Outside the safe operating space of a new planetary boundary for PFAS

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Swedish PFAS Network Meeting,

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Perspective

Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS)

Ian T. Cousins,* Jana H. Johansson, Matthew E. Salter, Bo Sha, and Martin Scheringer

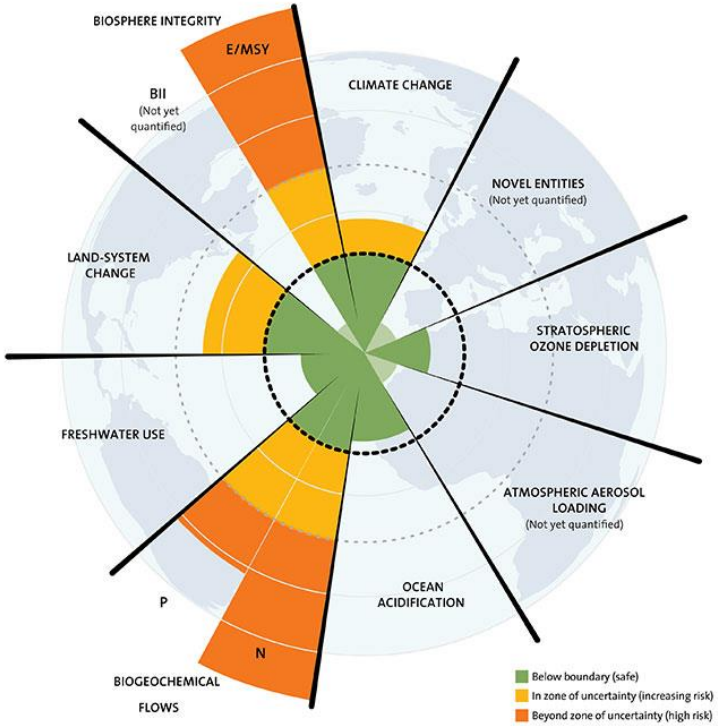
Hypotheses

- Ambient levels of PFOS, PFOA, PFHxS and PFNA are above the most stringent guidelines/health advisories

- Environmental resources on Earth irreversibly contaminated to the point where we're concerned about using them

  – new planetary boundary for PFAS exceeded

Planetary Boundaries



In the planetary boundary concept, an attempt is made to estimate the boundaries for "a safe operating space for humanity"

Highly predictable problem!

- **All PFAS are highly persistent** (EU REACH)
  - either non-degradable or transform ultimately into stable terminal transformation products
- Continual release results in global spread, increasing levels and increasing probabilities of known and unknown effects.
- Exposure poorly reversible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Why is high persistence alone a major cause of concern?

