# Personal exposure to $NO_2$, BC and PM of the participants of Polluscope campaign in the Paris region


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## INTRODUCTION

### Context

- Atmospheric pollution → Major public health problem[1]
- 40 000 deaths per year in France due to air pollution[1]
- Several pollutants subjects to regulation like $NO_x$, $O_3$, $PM_{2.5}$, $PM_{10}$ [2]
- Paris region → 12 million inhabitants
- AirParif: air quality monitoring stations in Paris area (+ modelling) → Good representation of the outdoor air
- Indoor air less monitored → Personal exposure to pollutants is not really known because we spend majority of our time indoor

Association of 12 partners

### ANR-Polluscope Project (2016-2022)

**Objective: Estimation of personal exposure to pollutants in Paris area using portable sensors worn by volunteers[3]**

- Studied pollutants: $NO_2$, $PM_1$, $PM_{2.5}$, $PM_{10}$ and BC
- Studies of potential health impacts
- Using portable sensors to have better idea of personal exposure
- Development of a data collection and processing platform

## MATERIAL AND METHOD

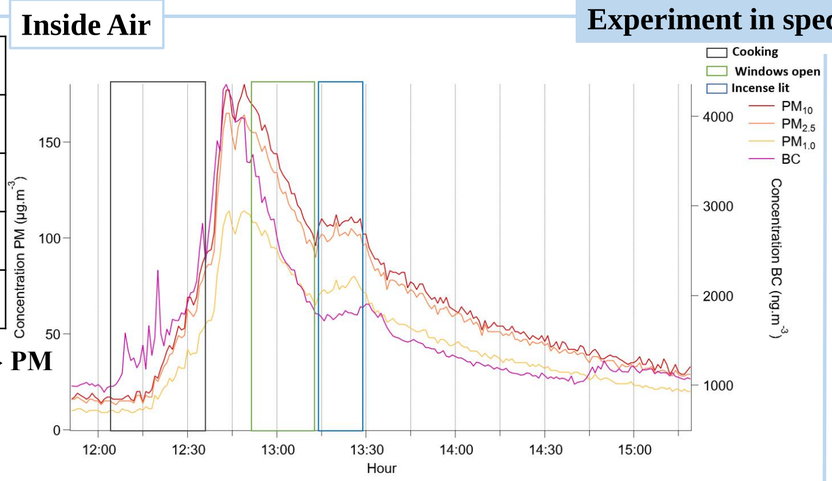
- Selection of sensors in 2017 : Cairsens($NO_2$), Canarin II($PM_1$, $PM_{2.5}$ and $PM_{10}$), AE51 (BC)[4]
- Sensor qualification in 2019[4]: sensors compared to reference instruments at the SIRTA-ACTRIS station (suburban site in Paris area), performing IPI (Integrated Performance Index) determined following Fishbein (2017)[5]
- Measurement campaign : 63 participants from Versailles, 5 weeks (mid-October to mid-December 2019), 1 week per volunteer
- Data Analysis in 2020-2021: data filtering, Machine-Learning
- Additional experiments in several environments in 2021 (indoor, car, subway, outdoor)

| Sensors | Pollutants | Mean IPI index Campaign 2019 qualification |
|---|---|---|
| AE51 | BC | 0.75 |
| Cairsens | $NO_2$ | 0.69 |
| Canarin II | $PM_1$ | 0.77 |
| | $PM_{2.5}$ | 0.73 |
| | $PM_{10}$ | 0.21 |


## RESULTS

### Inside Air

| | Mean Background Concentration | Max Cooking |
|---|---|---|
| $PM_1$ ($\mu g.m^{-3}$) | 9.9 | 114 |
| $PM_{2.5}$ ($\mu g.m^{-3}$) | 15.2 | 165 |
| $PM_{10}$ ($\mu g.m^{-3}$) | 16.8 | 180 |
| BC ($ng.m^{-3}$) | 989.8 | 4356 |

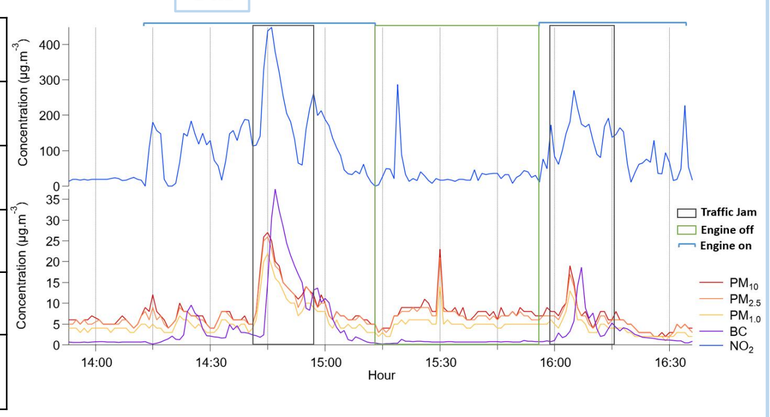



- Cooking and incense burning → PM and BC concentrations increase
- $PM_1$ → greater proportion than other PM
- Open windows → Concentrations quickly decrease
- Close windows → Concentrations slowly decrease

