PFAS in ambient air: initial quantitative data and evidence of atmospheric transfer from industrial sources

Exploratory study of the Lyon metropolitan area revealing a contamination gradient and specific chemical signatures of emissions

Speaker

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Emerging Contaminants Project Manager

Atmo-AuRA

17/06/2026

Timeline

30min

1. Context and objectives
2. Measurements campaign
3. Results
4. Conclusions and further perspectives
5. Time for questions

CONTEXT AND OBJECTIVES

Atmo AuRA → Who are we?

AURA's unique features and the Lyon metropolitan area

Atmo AuRA: A nationally coordinated network

6 Atmo hubs
in Auvergne-Rhône-Atlpes

The **Approved Air Quality Monitoring Associations** (AASQA) are non-profit organizations (governed by the French law of 1901) approved by the Prefects for monitoring and providing information on air quality in the various French regions. They are grouped within the **Atmo France federation**.

In Auvergne-Rhône-Alpes

votre parten'air Atmo AUVERGNE-RHÔNE-ALPES

4 COLLEGES *(STATE, LOCAL AUTHORITIES, BUSINESS SECTOR, ASSOCIATIONS AND QUALIFIED INDIVIDUALS)*

245 MEMBERS

MORE THAN **80** THEMATIC PARTNERS

This governance model provides citizens with a **guarantee of transparency and independence in the processing and dissemination of information** relating to air quality.

Atmo AuRA: Working towards a better air quality

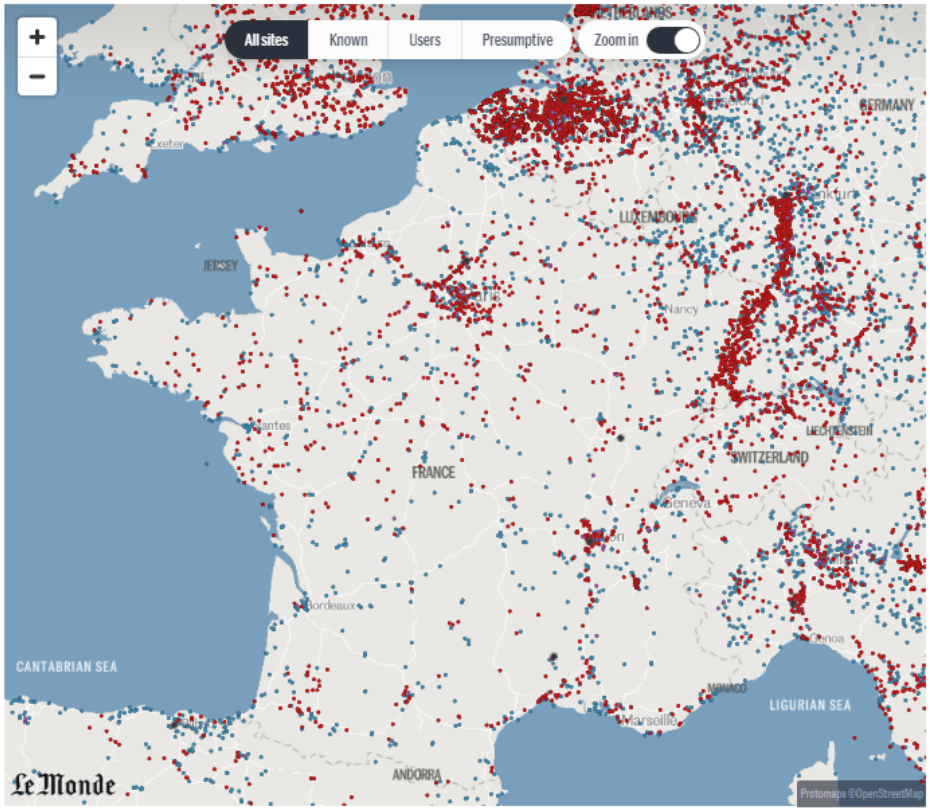
- **Monitor and report** on the regulatory air quality status of the Auvergne-Rhône-Alpes region.
- **Support decision-makers** in developing and monitoring action plans aimed at improving air quality.
- Provide technical support to members and diagnostic information in **emergency situations** : pollution episodes, industrial incidents or accidents.
- Improve **knowledge** on atmospheric pollution phenomena.
- **Encourage action** to improve air quality.
- **Anticipate** future monitoring needs by addressing emerging challenges (science, territorial demands, societal issues…)

KEY FIGURES

The shared observatory costs €1/inhabitant
(of which ¾ dedicated to regulatory monitoring)
Knowledge improvement : €0.30/inhabitant

Atmo AuRA: Pollutant monitoring

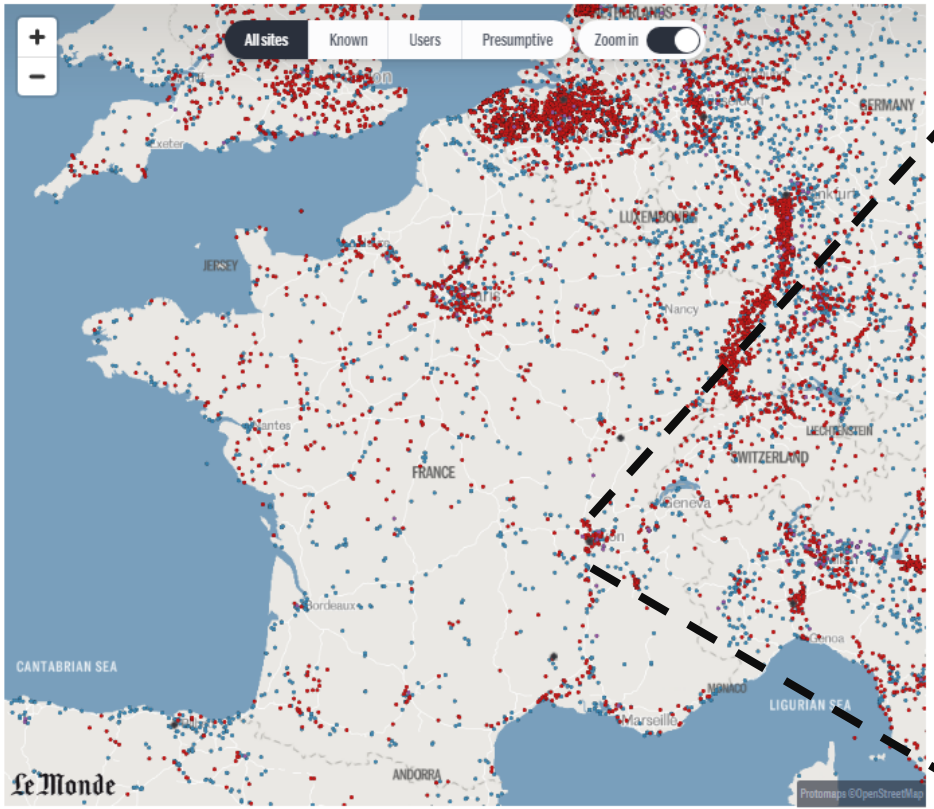
AURA's unique features and the Lyon metropolitan area

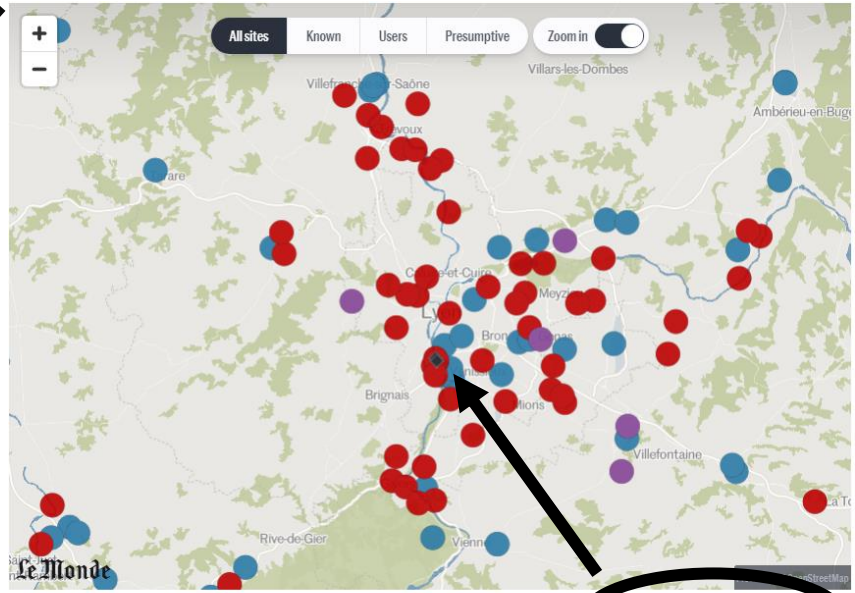


« In early 2023, the Forever Pollution Project showed that nearly 23,000 sites all over Europe are contaminated by the "forever chemicals" PFAS. This unique collaborative, cross-border and cross-field investigation by 16 European newsrooms revealed an additional 21,500 presumptive contamination sites due to current or past industrial activity. PFAS contamination spreads all over Europe »

Source: Forever Pollution Project

AURA's unique features and the Lyon metropolitan area





Known contamination · Known PFAS User · Presumptive contamination · PFAS manufacturing facility

