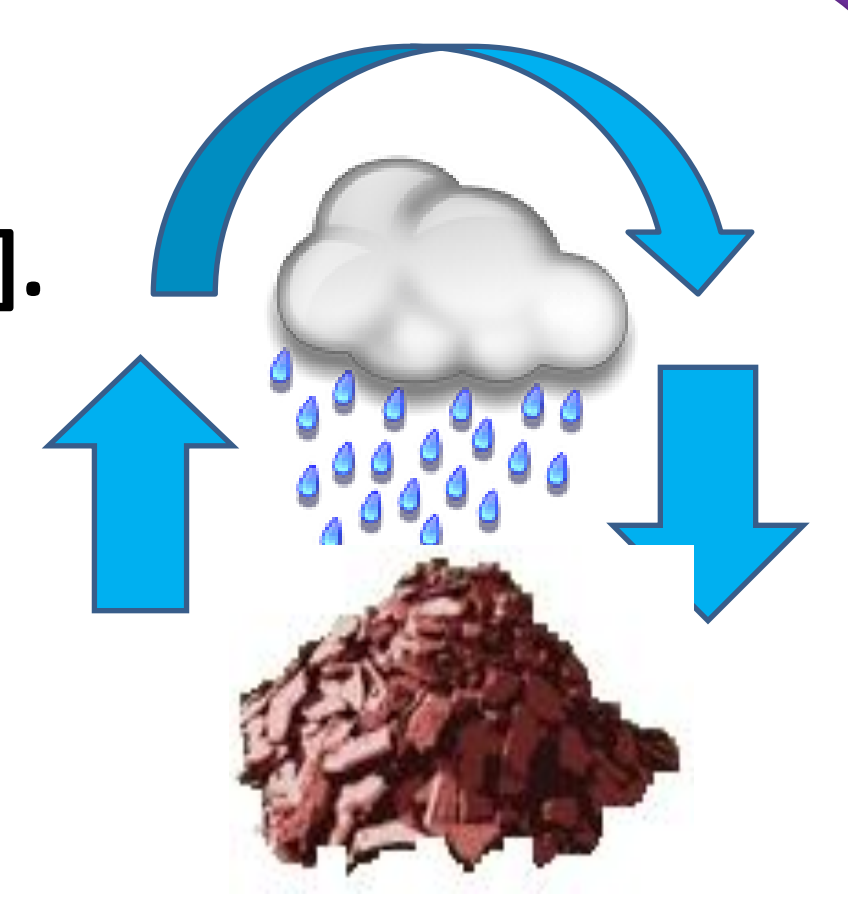


HEAVILY CONTAMINATED SOIL AROUND AN INDUSTRIAL WASTEWATER TREATMENT PLANT: THE EVIDENCE OF AN AQUEOUS AEROSOL-MEDIATED TRANSPORT OF PFASs?

Virginie BOITEUX, Cristina BACH, Jessica HEMARD, Christophe ROSIN, Jean-François MUNOZ, Xavier DAUCHY
ANSES, Nancy Laboratory for Hydrology, Water Chemistry Department, 40 Rue Lionnois, 54000 Nancy, France

