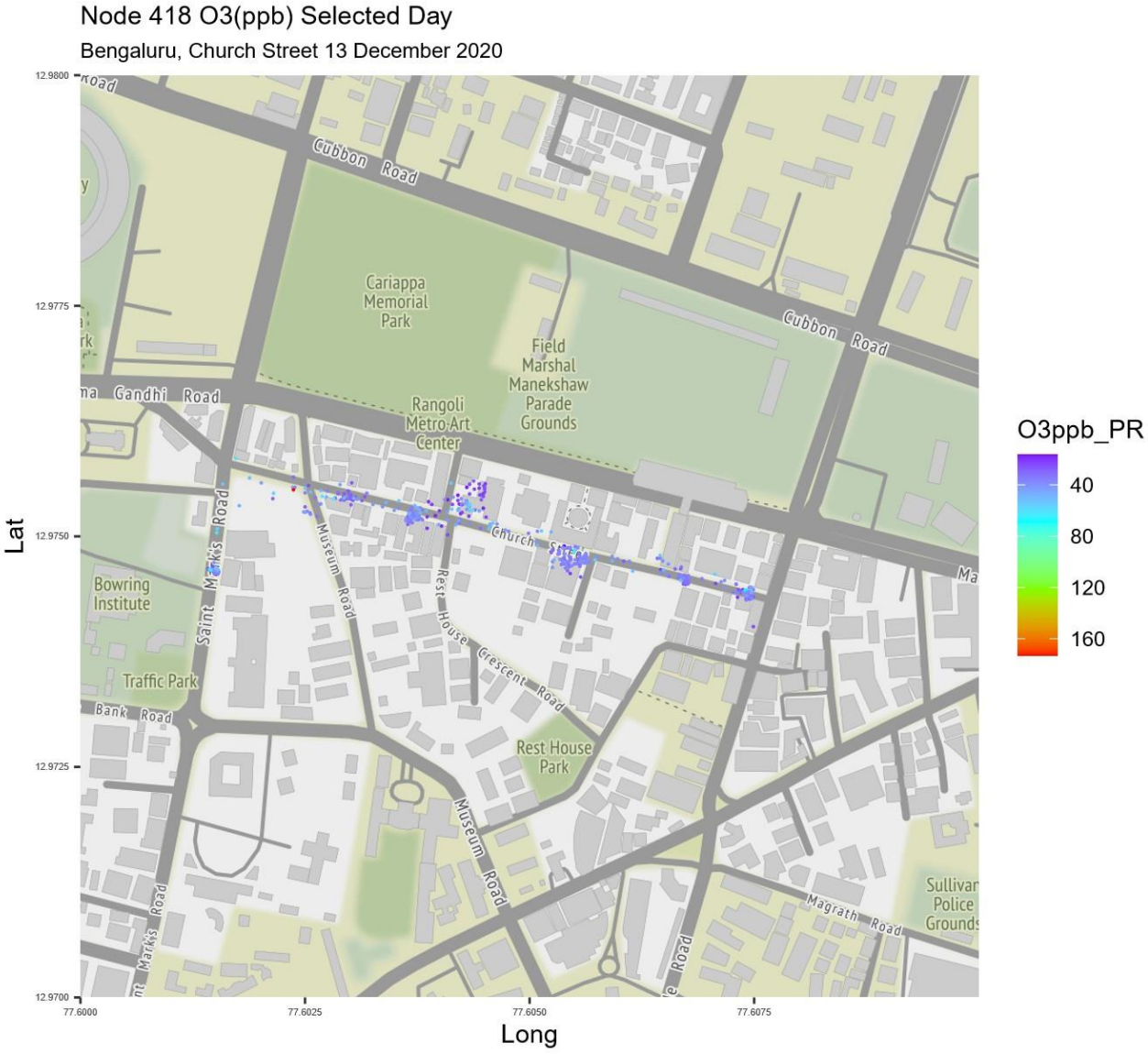