Source: Forever Pollution Project

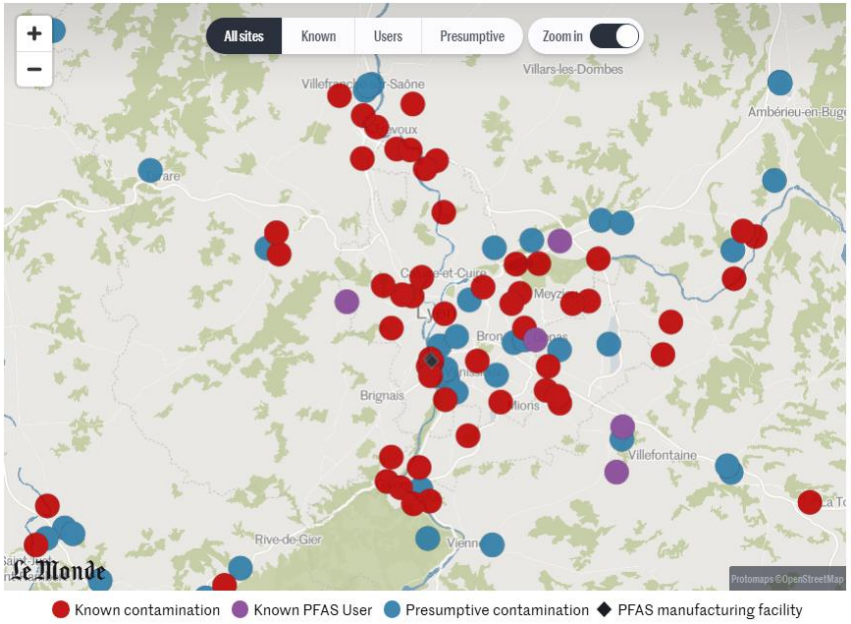
Source: Forever Pollution Project

AURA's unique features and the Lyon metropolitan area

Atmo AuRA commitment to address the concerns of the territory, and its citizens by adopting a scientific and neutral approach, in accordance with our internal regulations.

- An issue at the top of public and local government concerns.
- Efforts that are proving difficult to establish at international and national levels, particularly regarding ambient air : Interministerial Plan 2023–2027 : ambient air component in the final stage of investigation.
- ANSES* referral in 2024, requiring a reference method to be established beforehand
- Decree requiring PFAS measurements in atmospheric emissions from incinerators

National Agency for Food, Environmental and Occupational Health & Safety



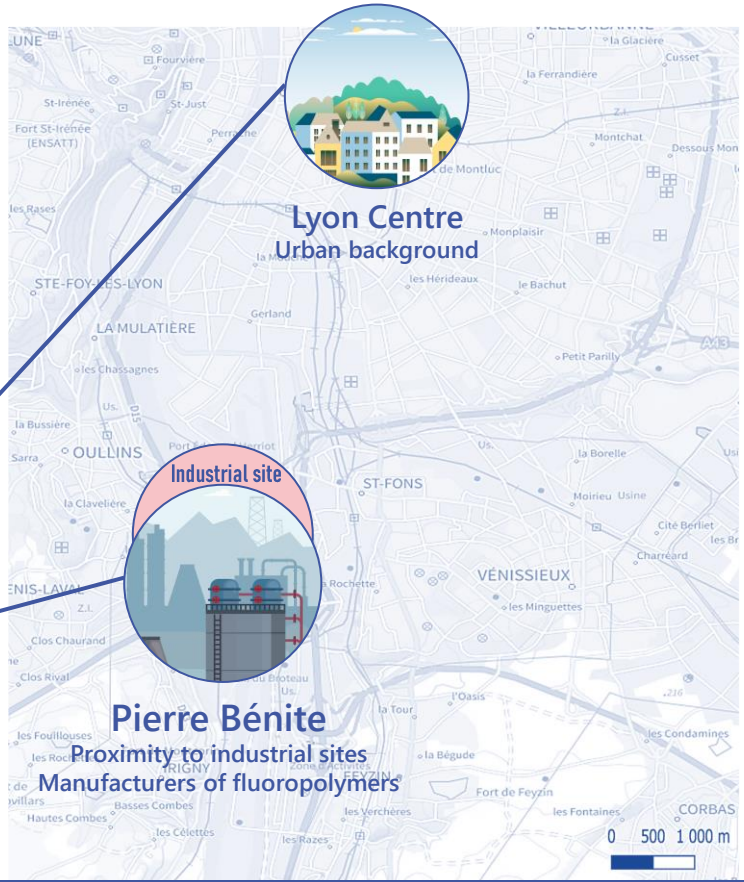
Source: Forever Pollution Project

MEASUREMENTS CAMPAIGN

Sampling sites and substances

Sampling sites

Active PFAS ambient air measurements in Auvergne-Rhône-Alpes were conducted at a location where PFAS were highly likely to be found and compared to an urban background site



Measurements' location for the first methodological tests

Sampling sites

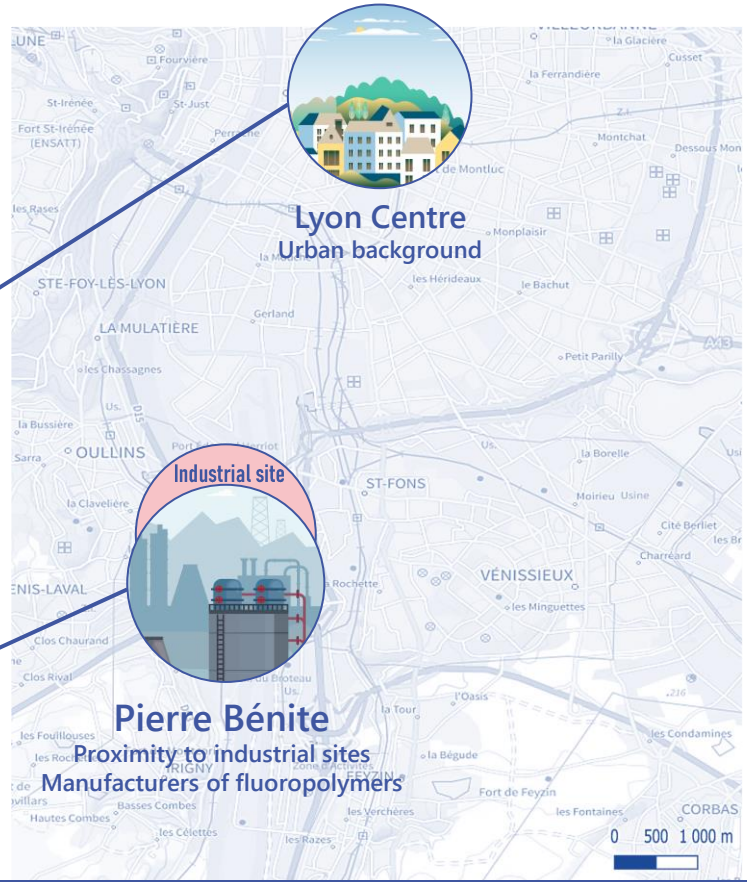
Sampling was performed from October 2023 until December 2025 during different campaigns and seasons

