



Evaluation of the effectiveness of filtration systems in Parisian underground railway stations

Valisoa Rakotonirinjanahary, Suzanne Crumeyrolle, Mateusz Bogdan,
Benjamin Hanoune

► To cite this version:

Valisoa Rakotonirinjanahary, Suzanne Crumeyrolle, Mateusz Bogdan, Benjamin Hanoune. Evaluation of the effectiveness of filtration systems in Parisian underground railway stations. Indoor Air 2024, Jul 2024, Honolulu, United States. . hal-04648640

HAL Id: hal-04648640

<https://hal.science/hal-04648640v1>

Submitted on 15 Jul 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



EVALUATION OF THE EFFECTIVENESS OF FILTRATION SYSTEMS IN PARISIAN UNDERGROUND RAILWAY STATIONS

Valisoa RAKOTONIRINJANAHAARY^{1,4}, Suzanne CRUMEYROLLE², Mateusz BOGDAN³, Benjamin HANOUNE¹

¹ Univ. Lille, CNRS, UMR 8522 – PC2A – Physicochimie des Processus de Combustion et de l'Atmosphère, F-59000 Lille, France

² Univ. Lille, CNRS, UMR 8518 – LOA – Laboratoire d'Optique Atmosphérique, F-59000 Lille, France

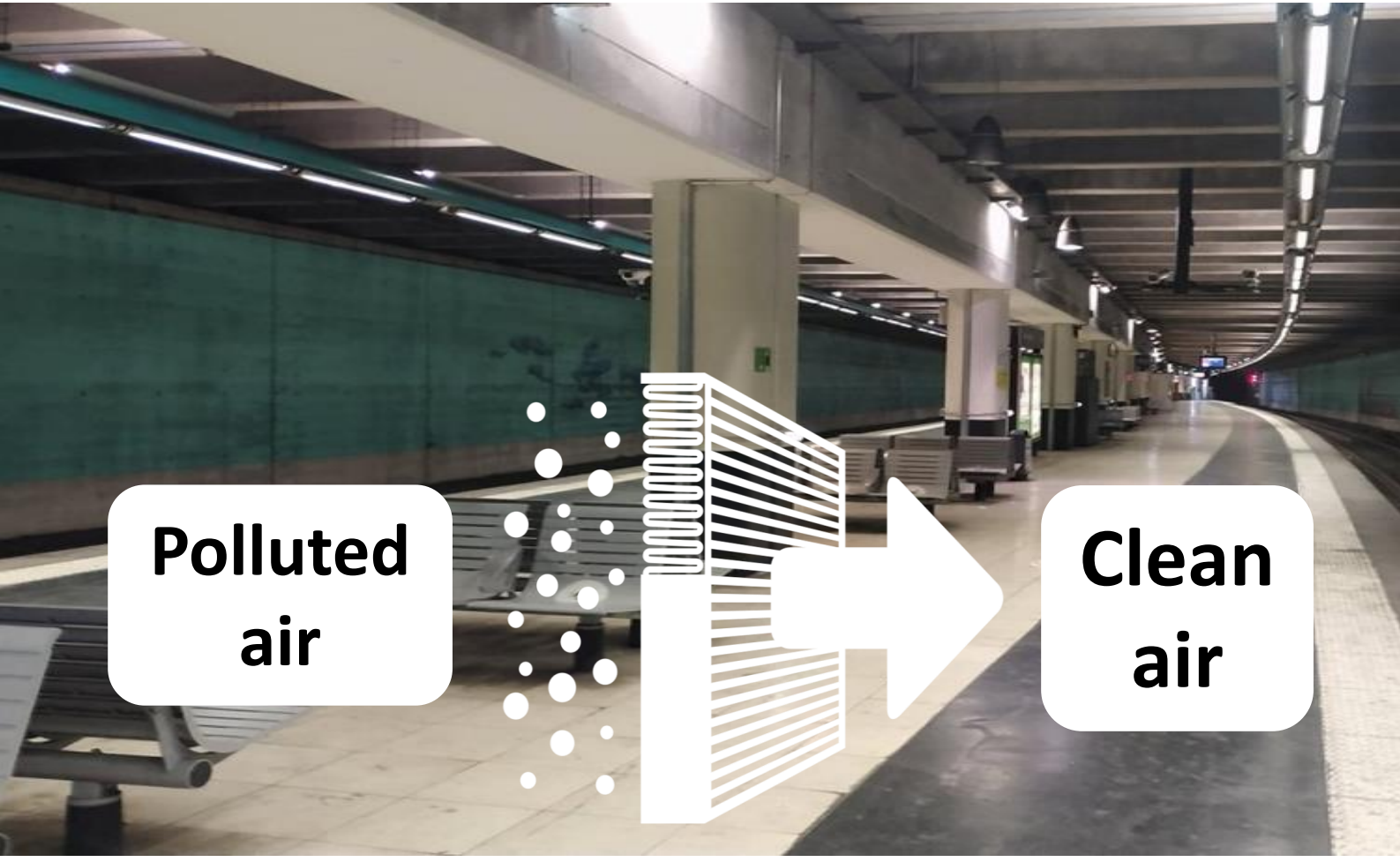
³ AREP L'hypercube, 16 avenue d'Ivry, 75013 Paris, France