INTRODUCTION

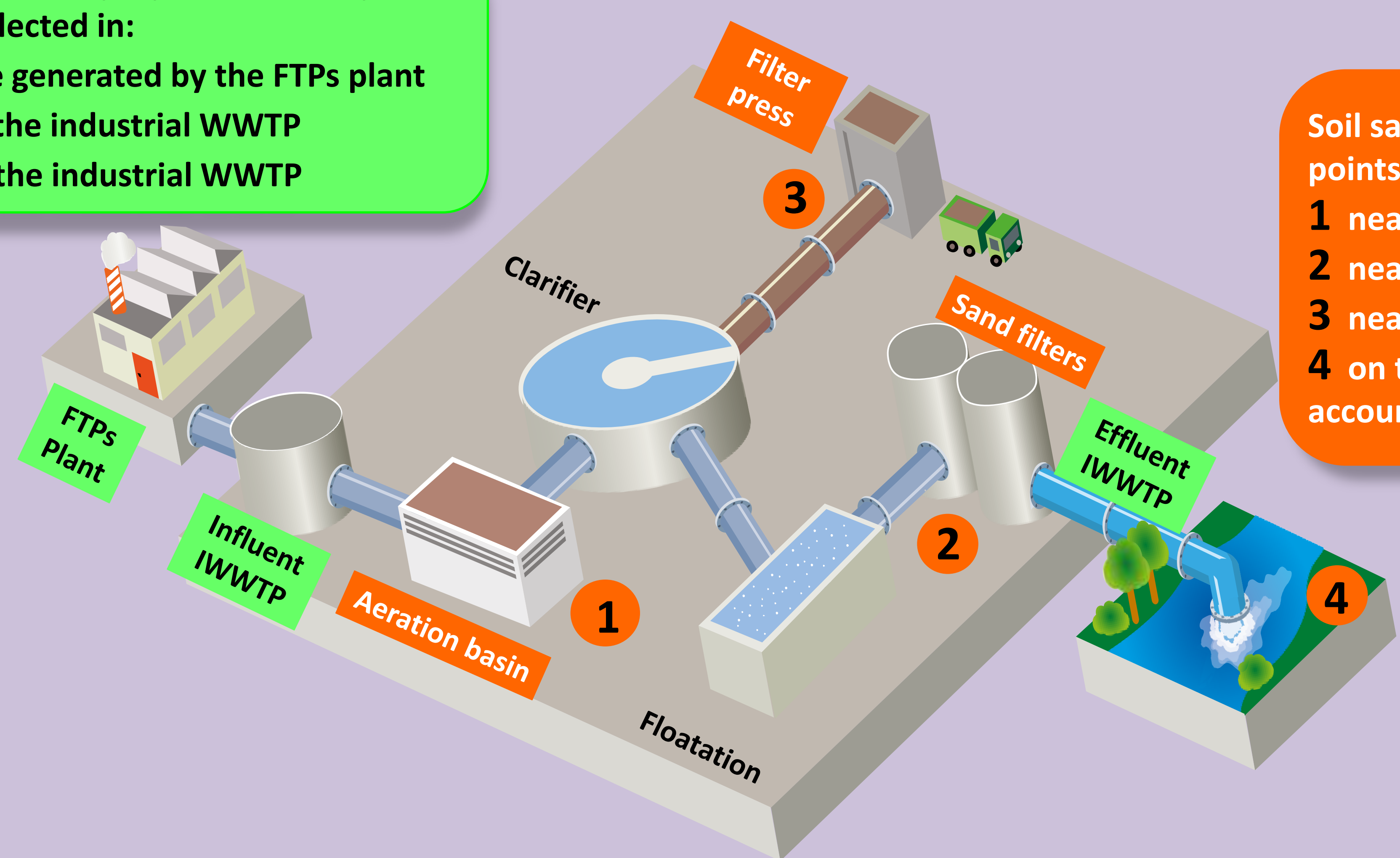
Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are mainly surveyed in aqueous phase and sludge during the wastewater treatment. However, emission data of PFASs into the atmosphere from this potential source are very scarce [1]. The aim of this study was to highlight an aqueous aerosol-mediated transport of PFASs by measuring their concentrations in soil samples collected from an industrial wastewater treatment plant (IWWTP). This IWWTP receives raw effluent of a fluorotelomer polymers (FTPs) manufacturing plant. The concentrations of 46 PFASs were determined in soil samples, the raw effluent, the inlet and the outlet of the IWWTP.



MATERIAL AND METHODS

Twenty four hours flow-proportional composite samples were collected in:

- the raw sewage generated by the FTPs plant
- the influent of the industrial WWTP
- the effluent of the industrial WWTP