17 ACTIVES PRELEVEMENTS of 96 hours

26/10/2023 – 02/12/2025

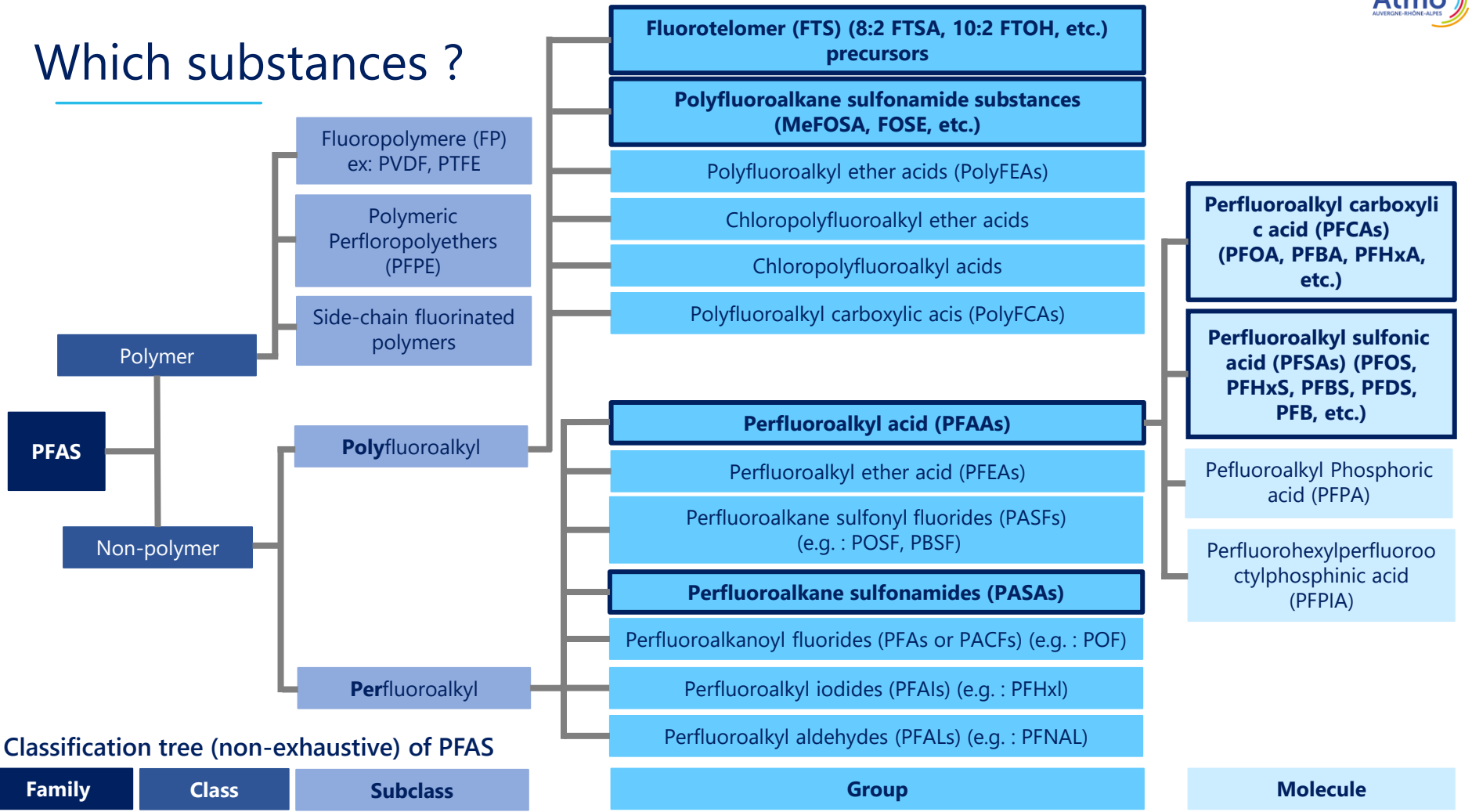
26 ACTIVES PRELEVEMENTS of 96 hours

26/10/2023 – 02/12/2025



Measurements' location for the first methodological tests

Which substances ?



Classification tree (non-exhaustive) of PFAS

Family	Class	Subclass	Group	Molecule

Which substances ?

38 PFAS substances
36 compounds from the **US standard OTM-45**
25 compounds targeted in the **European Directive 2020/2184** on the quality of water intended for human consumption

50 Substances of the OTM-45			
Class	**Common name**	**Full name**	**CAS Number**
PFCAs (Perfluoroalkylcarboxylic acids)	**PFBA**	Perfluorobutanoic acid	375-22-4
	PFPeA	Perfluoropentanoic acid	2706-90-3
	PFHxA	Perfluorohexanoic acid	307-24-4
	PFHpA	Perfluoroheptanoic acid	375-85-9
	PFOA	Perfluorooctanoic acid	335-67-1
	PFNA	Perfluorononanoic acid	375-95-1
	PFDA	Perfluorodecanoic acid	335-76-2
	PFUnDA	Perfluoroundecanoic acid	2058-94-8
	PFDoA	Perfluorododecanoic acid	307-55-1
	PFTrDA	Perfluorotridecanoic acid	72629-94-8
	PFTeDA	Perfluorotetradecanoic acid	376-06-7
	PFHxDA	Perfluoro-n-hexadecanoic acid	67905-19-5
	PFODA	Perfluoro-n-octadecanoic acid	16517-11-6
PFSAs (Perfluorinated sulfonic acids)	**PFBS**	Perfluoro-1-butanesulfonic acid	375-73-5
	PFPeS	Perfluoro-1-pentanesulfonic acid	2706-91-4
	PFHxS	Perfluoro-1 -hexanesulfonic acid	355-46-4
	PFHpS	Perfluoro-1-heptanesulfonic acid	375-92-8
	PFOS	Perfluoro-1-octanesulfonic acid	1763-23-1
	PFNS	Perfluoro-1-nonanesulfonic acid	68259-12-1
	PFDS	Perfluoro-1-decanesulfonic acid	335-77-3
	PFDoS	Perfluorododecane sulfonate	79780-39-5

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50 Substances of the OTM-45

Class	Common name	Full name	CAS Number
FOSAs (Perfluorinated sulfonamides)	**FOSA**	Perfluoro-1-octanesulfonamide	754-91-6
	MeFOSA	N-Methylperfluorooctanesulfonamide	31506-32-8
	EtFOSA	N-ethylperfluorooctanesulfonamide	4151-50-2
FOSEs (Perfluorinated sulfonamide ethanols)	**N-MeFOSE**	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	24448-09-7
	N-EtFOSE	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	1691-99-2
FOSAAs (Perfluorinated sulfonamidoacetic acids)	**MeFOSAA**	N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9
	EtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6
FTS (Fluorotelomer sulfonates)	**4:2 FTS**	1H,1H,2H,2H-Perfluorohexane sulfonic acid	757124-72-4
	6:2 FTS	1H,1H,2H,2H -Perfluorooctane sulfonic acid	27619-97-2
	8:2 FTS	1H,1H,2H,2H -Perfluorodecane sulfonic acid	39108-34-4
	10:2 FTS	1H,1H,2H,2H-perfluorododecane sulfonate (10:2)	120226-60-0
Fluorinated Replacement Chemicals	**ADONA1**	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4
	HFPO-DA / GenX	Hexofluoropropylene oxide dimer acid	13252-13-6
	F-53B Major / 9Cl-PF3ONS	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1 / 73606-19-6 (sel)
	F-53B Minor / 11Cl-PF3OUdS	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9 / 83329-89-9 (sel)
Additionnal Targets	NFDHA	Nonafluoro-3,6-dioxaheptanoic acid	151772-58-6
	PFEESA	Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7
	PFDoS	Sodium perfluoro-1-dodecanesulfonate	1260224-54-1
	PFMBA	Perfluoro-4-methoxybutanoic acid	863090-89-5
	PFMPA	Perfluoro-3-methoxypropanoic acid	377-73-1
	PFecHS	Decafluoro-4-(pentafluoroethyl)cyclohexanesulfonate)	67584-42-3
	8:2 FTUCA or FOUEA	2H-perfluoro-2-decenoic acid	70887-84-2
	10:2 FDEA	2-perfluorodecyl ethanoic acid	53826-13-4
	8:2 FTA or FOEA	2-perfluorooctyl ethanoic acid	27854-31-5
	6:2 FHUEA	2H-perfluoro-2-octenoic acid	70887-88-6
	6:2FTCA or 6:2 FHEA	2-perfluorohexyl ethanoic acid	53826-12-3
	3:3 FTCA	3:3 Fluorotelomer carboxylic acid	356-02-5
	5:3 FTCA	5:3 Fluorotelomer carboxylic acid	914637-49-3
	7:3 FTCA or FHpPA	7:3 Fluorotelomer carboxylic acid or 3-perfluoropheptyl propanoic acid	812-70-4

Which substances ?

38 PFAS substances
36 compounds from the **US standard OTM-45**
25 compounds targeted in the **European Directive 2020/2184** on the quality of water intended for human consumption

List of the 20 substances targeted by the European Drinking Water Directive of December 16, 2020 + The 8 additional compounds recommended in the decree of June 20, 2023

Class	Common name	Full name	CAS Number
PFCAs (Perfluoroalkylcarboxylic acids)	0	Acide perfluorobutanoïque	375-22-4
	PFPeA	Acide perfluoropentanoïque	2706-90-3
	PFHxA	Acide perfluorohexanoïque	307-24-4
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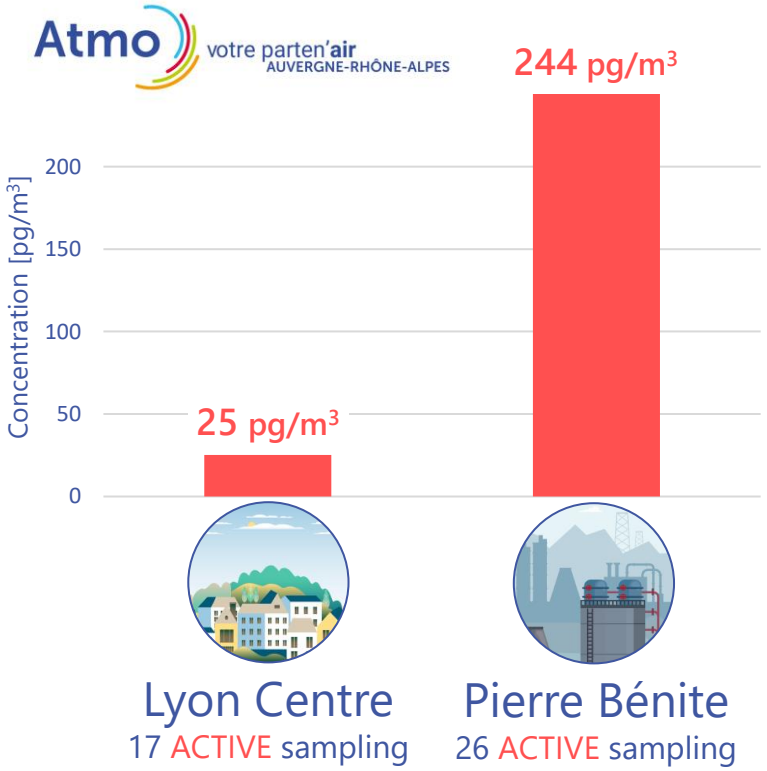
	PFDS	Acide perfluorodécane sulfonique	335-77-3
	PFUndS, PFUDaS, PFUnDa	Acide perfluoroundécane sulfonique	749786-16-1
	PFDodS	Acide perfluorododécane sulfonique	79780-39-5
	PFTrS ; PFTrDA ; PFTDaS	Acide perfluorotridécane sulfonique	791563-89-8
Fluorinated Replacement Chemicals	HFPO-DA (Gen X)	Ammonium perfluoro (2-methyl-3-oxahexanoate)	13252-13-6 (62037-80-3)
	DONA ; ADONA	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4 (958445-44-8)
Additionnal Targets	C6O4	Perfluoro([5-methoxy-1,3-dioxolan-4-yl]oxy) acetic acid	1190931-27-1 (1190931-41-9)
Fluorotelomeric alcohols	6:2 FTOH	2-perfluorohexyl ethanol (6 : 2)	647-42-7
	8:2 FTOH	2-perfluorooctyl ethanol (8 : 2)	678-39-7

RESULTS

Main results

PFAS concentrations measured in ambient air

Ambient air concentrations in pg/m³
- Average* of the sum of 38 PFAS -



PFAS have been detected in both environments (industrial and urban).

