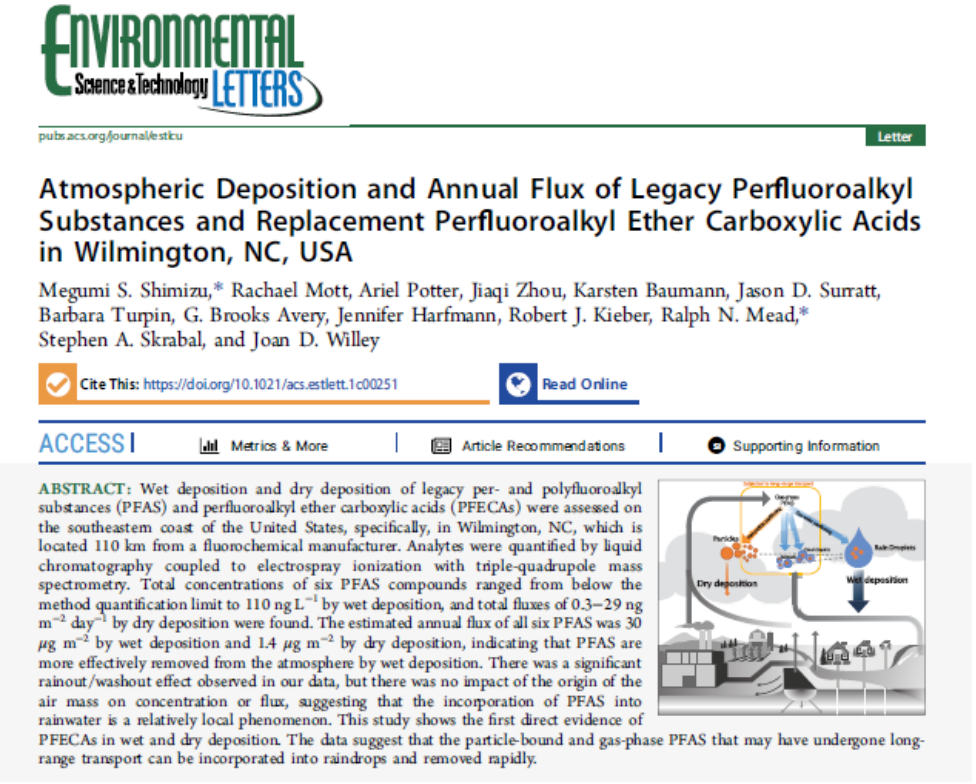
Atmospheric Dry Deposition of Legacy and Emerging Per- and Polyfluoroalkyl Substances (PFAS) in Wilmington, NC

- Legacy PFAS: PFOS and PFOA
  - Voluntary phase-out of PFOS began in 2002 and PFOA began in 2006
- Replacement PFAS: PFMOAA, PFMOBA, PFMOPrA/PMPA and HFPO-DA (GenX)
  - Short-chain (≤5 Carbons) replacements
  - Perfluoroalkyl Ether Carboxylic Acids (PFECAs)
  - Contaminating drinking water and human blood

Research Questions?

1) Are both legacy and replacement PFAS removed from the atmosphere through dry deposition?
2) What is the annual deposition of the individual PFAS and ΣPFAS for 2019 and 2020?



Environmental Science & Technology Letters

pubs.acs.org/journal/estlcu

Letter

Atmospheric Deposition and Annual Flux of Legacy Perfluoroalkyl Substances and Replacement Perfluoroalkyl Ether Carboxylic Acids in Wilmington, NC, USA

Megumi S. Shimizu,* Rachael Mott, Ariel Potter, Jiaqi Zhou, Karsten Baumann, Jason D. Surratt, Barbara Turpin, G. Brooks Avery, Jennifer Harfmann, Robert J. Kieber, Ralph N. Mead,* Stephen A. Skrabal, and Joan D. Willey