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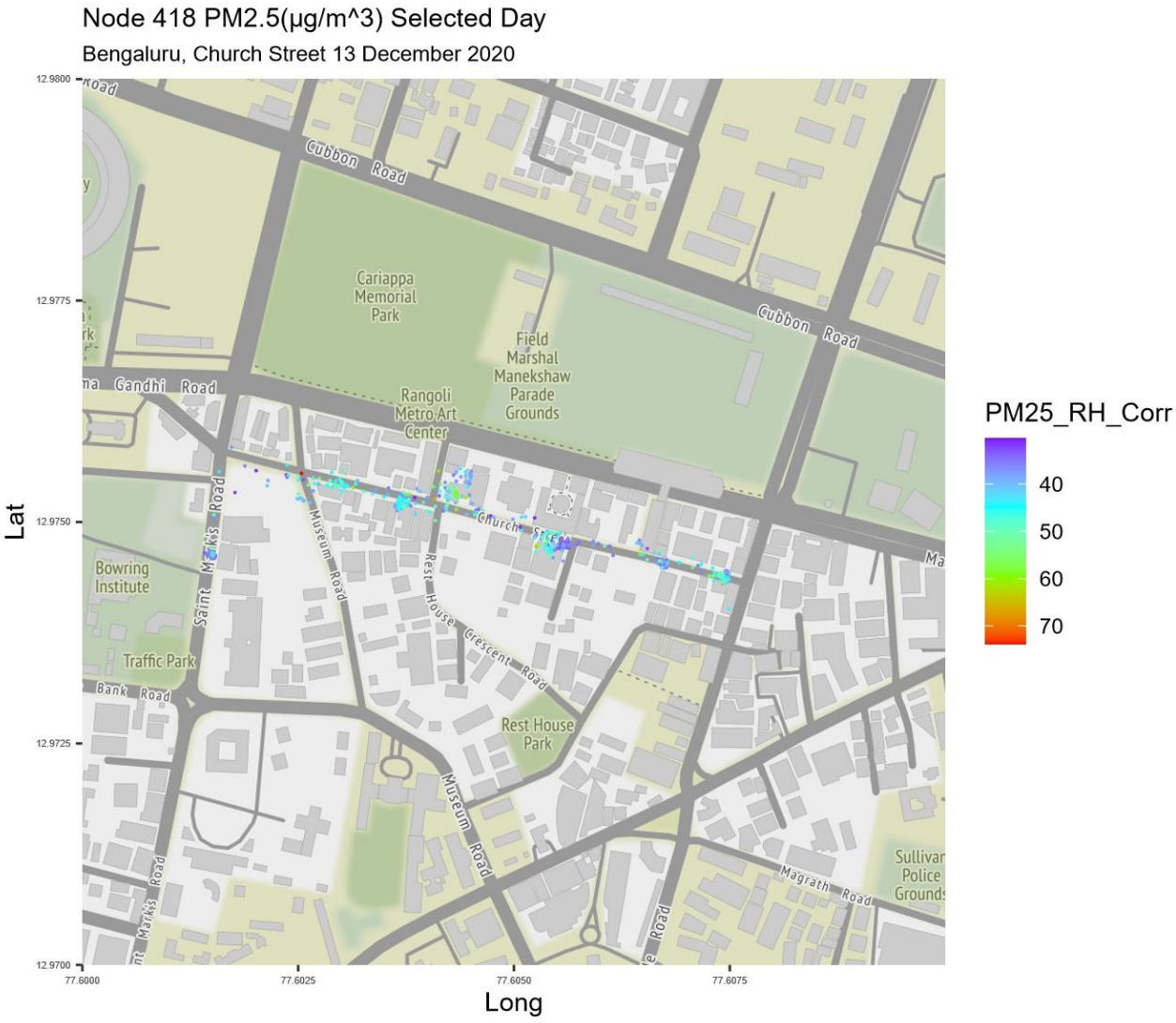