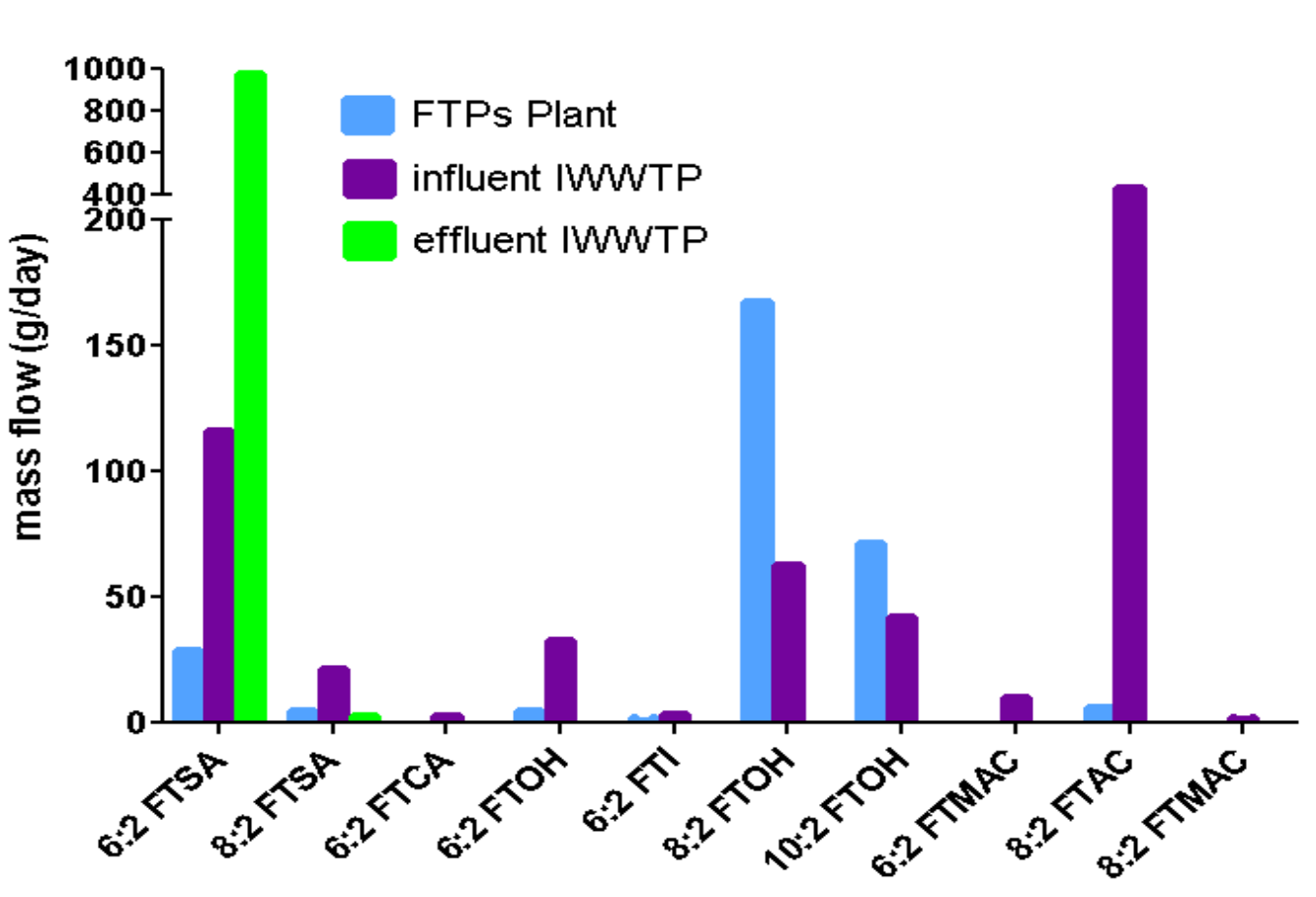


Soil samples were collected from 4 different points of the IWWTP:

- 1 near the aeration basin
- 2 near the sand filters
- 3 near the sludge treatment unit (filter press)
- 4 on the opposite bank of the river, taking into account the prevailing winds