### Experiment in specific environment

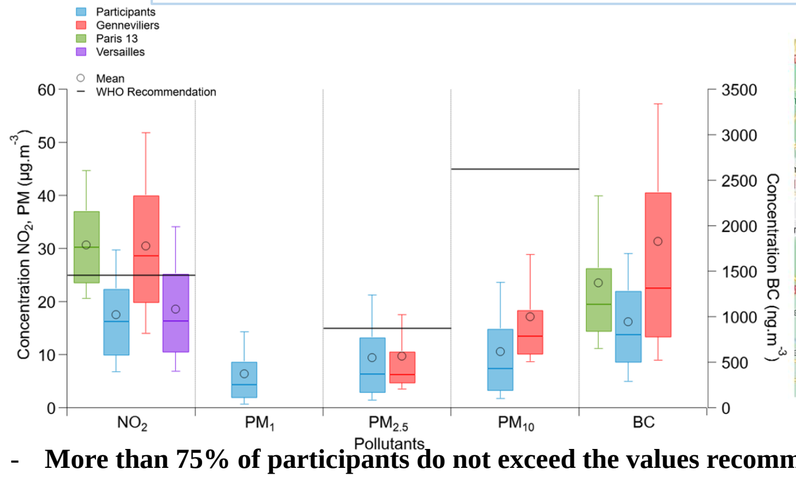
| | Background concentration | Engine on | Engine off | Traffic jam |
|---|---|---|---|---|
| PM1 (µg.m-3) | 3.9 | 5.7 | 5.3 | 8.6 |
| PM2.5 (µg.m-3) | 5.5 | 7.7 | 7.6 | 11.1 |
| PM10 (µg.m-3) | 5.9 | 8.2 | 8.3 | 11.8 |
| NO2 (µg.m-3) | 18.1 | 121.8 | 34.0 | 184.2 |
| BC (µg.m-3) | 0.6 | 5.6 | 0.7 | 10.6 |

### Car




- Concentrations of all pollutants increase during traffic jams
- BC and $NO_2$ → Concentrations increase with engine on
- Engine off → Concentrations decrease

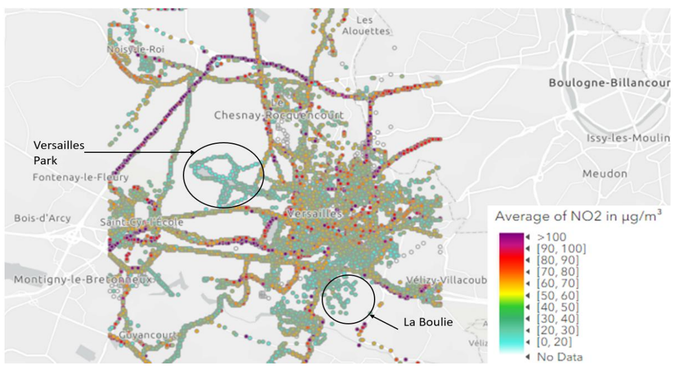
### Comparison of participants measurements and AirParif stations




- More than 75% of participants do not exceed the values recommended by WHO[6]
- 75% of concentrations measured in Versailles do not exceed the values of WHO[7]
- Exposure seems higher in Gennevilliers ($NO_2$, BC and $PM_{10}$) and Paris 13 ($NO_2$ and BC) than in Versailles[7]