⁴ SNCF Holding, 2 Place aux Etoiles, 93210 Saint-Denis, France



Introduction

Air quality in underground railway stations (URS) poses a significant public health challenge due to high particulate matter (PM) concentrations which exceed both outdoor air levels close to the station^[1] and the thresholds set by the WHO^[2]. The French railway company, SNCF, is addressing this issue by testing filtration systems in URS.



How can we assess filtration systems effectiveness within URS?

Instrumentation and dataset



- 2 TEOMs: one for PM₁₀ and the other for PM_{2.5}
- 12/04/2018 – 31/12/2022
- RER train line

Experiment 1: Positive ionization method (2019)

Experiment 2: Wet method (2020)



Data analysis methods

M1

Daily Amplitude Coefficient (DAC)

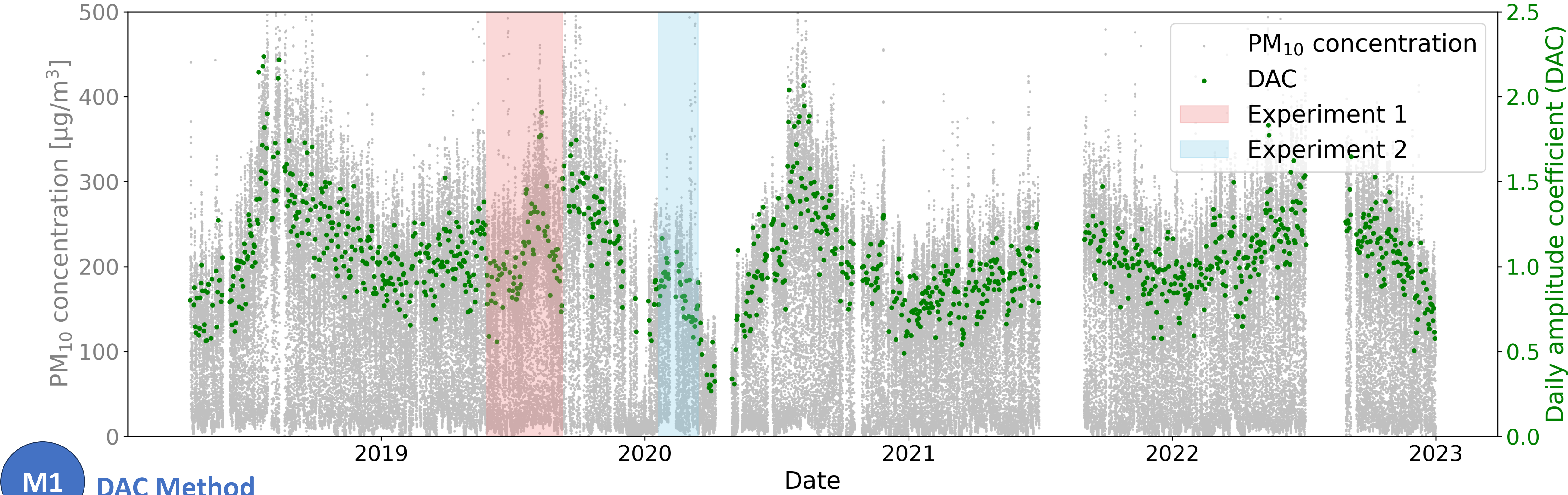
Using the methodology outlined in **POSTER M-Aerosols-126** to establish typical time profiles of PM concentrations in URS, we compare the daily amplitude coefficient (DAC) between a year with particle depollution experiment and a year without such an experiment, so as to take into account the annual variations in PM concentrations.