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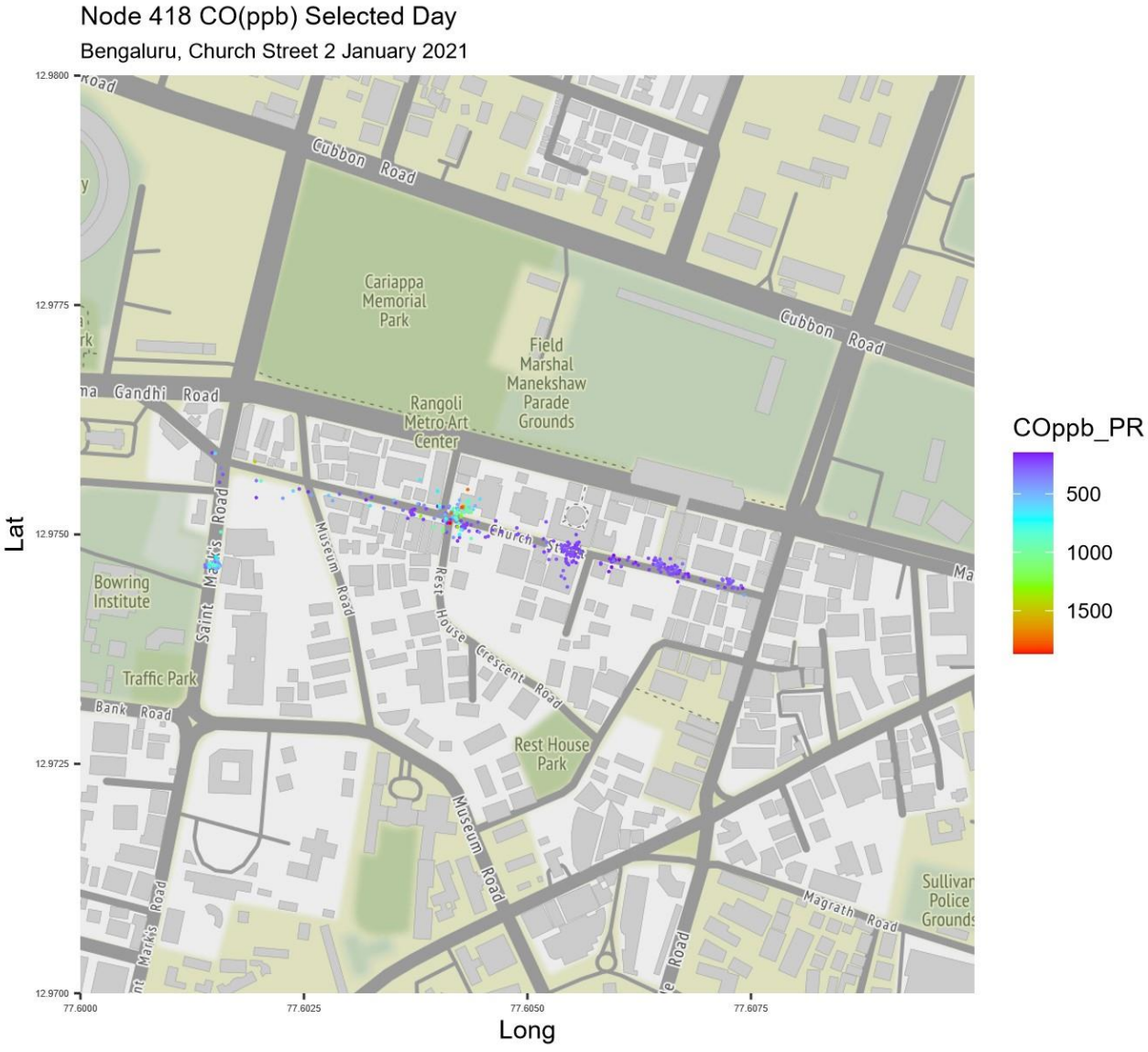