Ian T. Cousins, Carla A. Ng, Zhanyun Wang and Martin Scheringer


Environmental Science Processes & Impacts

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PERSPECTIVE

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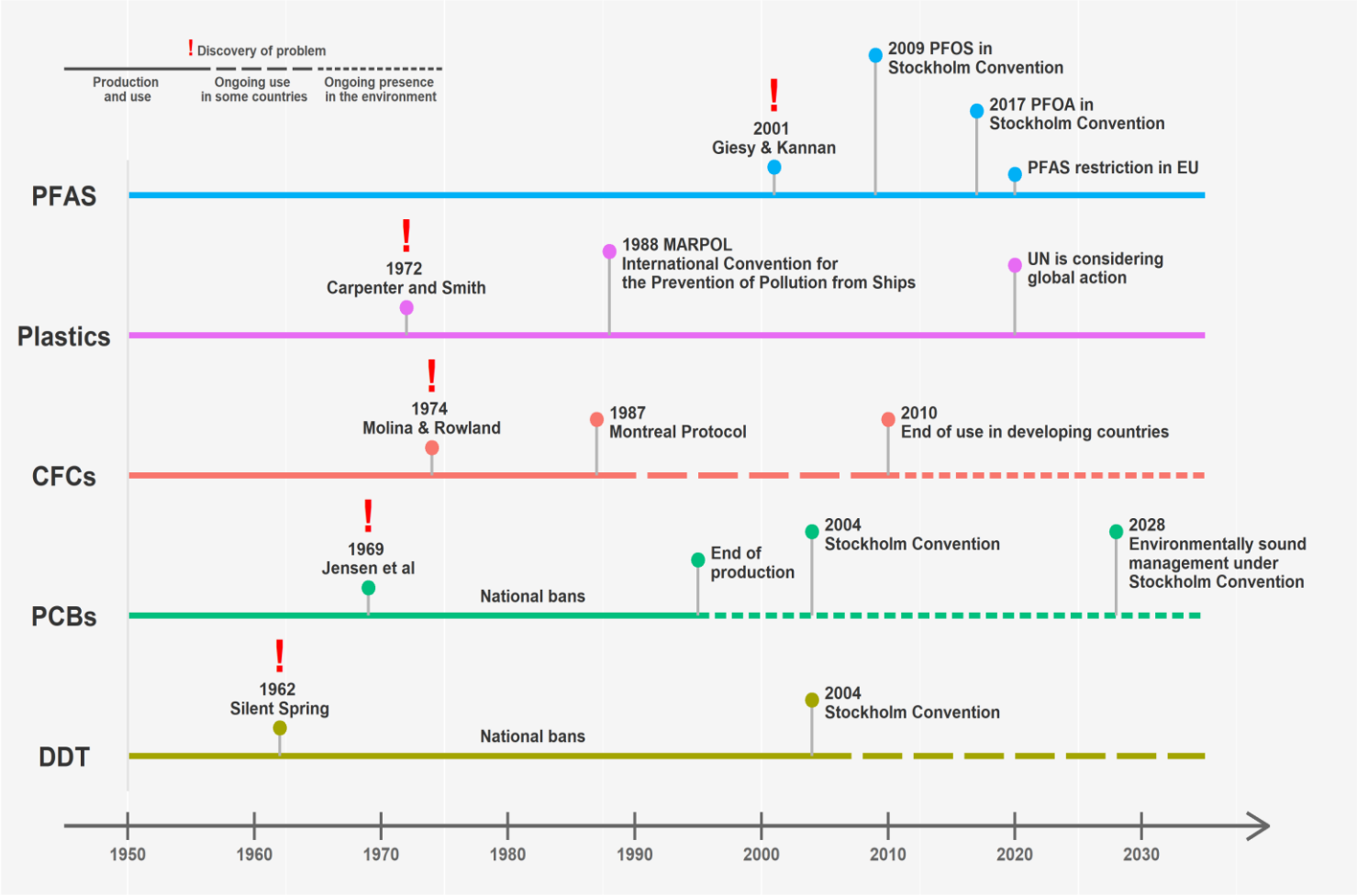
The high persistence of PFAS is sufficient for their management as a chemical class

Ian T. Cousins, Jamie C. DeWitt, Juliane Glüge, Gretta Goldenman, Dorte Herzke, Rainer Lohmann, Carla A. Ng, Martin Scheringer and Zhanyun Wang