The first active measurements of PFAS in ambient air show concentrations in the range of tens of picograms (pg) in central Lyon and hundreds of pg in Pierre Bénite, 10 times more.

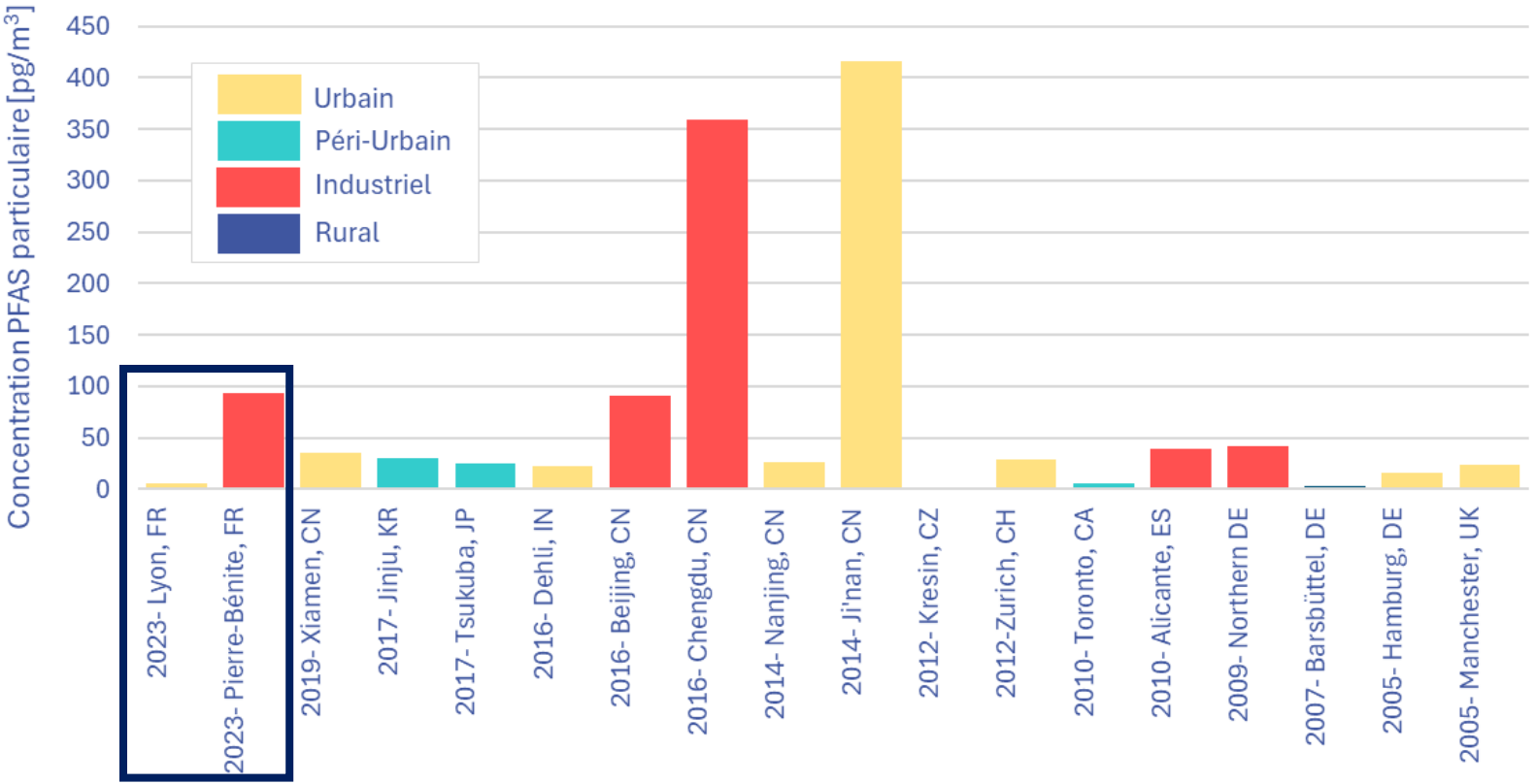
Particulate and gaseous phases – Measurement uncertainty ~ 50%.

Average based on a very limited number of measurement results

Further data is needed to obtain a representative estimate of average exposure.

PFAS concentrations measured in ambient air

Comparison of PFAS levels in the particulate phase relative to the literature, adapted from Faust 2023



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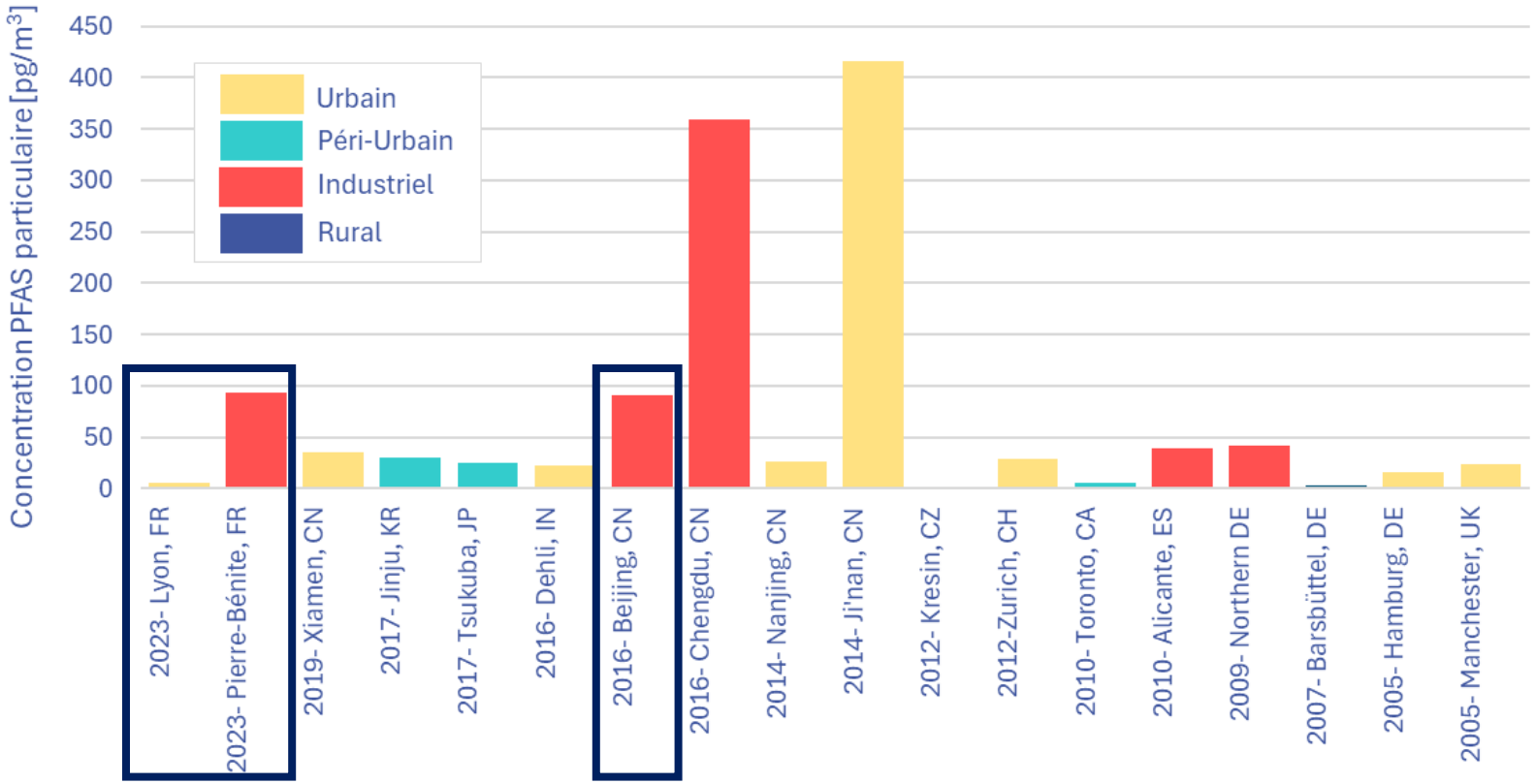
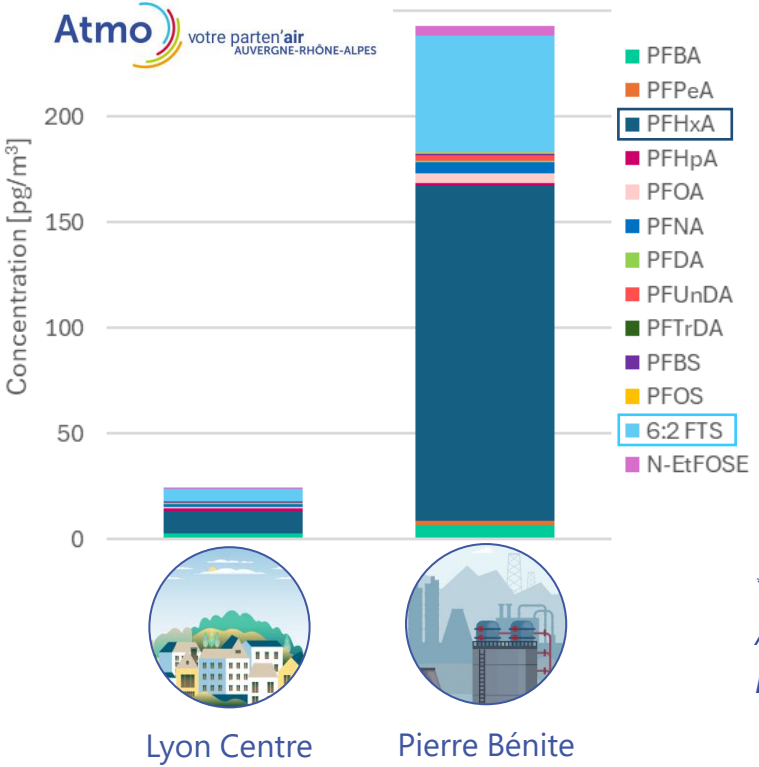