RESULTS AND DISCUSSION

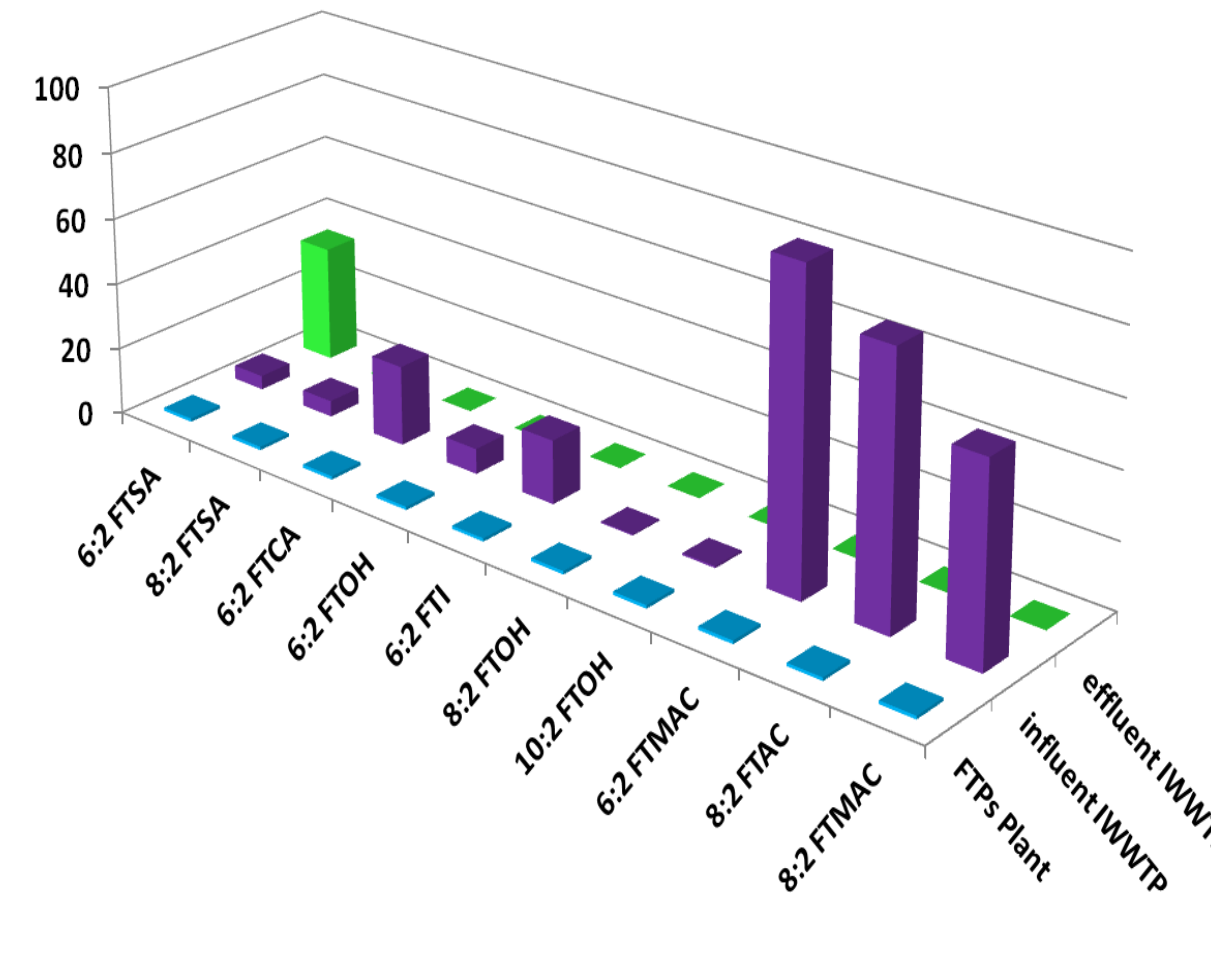
Mass flows of several FTs in the IWWTP



- ✓ 8:2 and 10:2 FTOH were the dominant chemicals in the FTPs plant effluent
- ✓ 8:2 FTAC and 6:2 FTSA were the dominant chemicals in the influent of IWWTP
- ✓ 6:2 FTSA is the dominant chemical in the effluent of IWWTP