Problems with high persistence

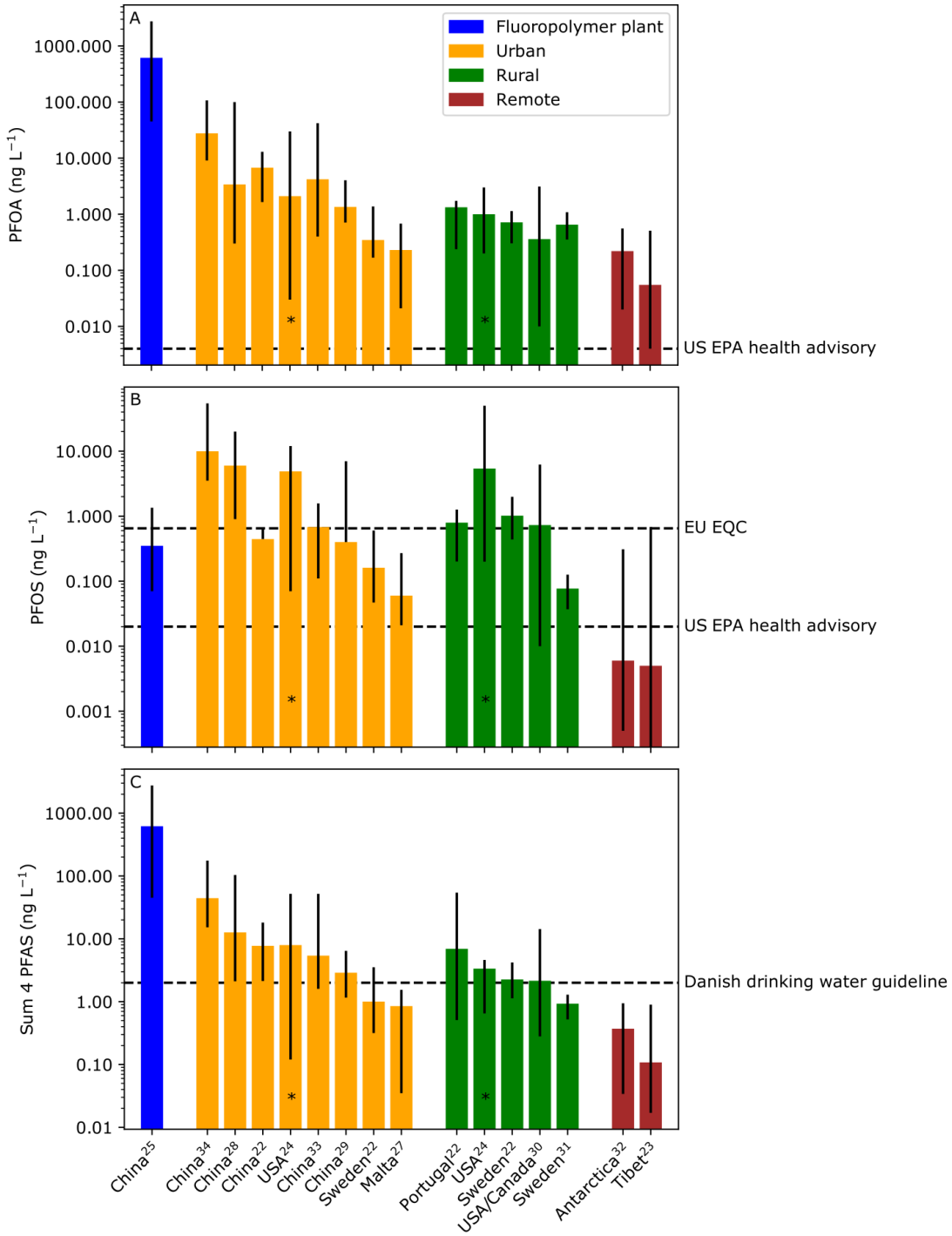


Results

- Rainwater levels everywhere higher than the US EPA drinking water health advisories for PFOA and close to Danish guidelines for sum of 4 PFAS

- Surface waters: lakes and rivers have levels above the EQS for PFOS and rainwater levels typically around the EQC level

- Soils: global ambient soil concentrations higher than the Dutch soil guideline values



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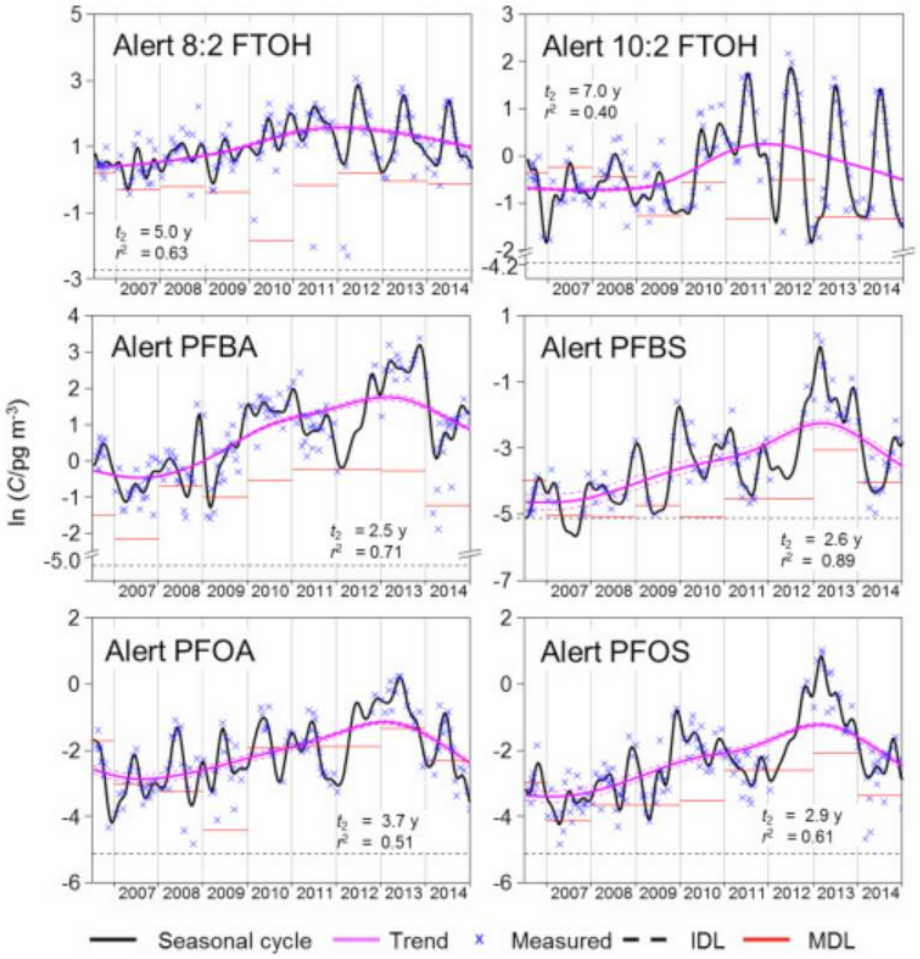
Time trends in environmental media stable