PFAS concentrations measured in ambient air

PFAS concentrations measured above the detection limit in ambient air - Average* per PFAS in pg/m³



The initial results show a predominance of 6:2FTS and PFHxA, as well as the presence of banned PFAS: PFOA and PFOS.

*Particulate and gaseous phases – Measurement uncertainty ~ 50%.

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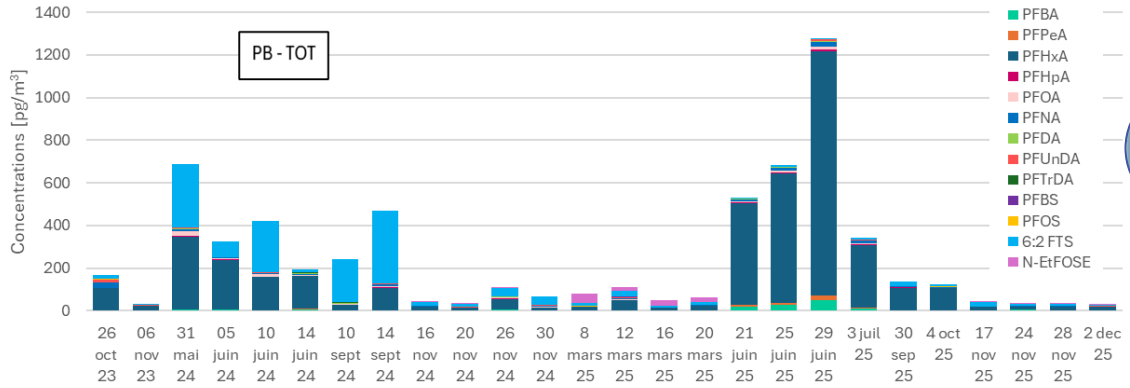
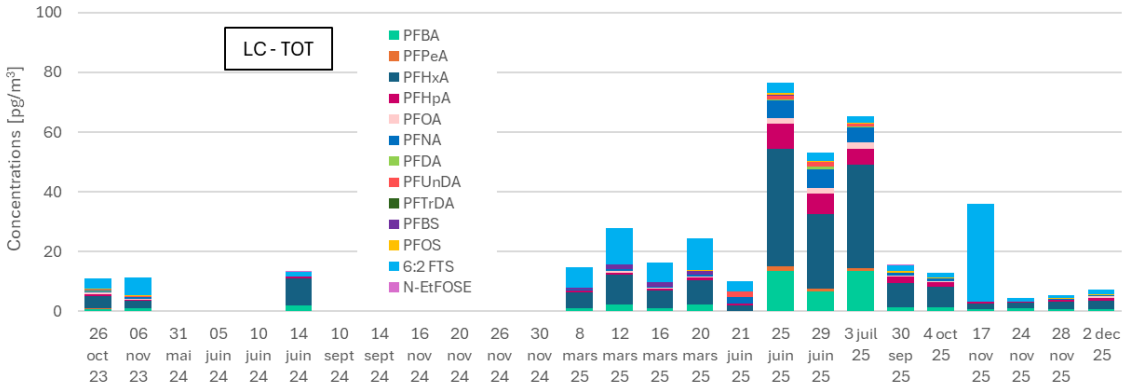
Further data is needed to obtain a representative estimate of average exposure.

PFAS concentrations measured in ambient air
PROFILE OF DETECTED SUBSTANCES



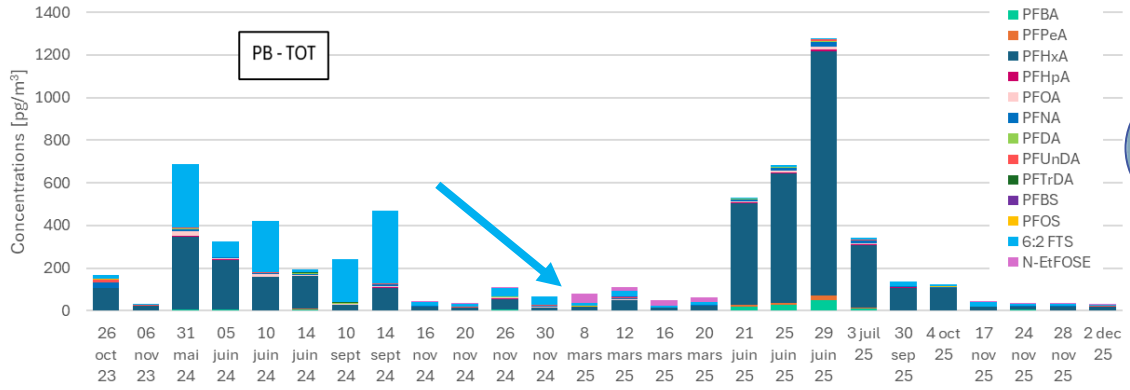
Pierre Bénite

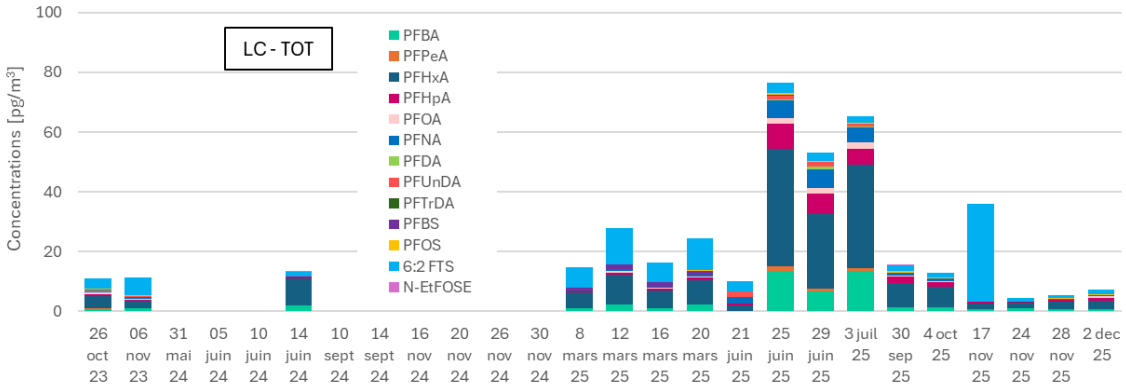


Lyon Centre

- Predominance of **6:2FTS** and **PFHxA**, (both sites)
- Presence of banned PFAS: **PFOA** and **PFOS** (both sites)
- 13 compounds predominantly detected with predominance of the PFCA class.

PFAS concentrations measured in ambient air
PROFILE OF DETECTED SUBSTANCES





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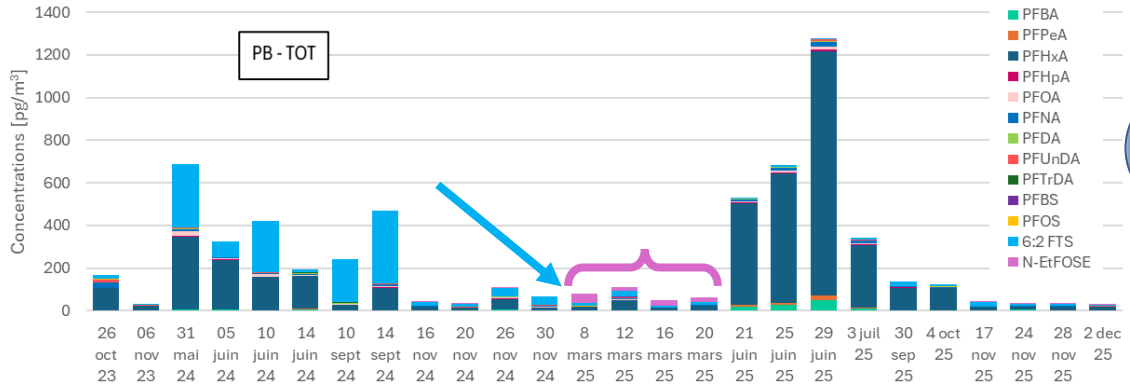
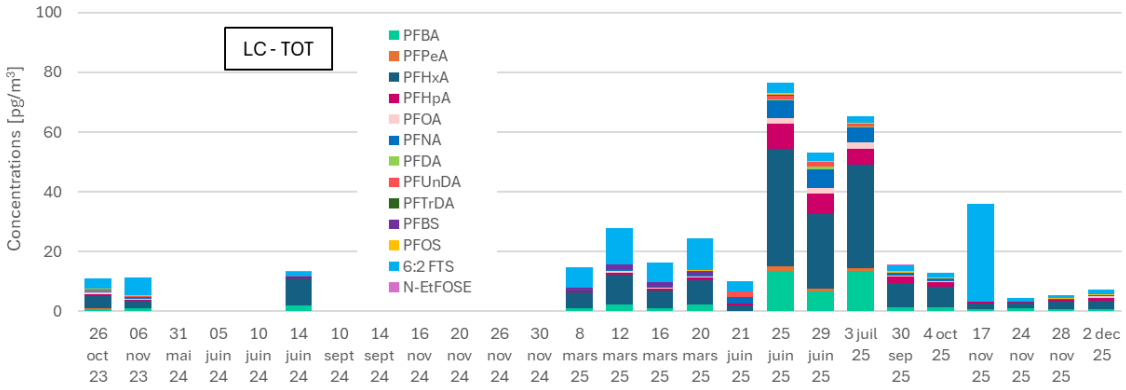
PFAS concentrations measured in ambient air
PROFILE OF DETECTED SUBSTANCES





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- **N-EtFose** appears in significant quantities in March 2025.