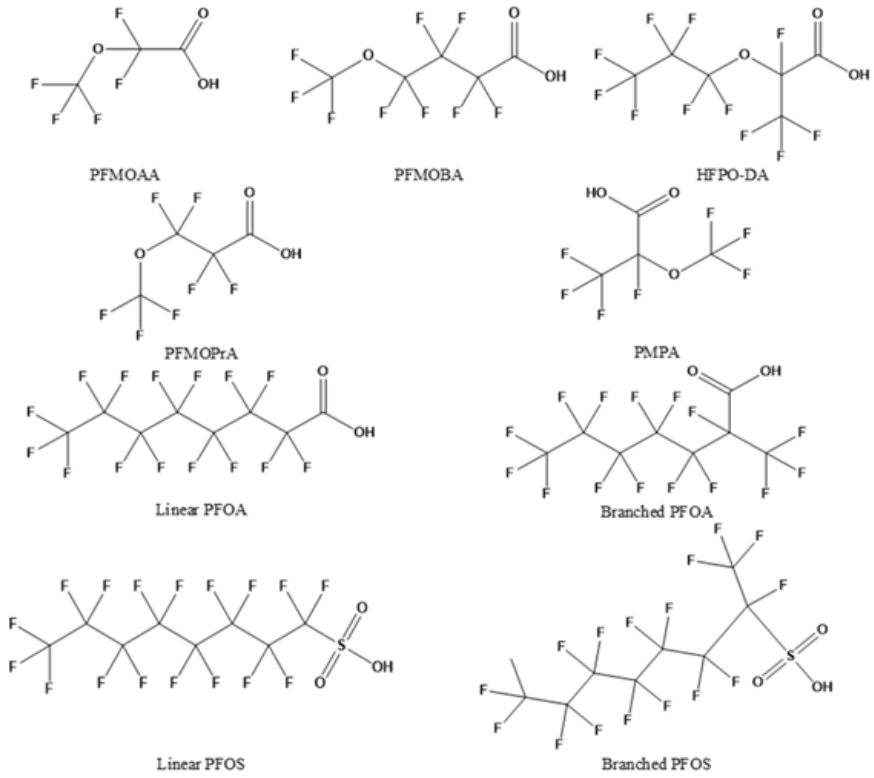
Cite This: https://doi.org/10.1021/acs.estlett.1c00251 Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: Wet deposition and dry deposition of legacy per- and polyfluoroalkyl substances (PFAS) and perfluoroalkyl ether carboxylic acids (PFECAs) were assessed on the southeastern coast of the United States, specifically, in Wilmington, NC, which is located 110 km from a fluorochemical manufacturer. Analytes were quantified by liquid chromatography coupled to electrospray ionization with triple-quadrupole mass spectrometry. Total concentrations of six PFAS compounds ranged from below the method quantification limit to 110 ng L^{-1} by wet deposition, and total fluxes of 0.3−29 ng m^{-2} day^{-1} by dry deposition were found. The estimated annual flux of all six PFAS was 30 μg m^{-2} by wet deposition and 1.4 μg m^{-2} by dry deposition, indicating that PFAS are more effectively removed from the atmosphere by wet deposition. There was a significant rainout/washout effect observed in our data, but there was no impact of the origin of the air mass on concentration or flux, suggesting that the incorporation of PFAS into rainwater is a relatively local phenomenon. This study shows the first direct evidence of PFECAs in wet and dry deposition. The data suggest that the particle-bound and gas-phase PFAS that may have undergone long-range transport can be incorporated into raindrops and removed rapidly.

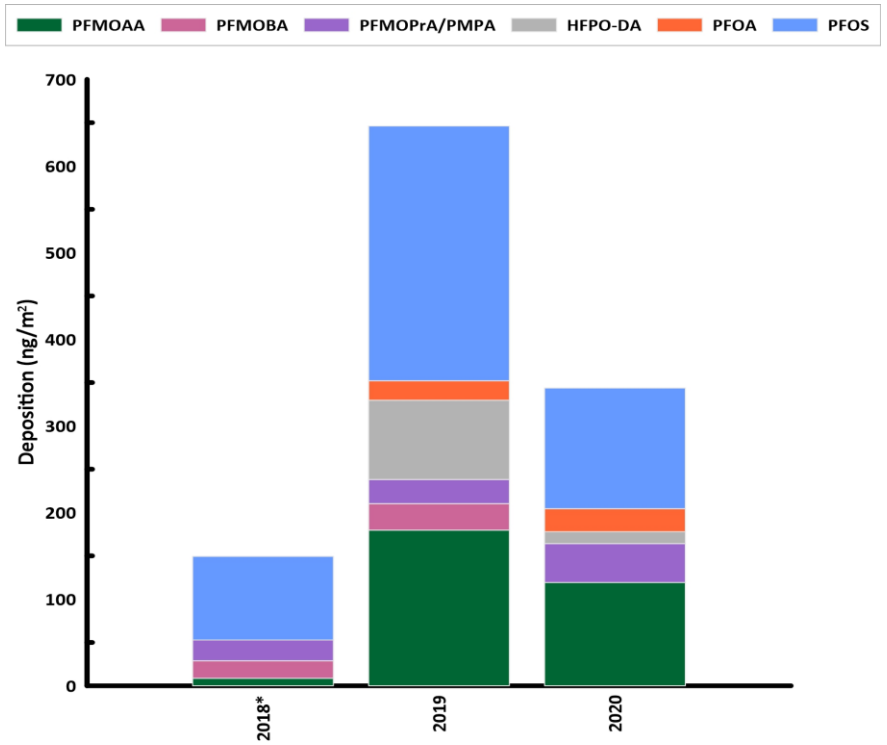
Atmospheric Dry Deposition

Targeted PFAS



1. Dry deposition collection included particles dense enough to settle from the atmosphere
2. Buckets rinsed with Milli-Q water and particles filtered off
3. PFAS extracted through Weak Anion Exchange (WAX)
4. Analysis through LC-MS

Annual PFAS Deposition in Wilmington



2018 = 8 collection days (n = 1)
2019 = 358 collection days (n = 23)
2020 = 352 collection days (n = 15)

- PFOS and PFMOAA are largest contributors to total PFAS deposition.
- ΣPFAS deposition decreased by almost ½ from 2019 to 2020
- PFMOPrA/PMPA and PFOA were the only 2 PFAS that increased from 2019 to 2020
- Average daily deposition rates generally decreased for all PFAS