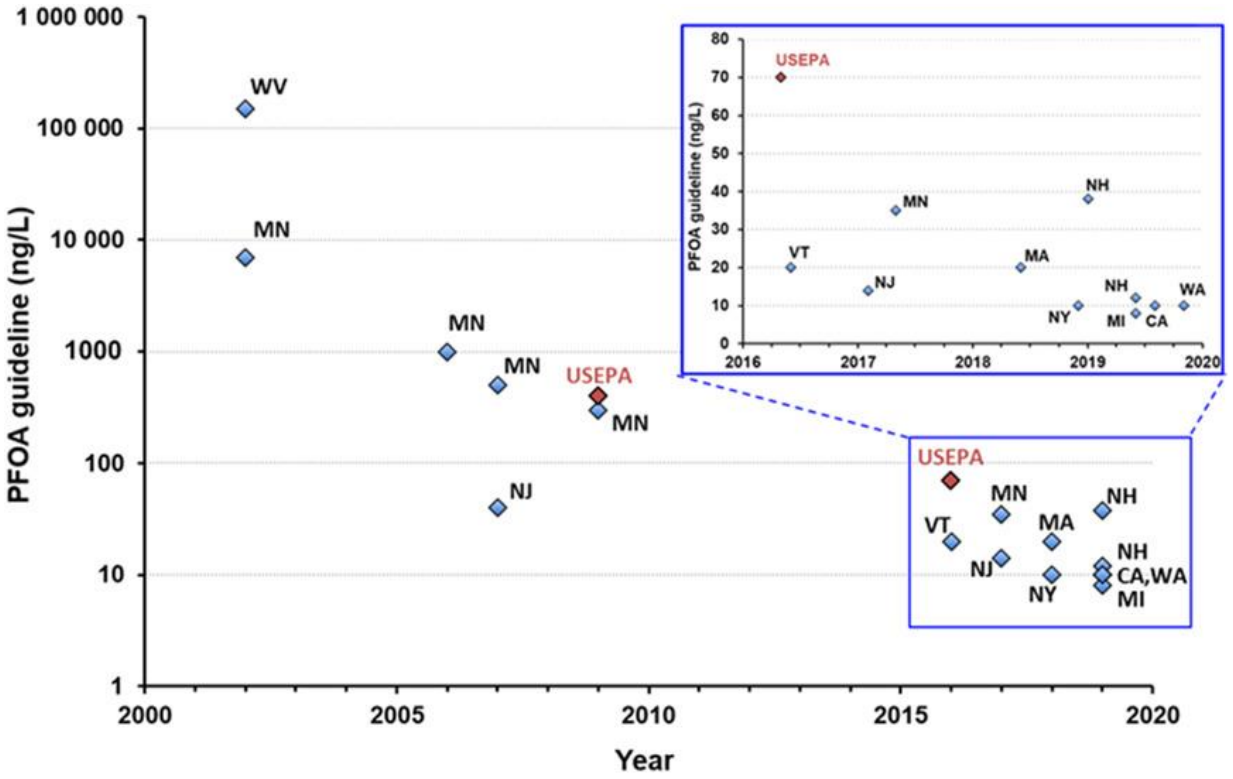
Systematic Review | Open Access | Published: 22 January 2018

What is the effect of phasing out long-chain per- and polyfluoroalkyl substances on the concentrations of perfluoroalkyl acids and their precursors in the environment? A systematic review

Magnus Land, Cynthia A. de Wit, Anders Bignert, Ian T. Cousins, Dorte Herzke, Jana H. Johansson & Jonathan W. Martin

Environmental Evidence **7**, Article number: 4 (2018) | Cite this article

As toxicity knowledge increases drinking water health advisories decrease



Now PFOA guidelines a factor of 37.5 million times lower than in 2002!