PFAS concentrations measured in ambient air
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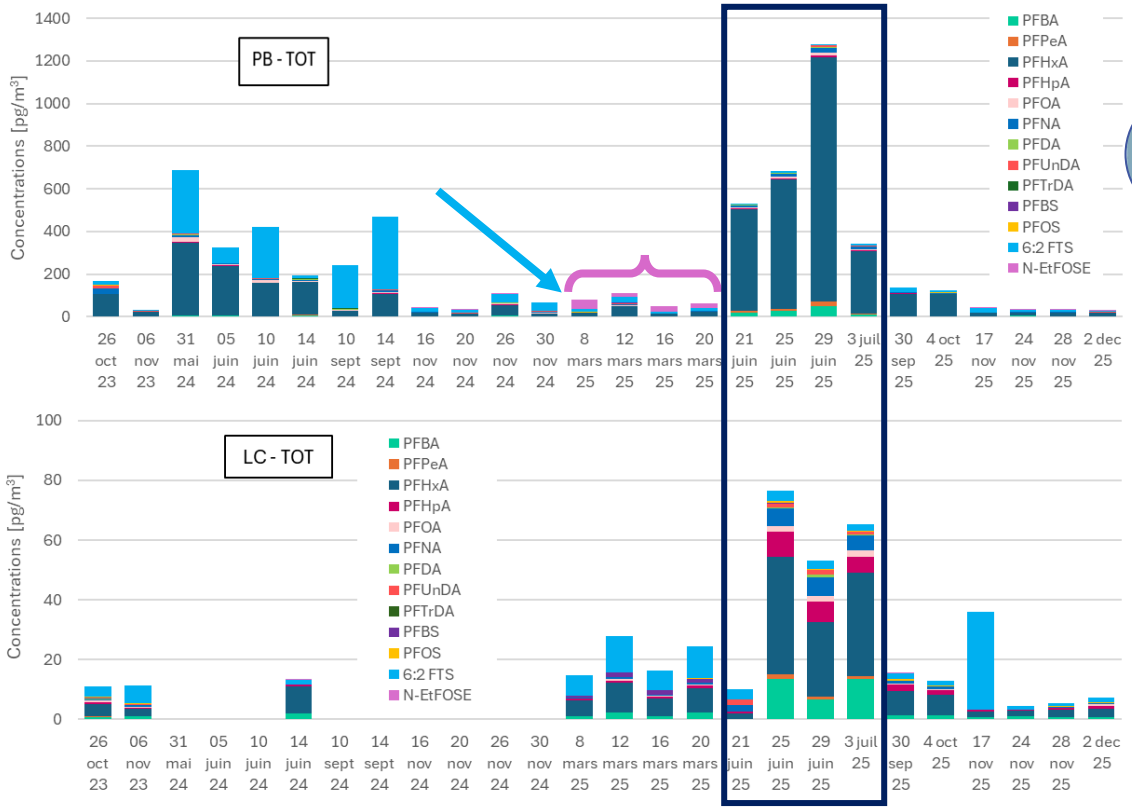

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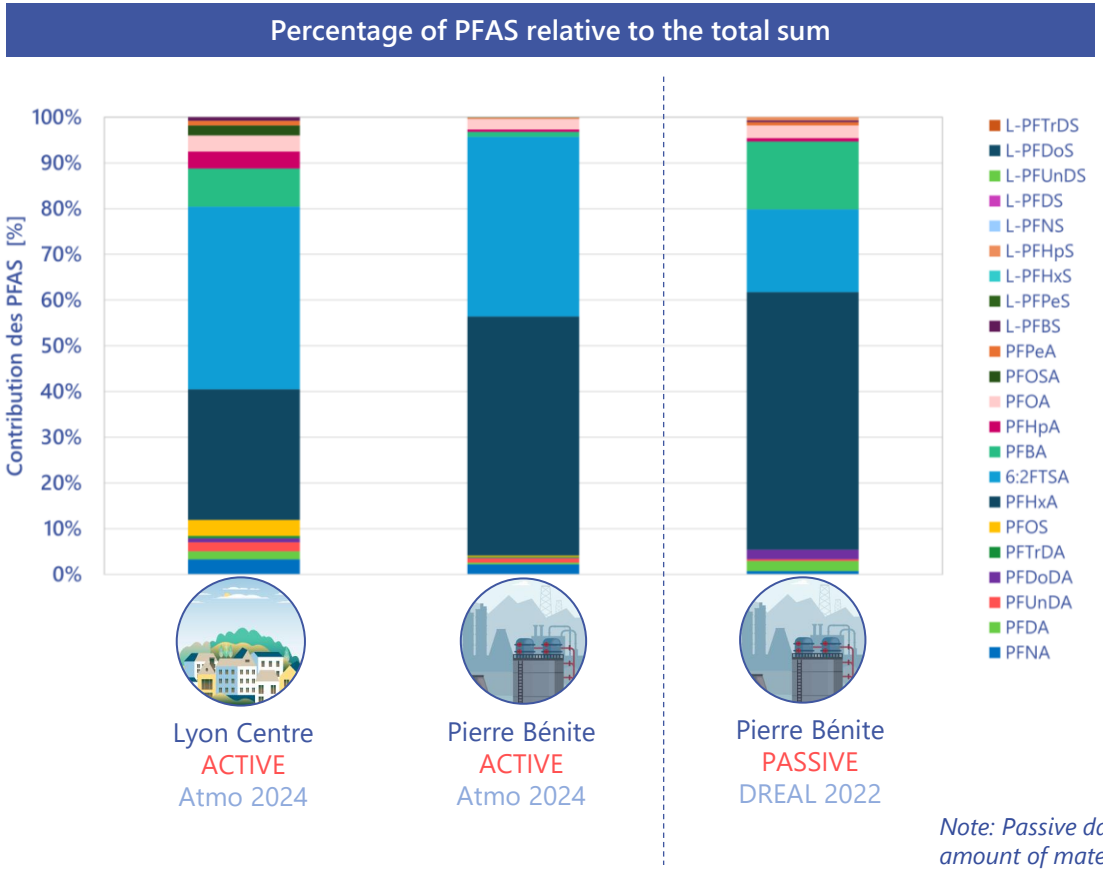
- In Pierre-Bénite, **6:2FTS** levels drop starting in early 2025 in connection with production changes made by one of the manufacturers.
- **N-EtFose** appears in significant quantities in March 2025.
- Profiles in June 2025 are quite different with higher levels (both sites).