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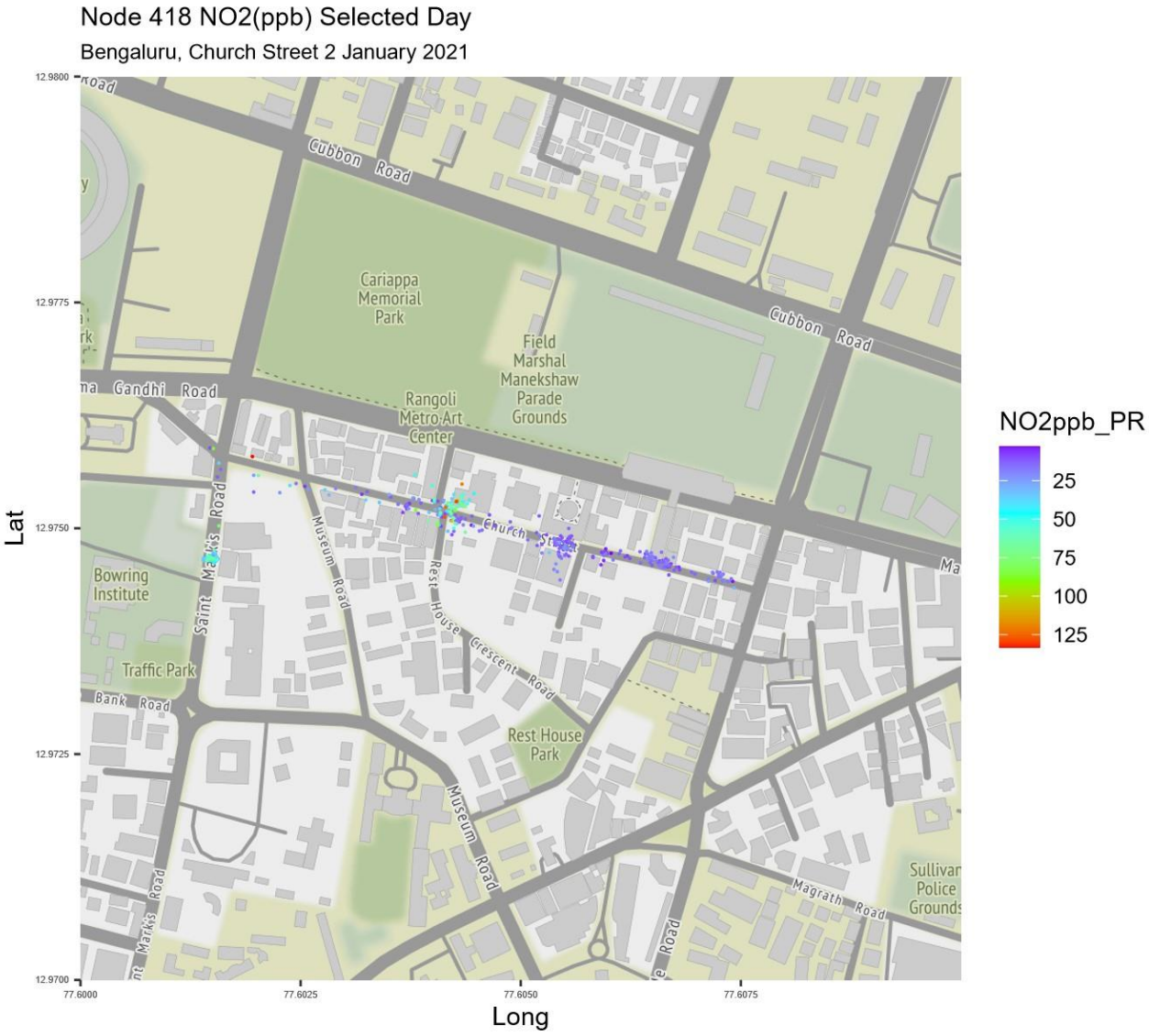
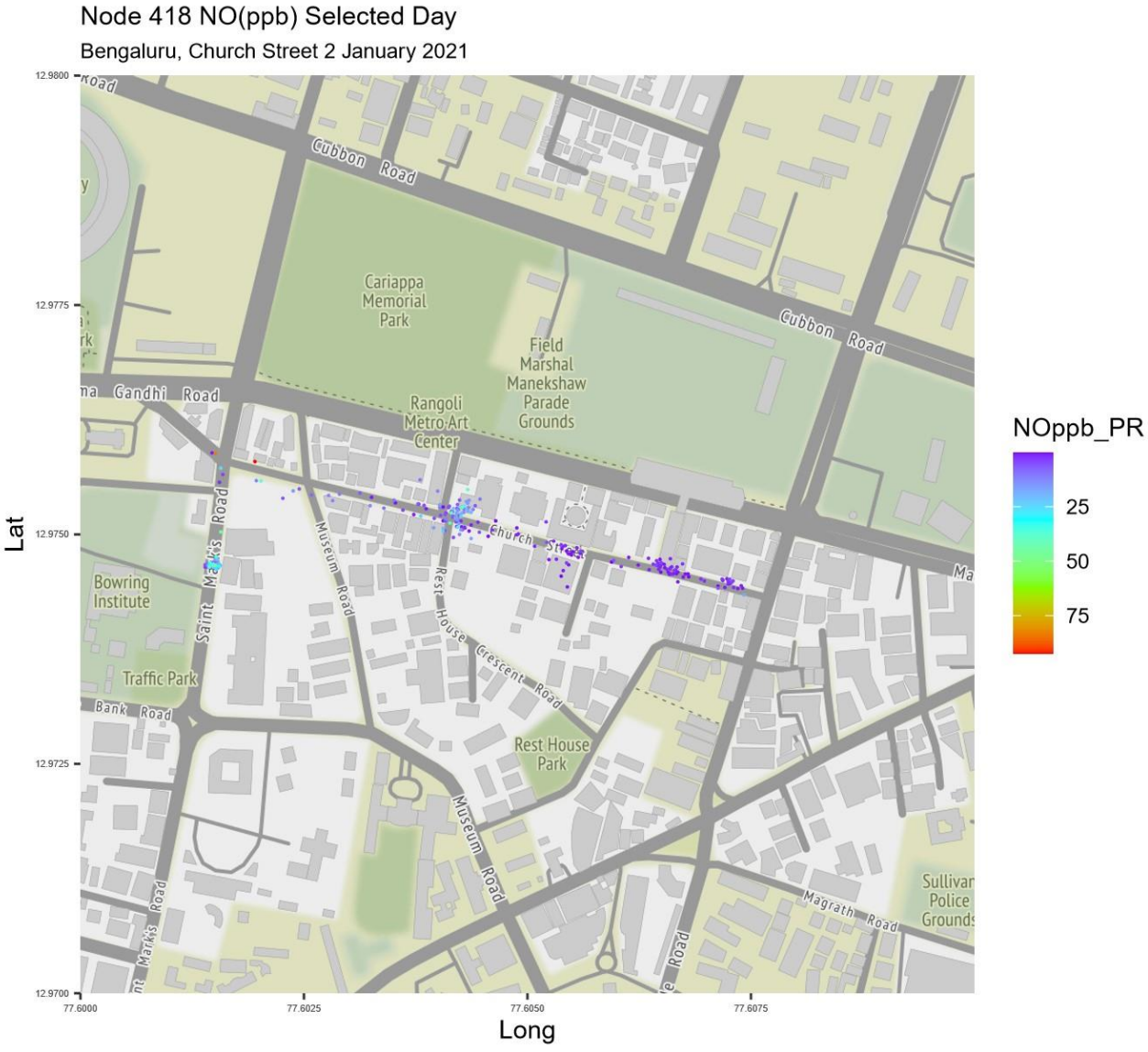