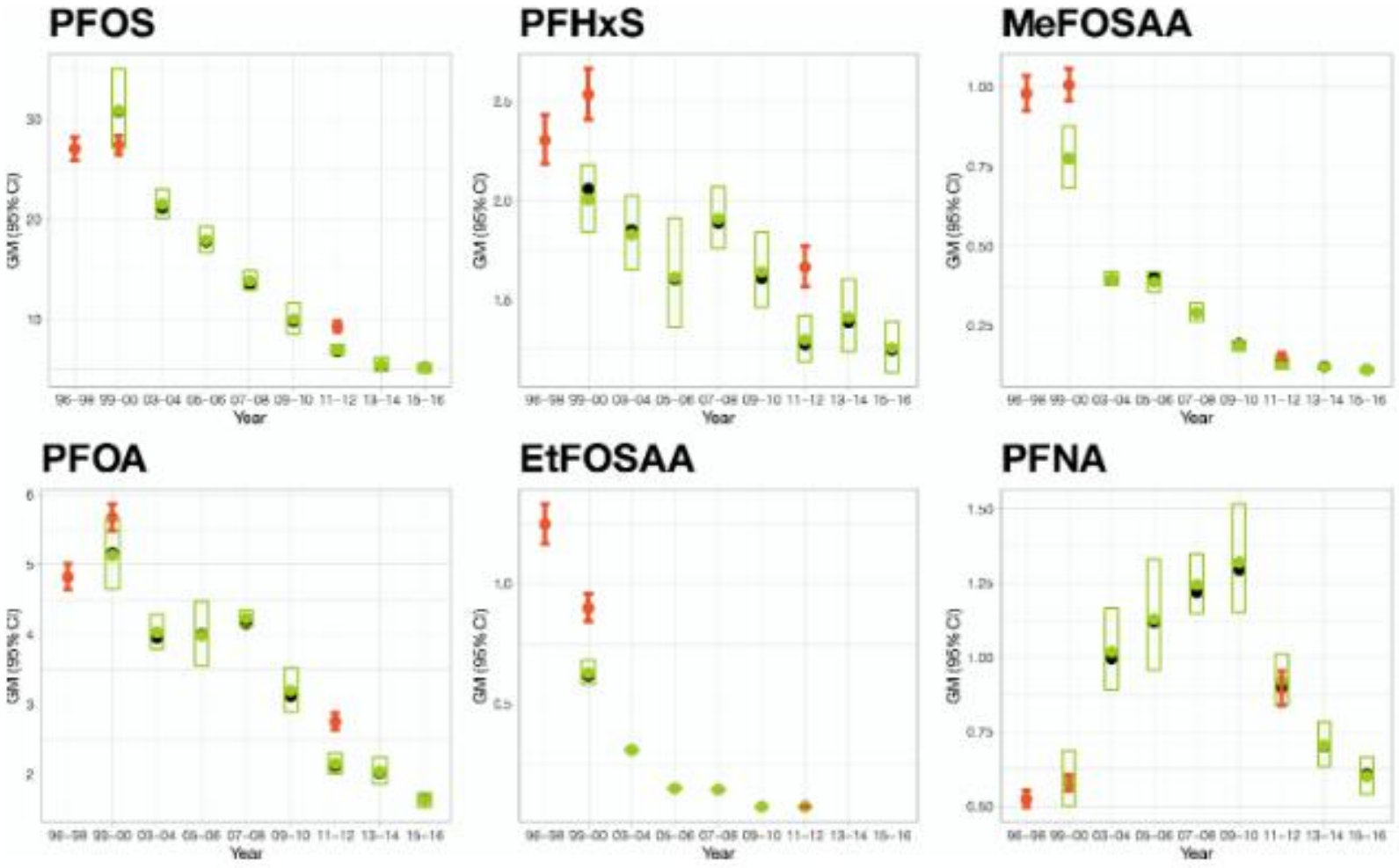
Environmental Toxicology and Chemistry—Volume 40, Number 3—pp. 550–563, 2021
Received: 31 May 2020 | Revised: 19 August 2020 | Accepted: 20 August 2020