Comparison of active and passive profiles

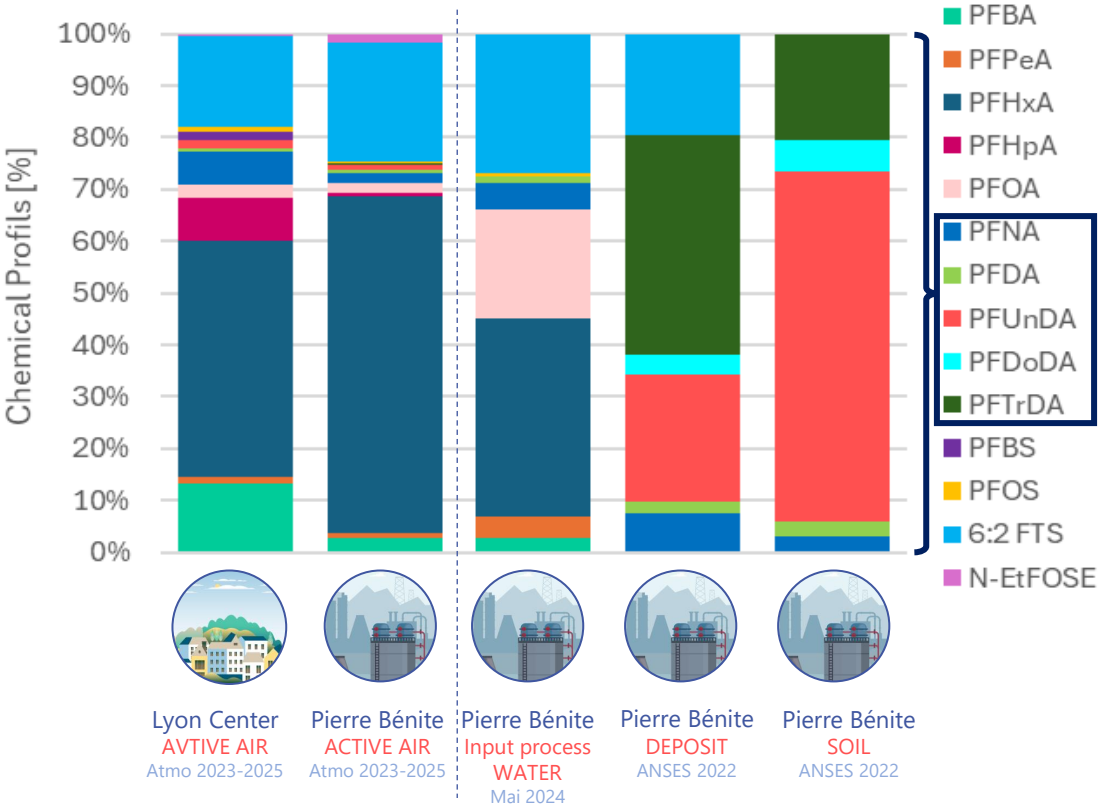


The analysis shows a high degree of consistency between the chemical profiles obtained through active and passive sampling, with the presence of the same major compounds **PFHxA** and **6:2FTSA** ; and banned PFAS: **PFOA** and **PFOS** in varying proportions.

Note: Passive data do not provide atmospheric concentrations, but rather the amount of material.

Comparison of air and soil matrix measurements

Percentage of PFAS relative to the total sum

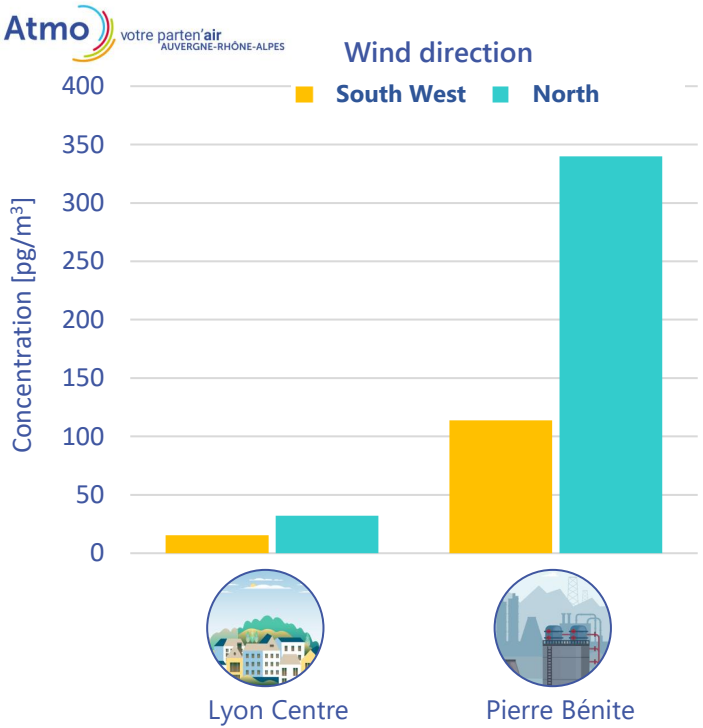


- The chemical profiles of sediments and soils differ from those measured in ambient air → the substances in the air do not originate from the resuspension of substances initially present in the soil or sediments.
- PFAS soil are among the longer-chain compounds (>C8 lower volatility).
- Air and water profiles quite similar linked to the solubility of the substances

PFAS concentrations measured in ambient air

Wind influence

Ambient air concentrations in pg/m³
- Average* of the sum of 38 PFAS -



- In Lyon Centre, wind do not have a significant impact on the measured PFAS levels.
- In contrast, in Pierre-Bénite, north wind have a noticeable impact, leading to an increase in the measured concentrations.

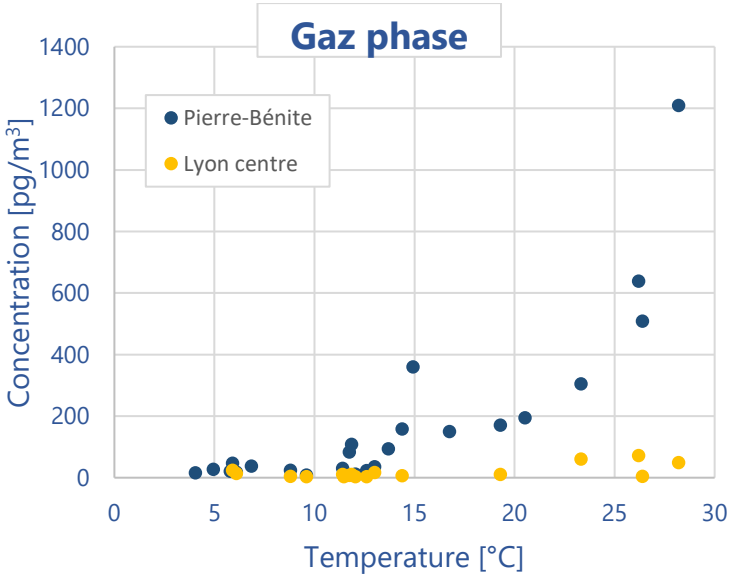
Particulate and gaseous phases – Measurement uncertainty ~ 50%.

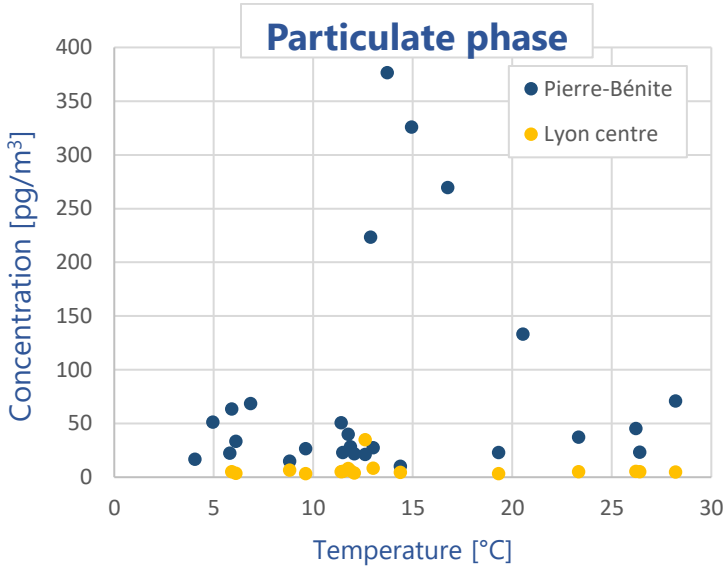
Average based on a very limited number of measurement results

Further data is needed to obtain a representative estimate of average exposure.