Figure 17



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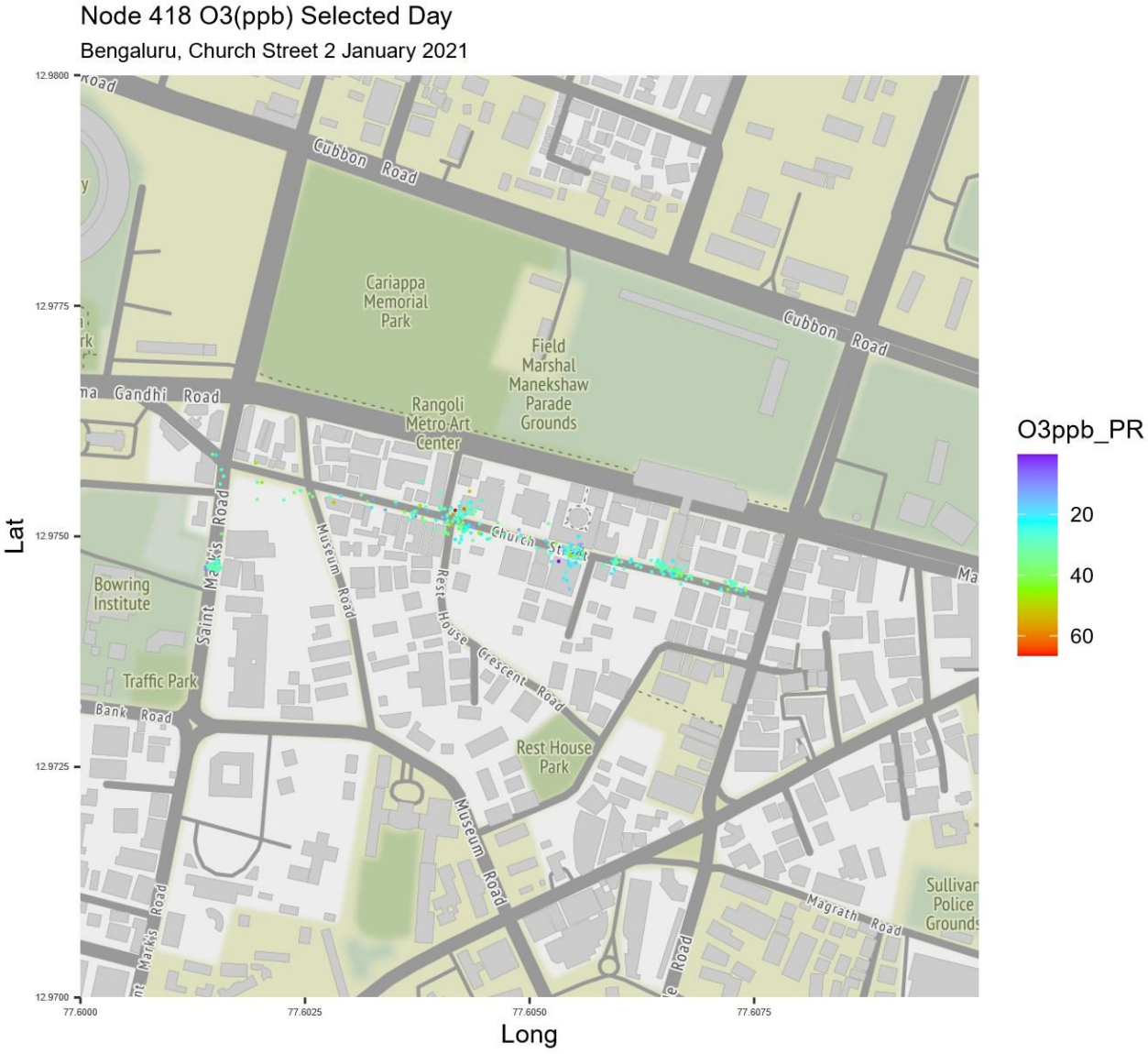