Critical Review

Recent US State and Federal Drinking Water Guidelines for Per- and Polyfluoroalkyl Substances

Gloria B. Post*
New Jersey Department of Environmental Protection, Trenton, New Jersey, USA

Temporal trends in US blood

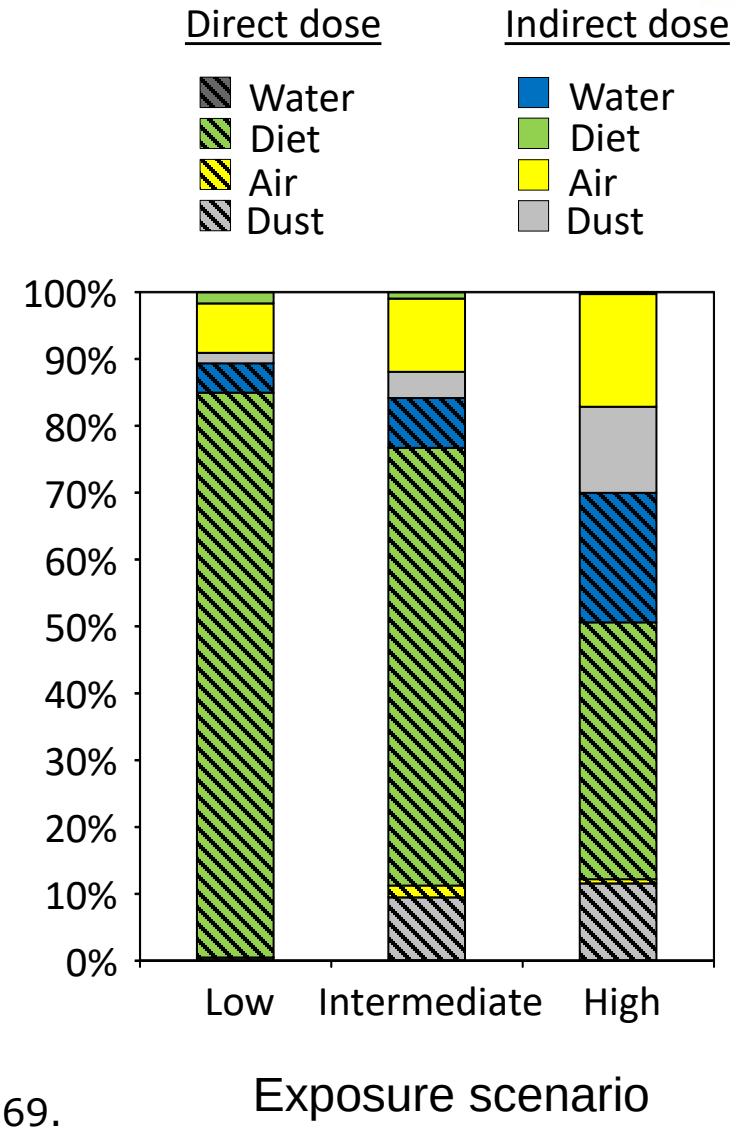


Lin et al., (2021) *Environ. Int.*, 157, 106789.

How are we exposed to these 4 PFAS?

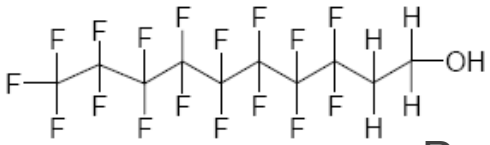
- PFOS: diet > dust > air > water
- Short-chain PFAAs: water and vegetables more important
- Long-chains PFAAs: diet (fish/meat) and dust more important

- **Diet ultimately contaminated from environment**



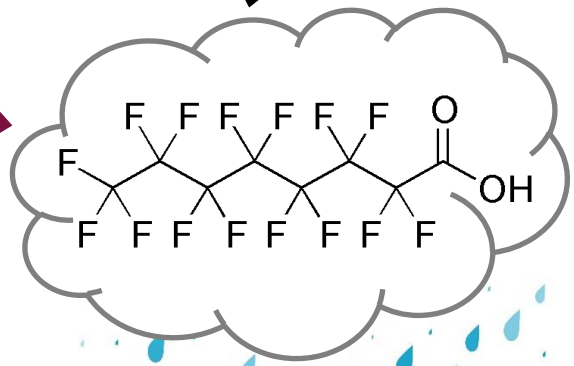
Gebbink et al., (2021) Environ. Int., 74, 160-169.