PFAS concentrations measured in ambient air

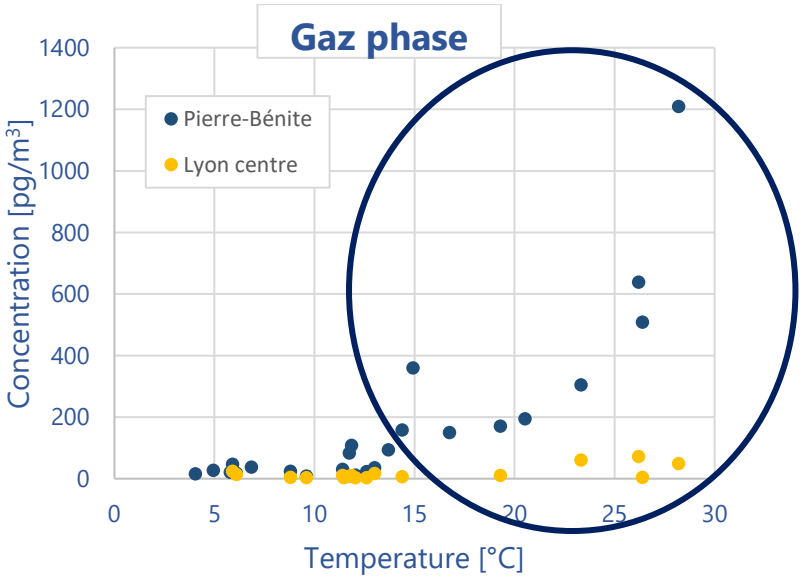
Temperature influence

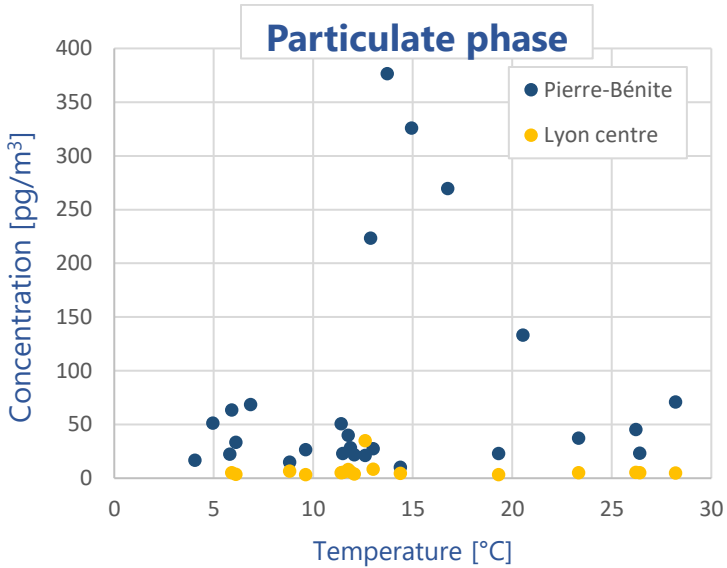




PFAS concentrations measured in ambient air

Temperature influence

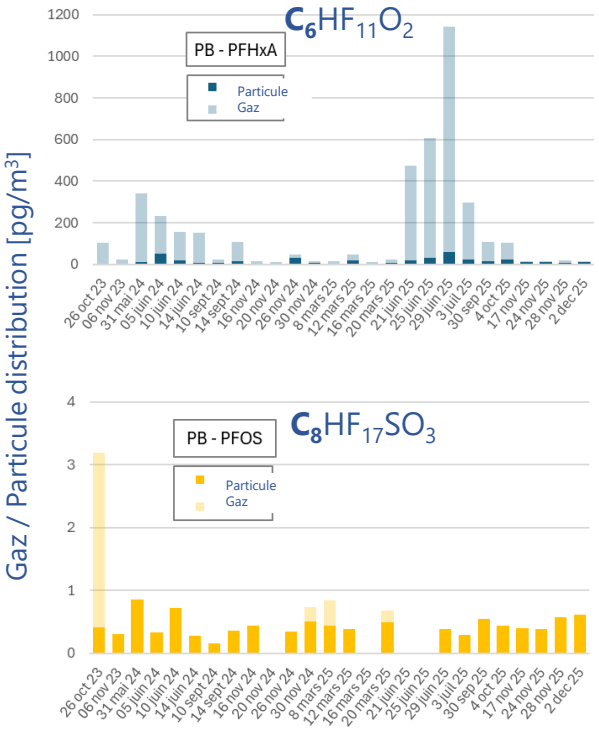


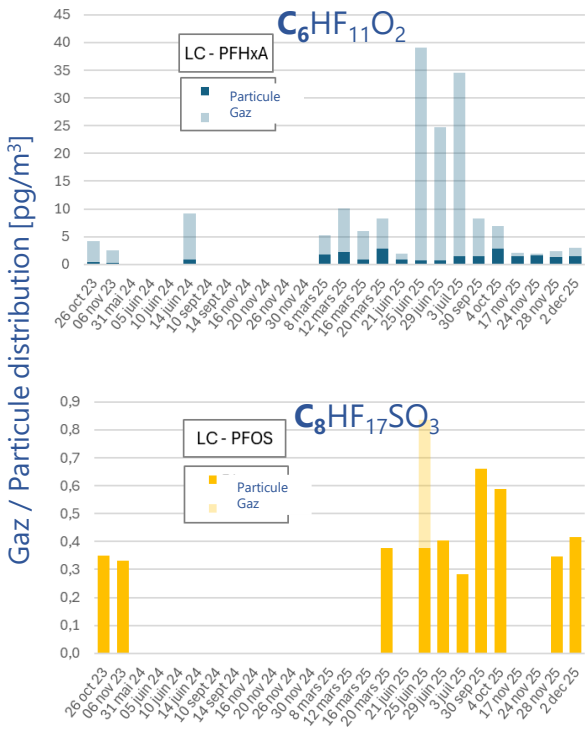


increase in gas-phase concentrations as temperature rises

PFAS concentrations measured in ambient air

Distinction between the gas phase and the particulate phase





PFAS exhibit a gas/particle phase distribution depending on their volatility :

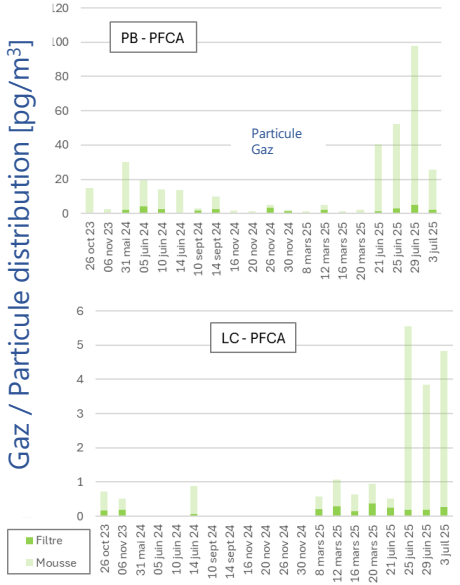
- related to chain length
- type of molecular function

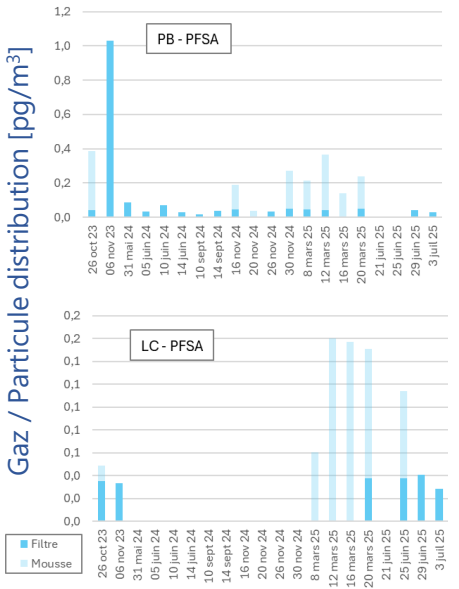
Usually :

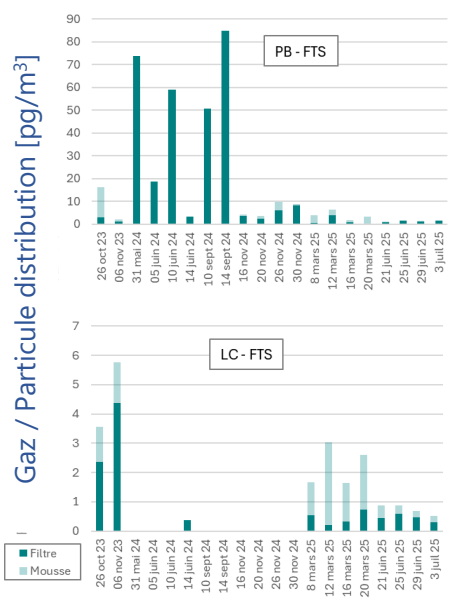
- Shorter and neutral molecules predominantly found in the gas phase
- Longer and ionized molecules associated with particles.
- PFCAs and PFSAs with C>6 tend to exist predominantly in the particulate phase,
- PFAS with C<6 and FTOH with 2<C<5 are more frequently detected in the gas phase.

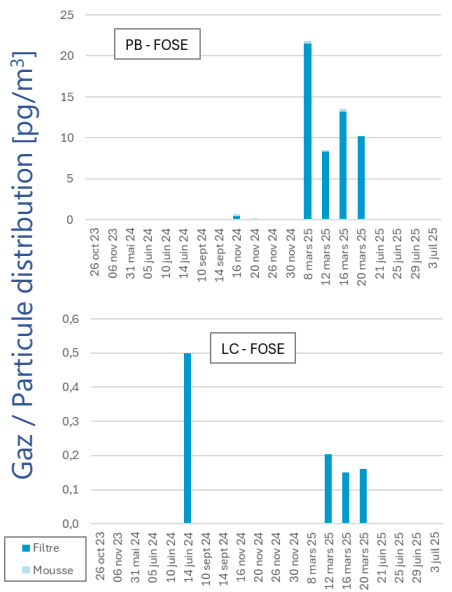
PFAS concentrations measured in ambient air

Distinction between the gas phase and the particulate phase









At both sites majority of :

- PFCA with C< 8
- PFSA with C < 6

- FOSE C = 8 → particulate phase
- FTS : At PB C > 8 and LC majority of C < 8

CONCLUSIONS AND FURTHER PERSPECTIVES

Take home message

Pioneering Data: First active quantitative measurements of PFAS in ambient air in France. Substances ubiquity : significant concentrations were measured both in industrial settings (Pierre-Bénite, ~244 pg/m^3) and in urban background areas (Lyon Center, ~25 pg/m^3), confirming widespread atmospheric contamination.

Gradient Validation: Clear link established between industrial fluoropolymer production and local air quality.

Signature Markers: 6:2 FTS identifies specific industrial sources, while PFOA/PFOS remain as persistent legacy contaminants.

Meteorological Drivers: Wind direction and temperature are critical variables for exposure modeling and risk assessment

What's next ?

Continued work: expand sample collection to study seasonal variations at the same monitoring sites. These additional data will aim to help reduce uncertainties related to inhalation exposure and better understand the influence of weather conditions and industrial activities.

Standardisation: AFNOR and EU methods harmonization. Ongoing intercomparisons with **INERIS** aim to harmonized active sampling protocols within the interministerial PFAS plan in France.

Project PFAhiStory: Reconstructing the Past – Long-term Retrospective Analysis

Funded by ADEME, PFAhiStory aims to reconstruct historical contamination trends through retrospective analysis of atmospheric particulate filters (in link with CARA program).

Future Frontiers: Toxic Gaseous PFAS -Beyond the Particle Phase

Volatility leads to higher long-range transport potential and widespread human exposure via inhalation.

Compound	Key Properties
FTOHs	Highly volatile fluorotelomer alcohols; dominant in air.
TFA	Highly mobile and persistent

TIME FOR QUESTIONS

To go further, the complete report is available online :

In French

In English