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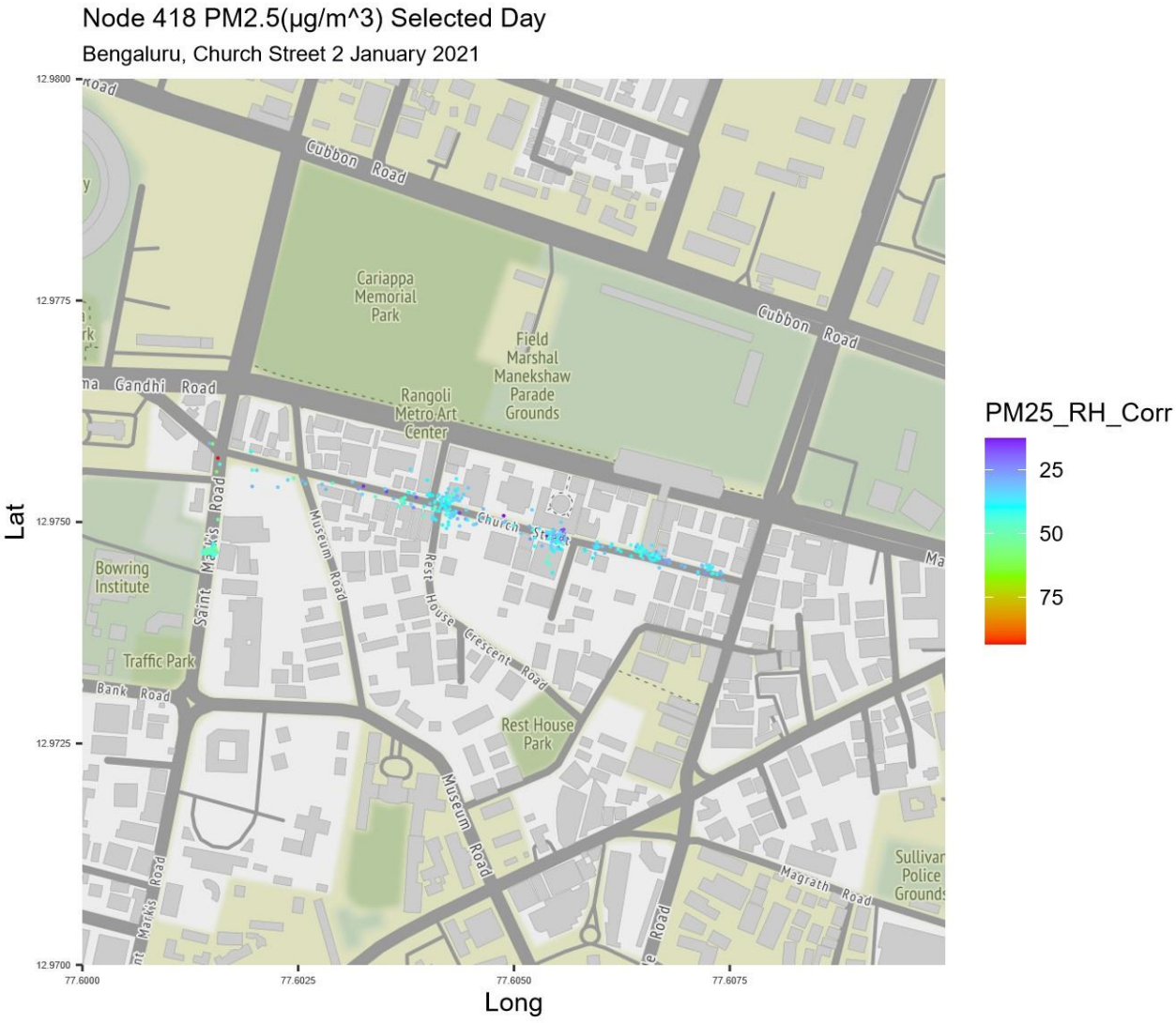

Figure 20

Facetted Church Street plots

To look in more detail at the Church Street result a range of facetted plots was produced, each broken down by different parameters. Figs 21-24 show four of these facet plots where the individual pollutant data is broken down by hour of the day (this is in UTC time, so needs to be +5:30 for Bengaluru time) and day of the week (where 1 = Sunday). All data for the hour or day of the week is accumulated for the month. These plots give a better idea of the variability across the day and the week across the Church Street area. One can see that the levels are somewhat higher at the weekend, but not by much. There are also significant differences across the month. Fig 25 shows the temperature variation, although this is not strongly correlated with pollutant levels. There are also somewhat different patterns for the different pollutants. Full data is available on request.