M2

LSTM (Long Short-Term Memory) model

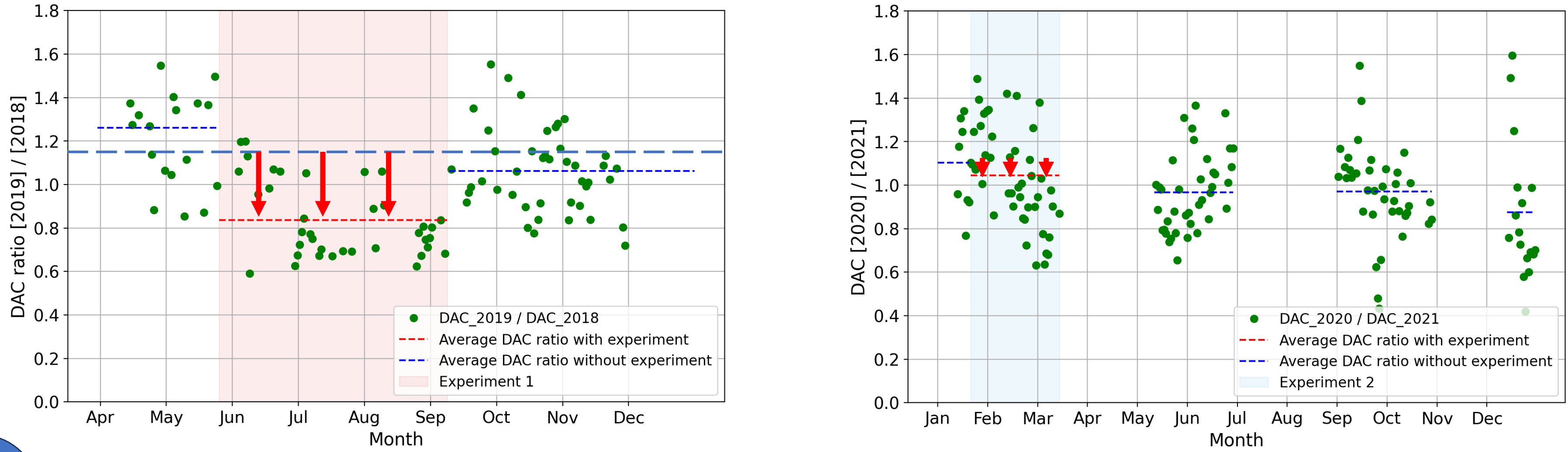
In our AI-based analysis^[3] of the initial days of the experiment, we compare the PM concentrations from the first two days of the experiment with those of the actual measurements.