### Campaign

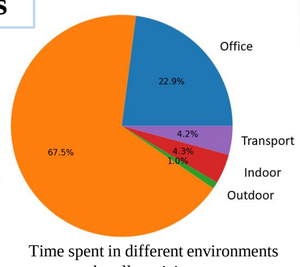

### Geolocalised NO2 map of Versailles



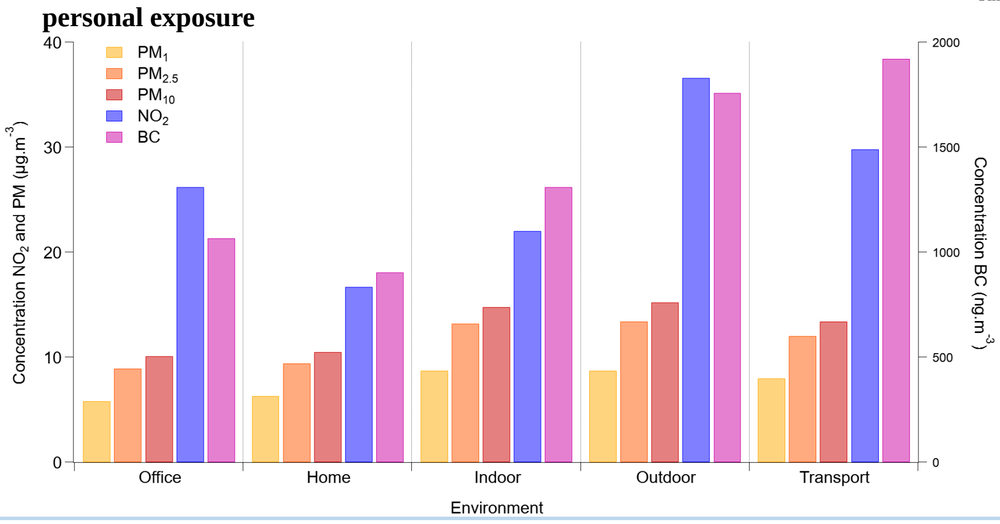

- La Boulie, Versailles Park → 0-20 µg.m-3 (background concentration)
- Major road → 60-100 µg.m-3 (higher concentration)
- High variability of concentration in Versailles city
- $NO_2$ short-lived → its concentration spatial distribution reflects its sources location

### Measurements of all participants in different environments

- Home → Low exposure except during specific activities (cooking, …)
- Office → Exposure similar of home excepted for NO2 (Closer to the road)
- PM concentration increases indoor (restaurants and train stations)
- $NO_2$ and BC concentrations higher in transports and outdoor (mainly from traffic sources)
- Time spent in different environments is important to consider to estimate personal exposure

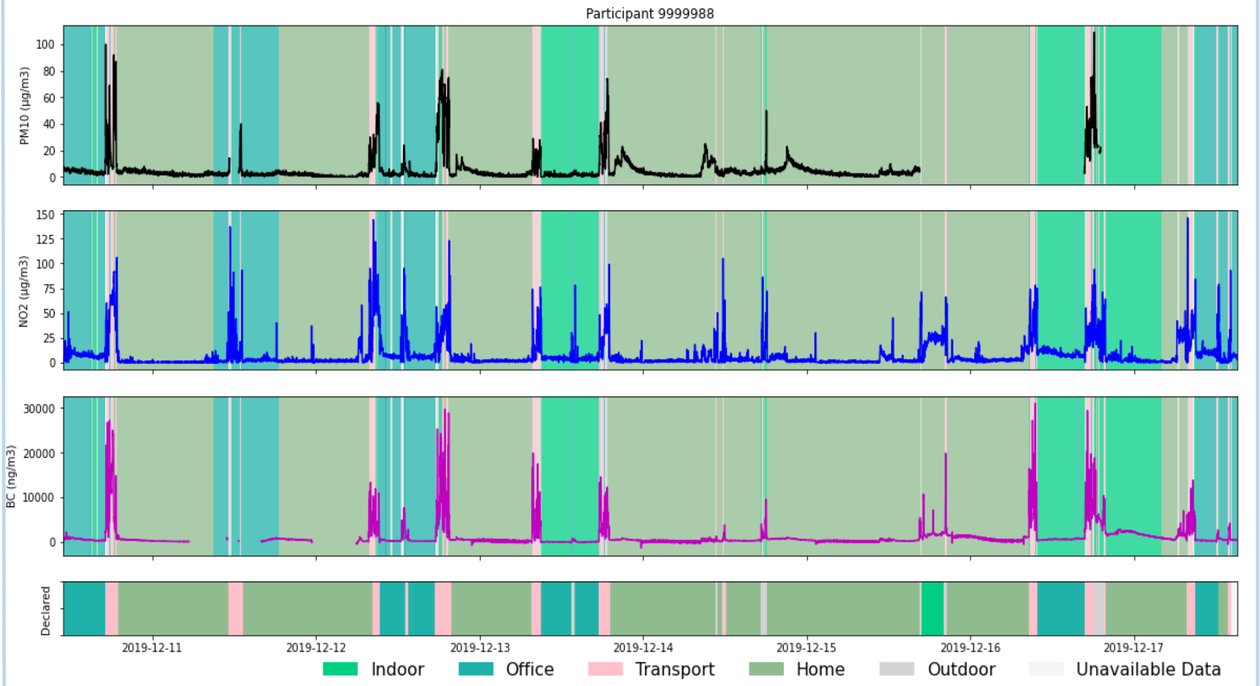



Time spent in different environments by all participants




### Concentration measured by 1 participant over a week

- Allocation in different environments using machine learning[8]
- Moderate exposure for all pollutants
- Pollution peaks in transport and outdoor → traffic
- Pollution peaks in home and indoor → cooking




## CONCLUSIONS AND PERSPECTIVES

- Encountered difficulties :
  - Sensor artifacts when environments changes abruptly
  - Participants didn't always annotate their environment
- Concentration of pollutants depends on the environments and activities → lifestyle
- Exposure is greater outdoor, but only 1% of the time is spent there
- Exposure is low at home and majority of the time is spent there but pollution peaks can occur depending on activities (cooking)

- New campaign 2022 → increasing representativity of measurements (more participants, other season, etc.)
- Measurement of other pollutants would be useful (ex : VOC important indoor)

## REFERENCES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