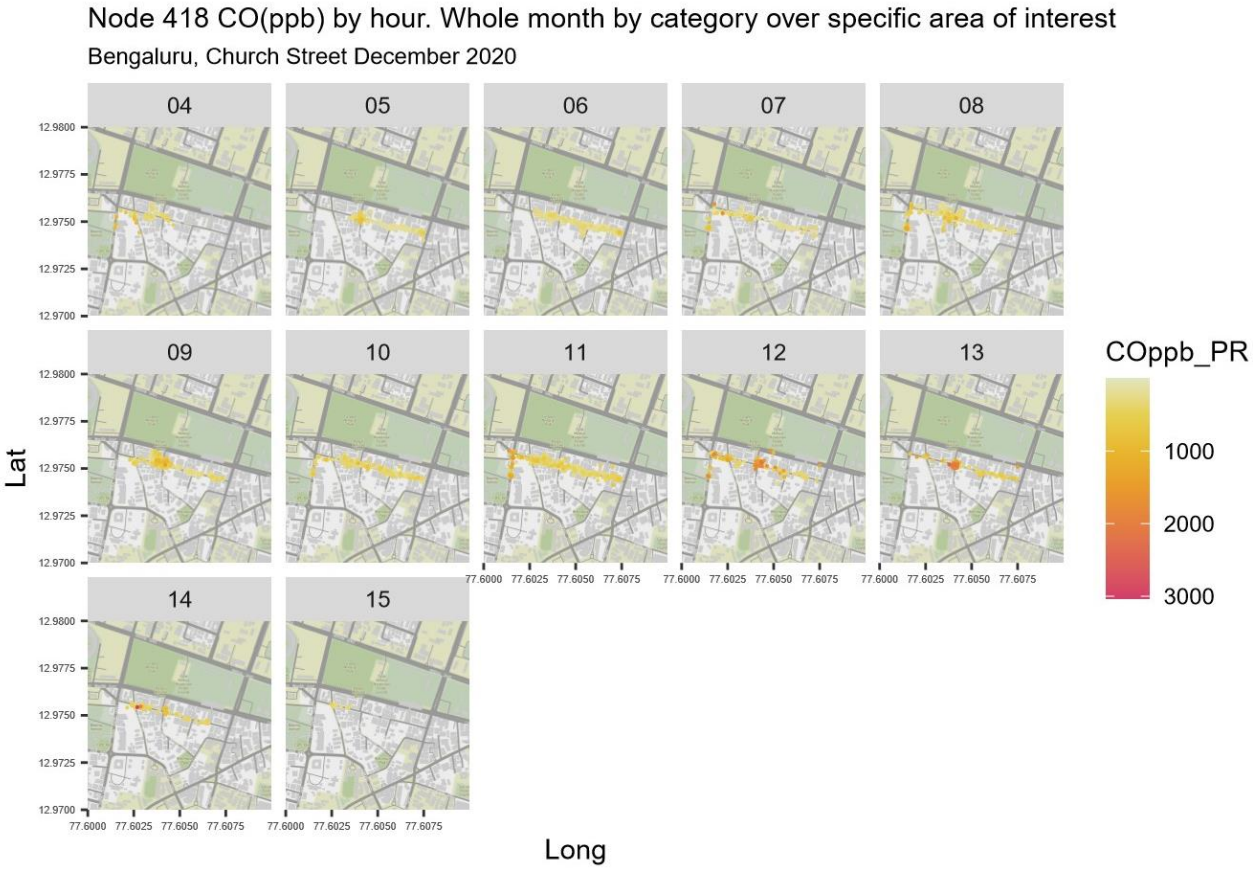

Figure 21

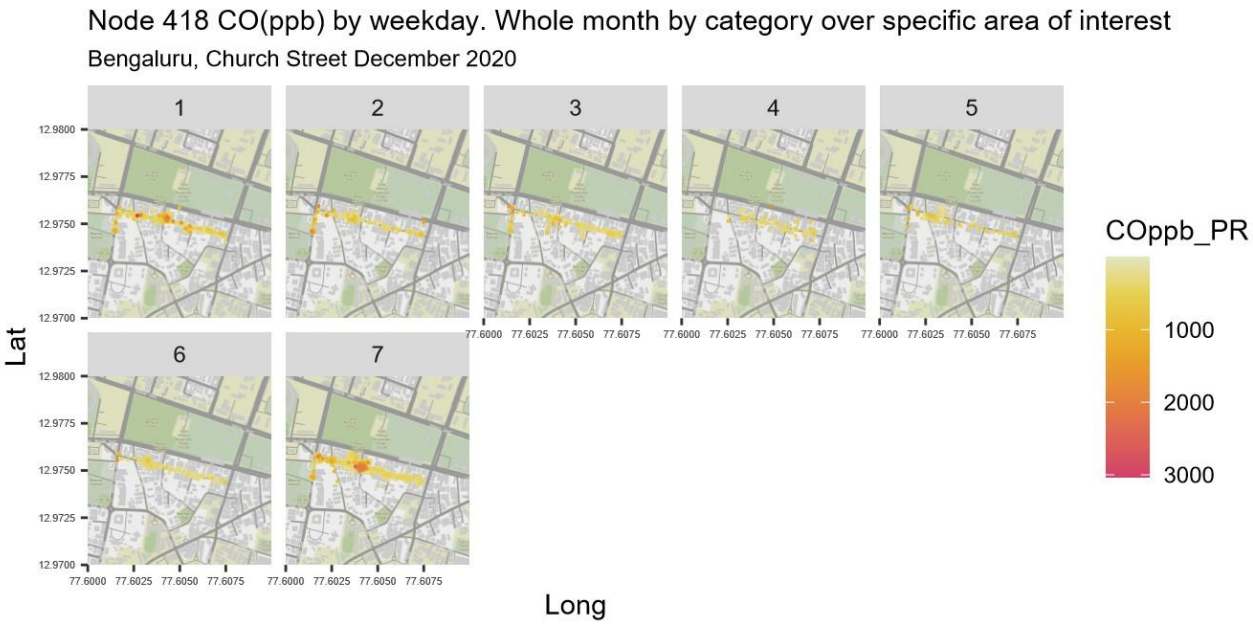

Figure 22

Figure 23

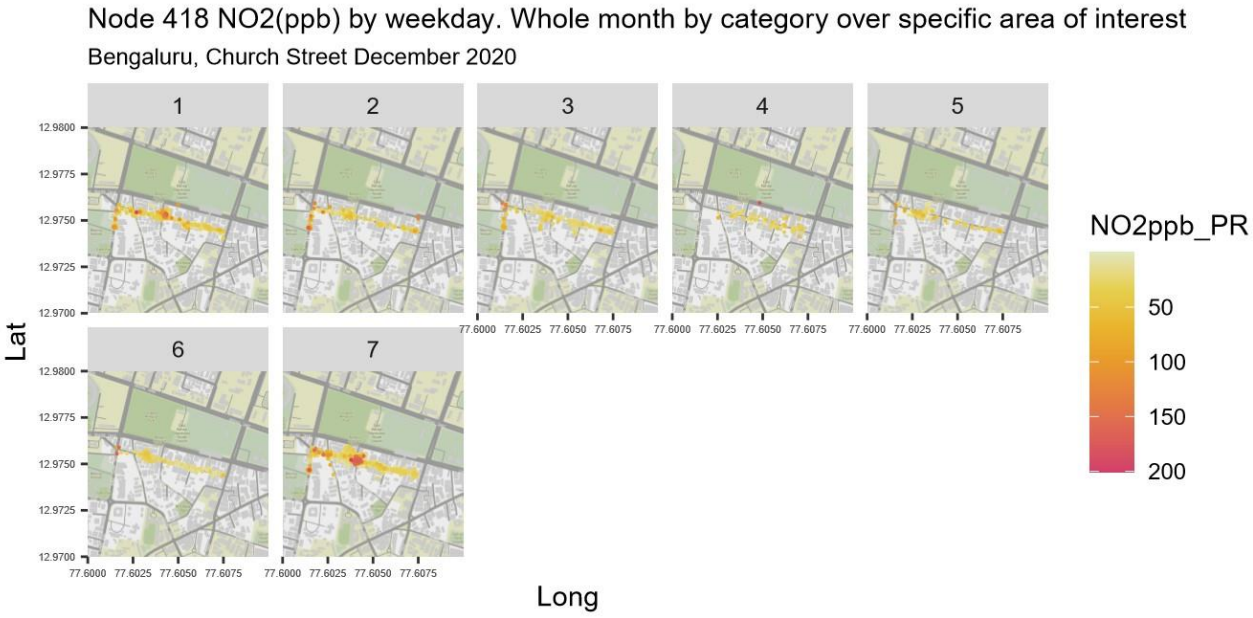

Figure 24

Figure 25

Other results

There is a lot of other useful information that can be extracted from the data, such as the speed of traffic on the routes taken by the participants and pollution levels on the metro, where journey segments can be identified by GPS location information.

Conclusions

That the pollution levels on Church Street during the Clean Street program were relatively low compared with other areas of Bengaluru.

That the levels at the weekends were higher than weekday levels, but not by a large amount. It is understood that the levels before the Clean Street program were significantly higher, but we don't have access to this data.

That correlation with temperature and sound levels does not explain the weekend changes.

That the PAMs gave a good view of pollution levels for several pollutants over a wide area, and along Church Street. This demonstrates the benefit of using portable monitors supplying high-quality data, which is particularly useful to add value to any fixed monitoring installations.

That more pre-planning of logistics would be required for any future test programmes, and in particular seeking a lot more help from local expertise.