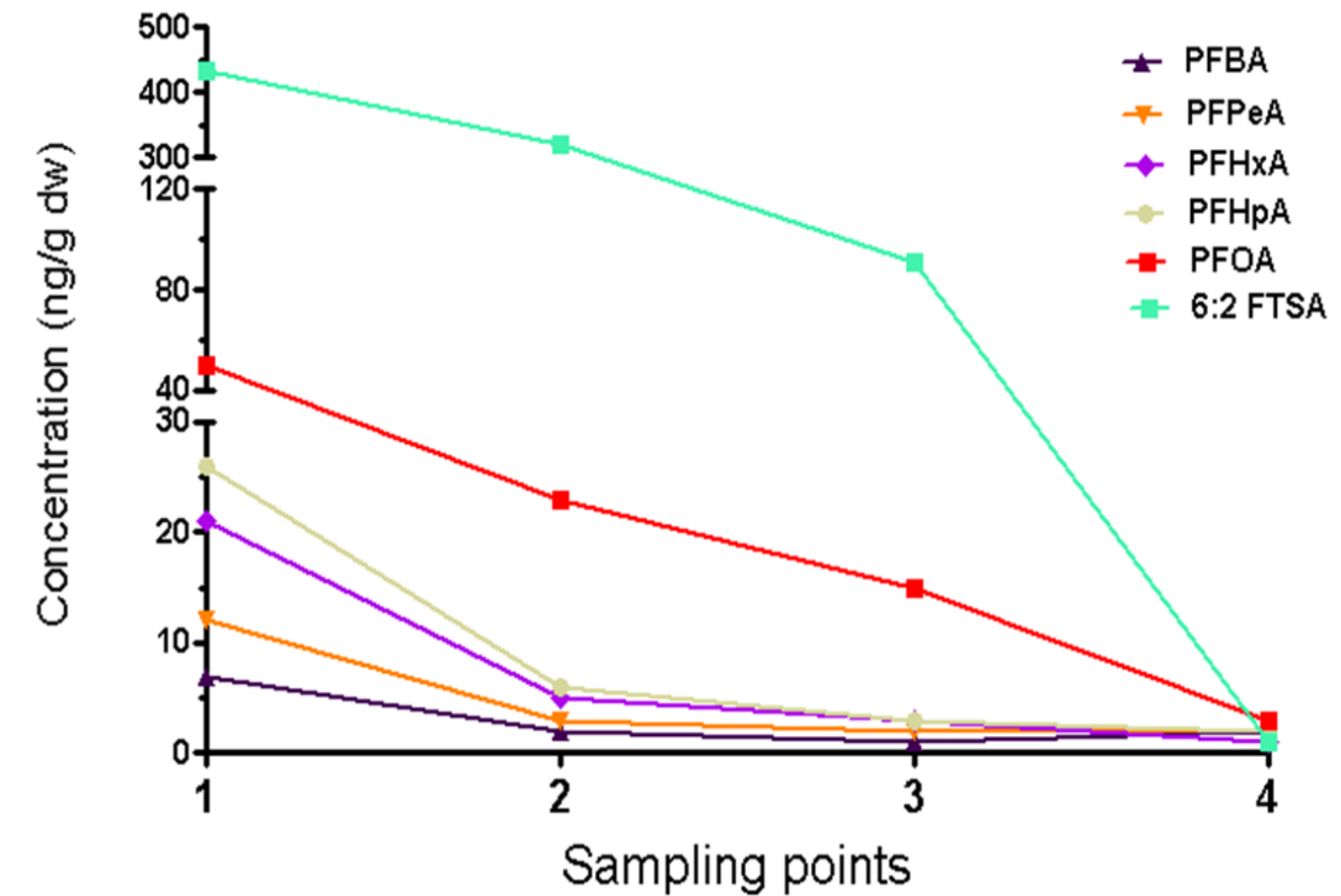
Changes of FTs mass flows in the IWWTP (using the FTPs plant mass flows of each FT as a reference)

- ✓ Steep increase of many of the fluorotelomers' mass flows in the IWWTP inlet (except for 8:2 and 10:2 FTOH): fast degradation of side-chain fluorinated polymers?
- ✓ Only 6:2 FTSA mass flow increased in the IWWTP outlet. As PFCAs, is 6:2 FTSA a metabolite of short-chain PFASs, which are not easily adsorbed onto sludge?



- ✓ What happened to the other FTs (FTOHs, FTACs, FTIs and FTMACs)?
- Degradation? Mass flows were 100 - 1000 times higher from PFBA to PFNA in the IWWTP outlet compared to the reference FTPs plant effluent.
- Sorption onto sludge? FTACs and FTSA concentrations in sludge ranged from 0.1-3 µg/g dw and from 5-360 µg/g dw respectively.
- Volatilization? The aqueous aerosol-mediated transport was investigated through analysis of soil samples collected on the IWWTP site.