Results



M1

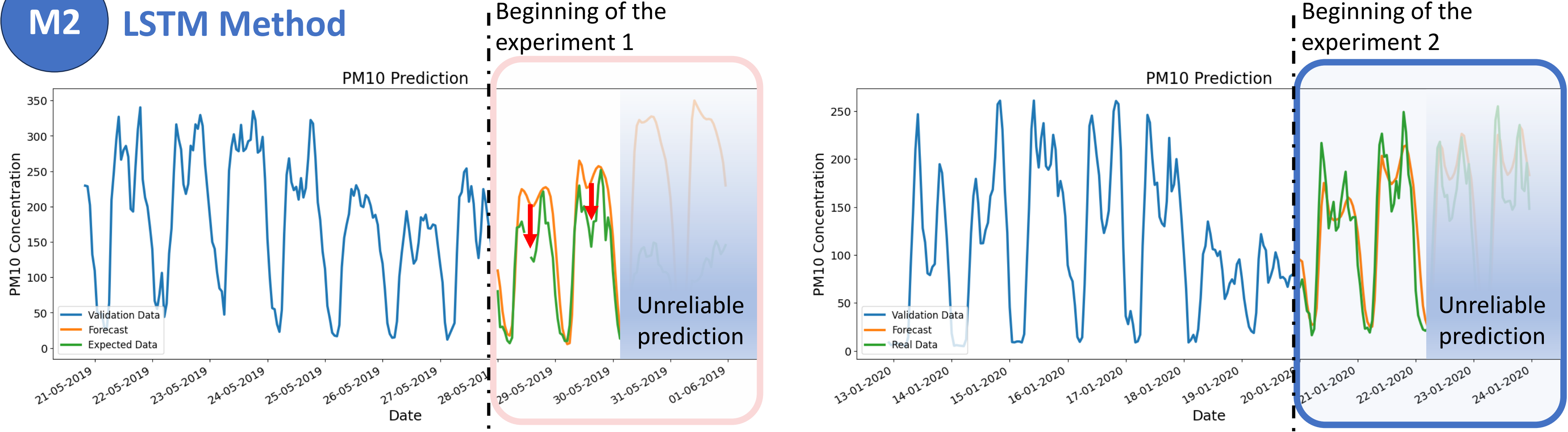
DAC Method



- Experiment 1: a significant 30% ± 9% reduction in PM₁₀ levels observed.
- Experiment 2: No observable reduction noted.

M2

LSTM Method



- Experiment 1: a 30% ± 1% reduction in PM₁₀ levels is expected starting from the 1st day of the experiment.
- Experiment 2 : No reduction in PM₁₀ levels is anticipated.

Conclusions

- DAC method: a posteriori evaluation over the entire period of the experiment.
- LSTM method: near real-time evaluation of the efficiency of the filtration system.
- Same reduction observed for both short-term and long-term analyses.
- Both methods require at least one year of data to produce reliable results (before/after for the DAC and pre-experimental data for the LSTM).
- No conclusion can be drawn regarding the distance at which the filtration system remains effective.

References

- [1] Passi, A., Nagendra, S.M.S., Maiya, M.P., Characteristics of indoor air quality in underground metro stations: A critical review, 2021. <https://doi.org/10.1016/j.buildenv.2021.107907>
- [2] World Health Organization, WHO global air quality guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide: executive summary, World Health Organization, 2021. <https://iris.who.int/handle/10665/345334>
- [3] Rahmani et al., PM FORECAST: Leveraging Temporal LSTM to Deliver In situ Air Quality Predictions, 2024 (Under review)

Acknowledgments

- Valisoa Rakotonirinjahanahary acknowledges SNCF for funding this work (ANRT CIFRE PhD grant n°2021/0856).
- Authors are grateful to AIRPARIF for conducting data collection.
- This work is a contribution to the Institut de Recherches Pluridisciplinaires en Sciences de l'Environnement (IrePSE Fed 4129), to the LabEx CaPPA project funded by the French National Research Agency under contract « ANR-11-LABX-0005-01 » and to the CPER research project ECRIN funded by the French Ministère de l'Enseignement Supérieur et de la Recherche. The authors thank the Regional Council « Hauts-de-France » and the « European Regional Development Fund » for their financial support to these projects."