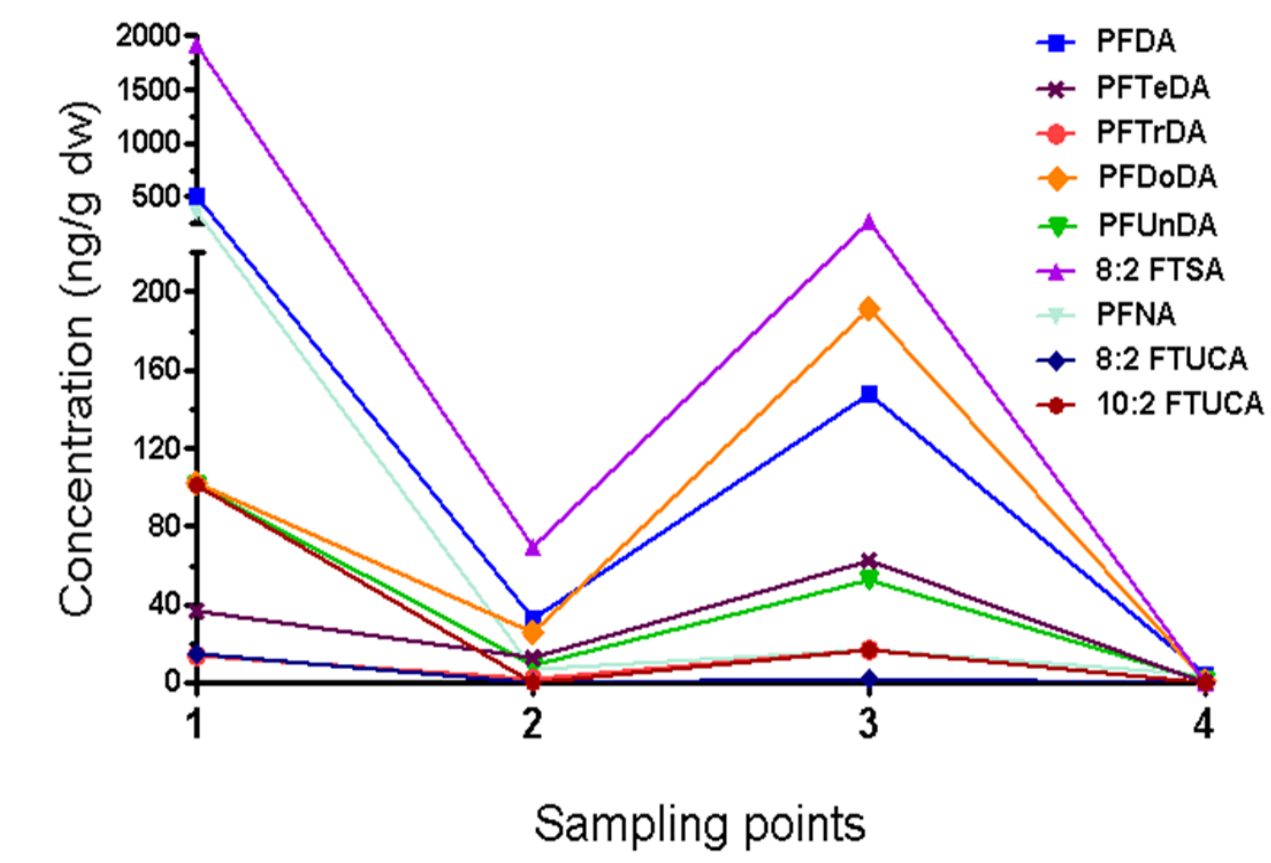
PFASs with decreasing patterns



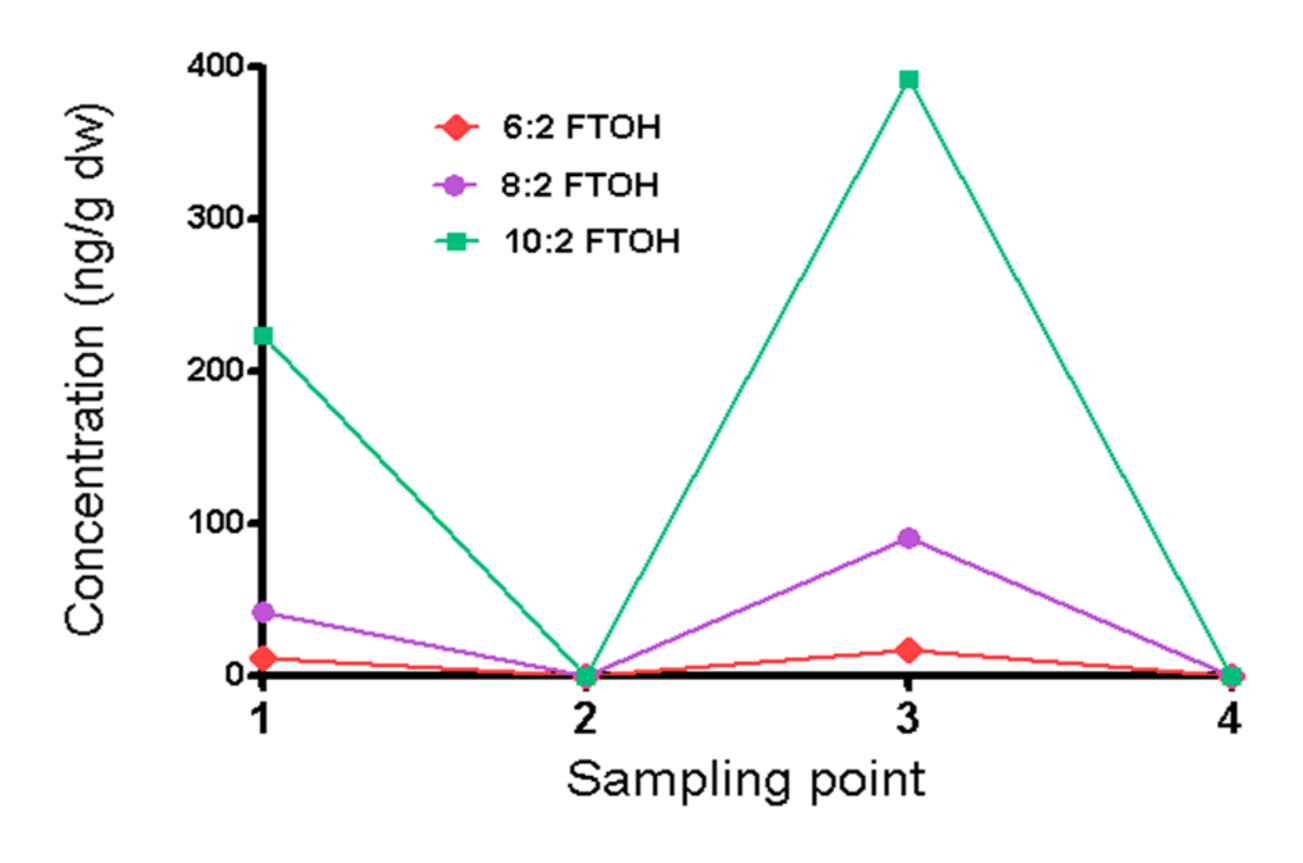
- A concentration decrease was observed for the short-chain PFCAs and 6:2 FTSA in soil further away from the aeration basin. These PFASs are likely end-stage metabolites of volatile PFASs, which have been deposited on the ground by an aqueous aerosol-mediated transport.
- Several intermediate metabolites (FTCAs, 5:3 Acid and 6:2 FTUCA) were only detected near the aeration basin. Short lifetime of these compounds (such as FTCAs [2]) or minor degradation products?

Volatile intermediate metabolites (FTOHs, FTACs) were found near the aeration basin, likely deposited on the ground by an aerosol transport, after the biodegradation of their precursors in this basin.

PFASs with fluctuating patterns



Severe concentration increase for the long chain PFCAs (≥ PFNA) and FTs (8:2 FTUCA and FTSA, 10:2 FTUCA) near the filter press. This is likely related to accidental spillage of dry sludge.



The presence of FTOHs near the filter pressure can be explained by a biodegradation of precursors present in the dry sludge (fluoroacrylate polymers [3], FTACs, FTMACs, etc.), not by an aerosol transport.

CONCLUSIONS

- End-stage (PFCAs) and intermediate metabolites (FTSAs, FTOHs, FTUCAs, FTCAs, etc.) were detected in soil samples, sometimes in high concentrations (435-1920 ng/g dw for FTSAs, 17-393 ng/g dw for FTOHs, 7-514 ng/g dw for PFCAs, 5-101 ng/g dw for FTUCAs, 4-11 for FTCAs).
- The soil around the filter press is likely mainly contaminated by spillage of dry sludge. The contamination of soils around the aeration basin and the sand filter is likely due to an aqueous aerosol-mediated transport.

PERSPECTIVES

The impact of the aqueous aerosol-mediated transport on the soil contamination could be more precisely defined by a new campaign with more sampling points. An emission of PFASs in the gas-phase is also highly likely [1], and specific measurements need to be carried out to quantify it. The overall atmospheric emission on this site (aerosol + gas-phase) raises the question of the exposure of IWWTP workers. A biomonitoring of these workers could confirm this hypothesis.