How do these 4 PFAS get into rain?



OH/NOx

Precursor transformation



Direct emissions to air

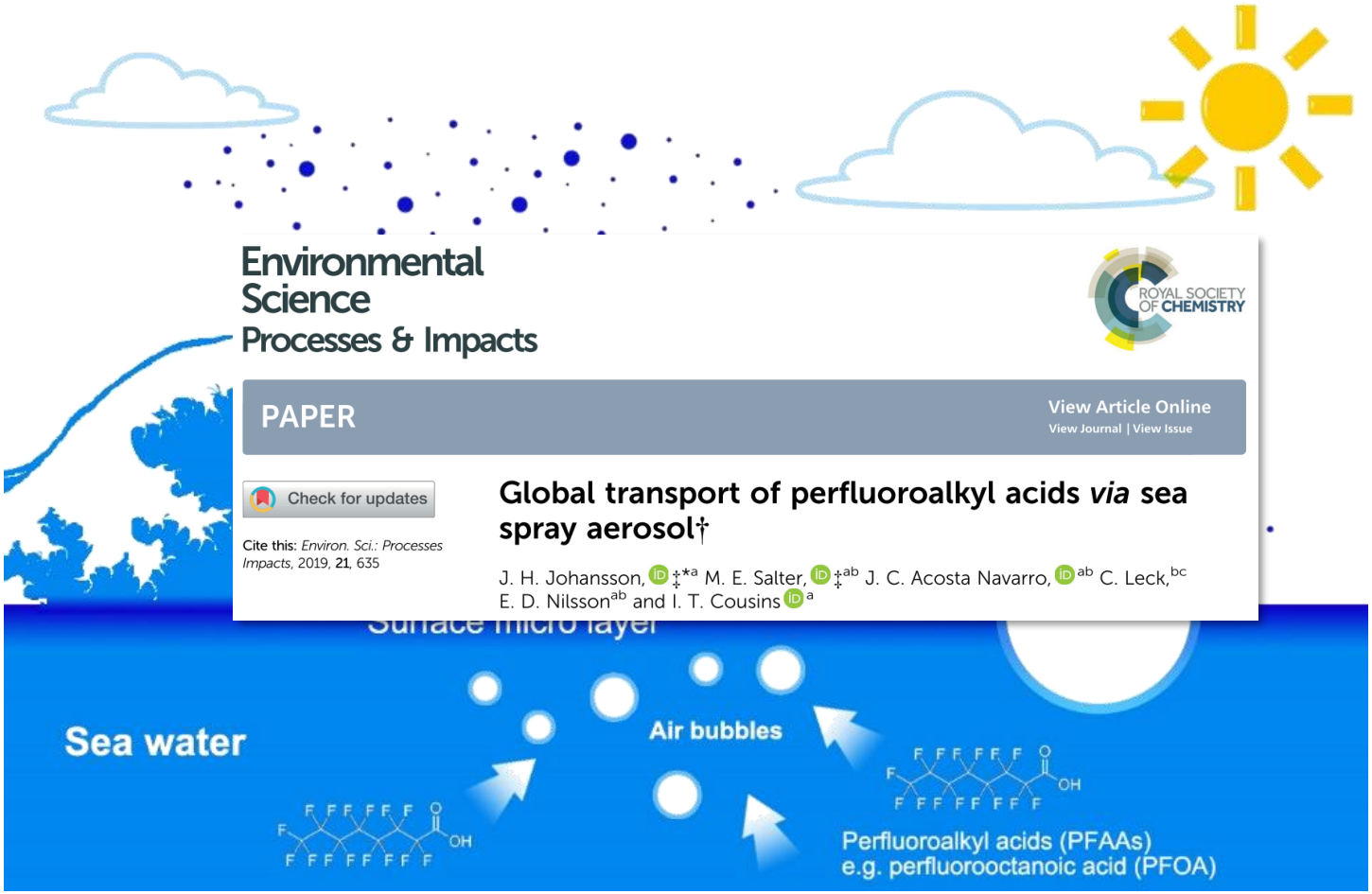
Sea spray aerosols

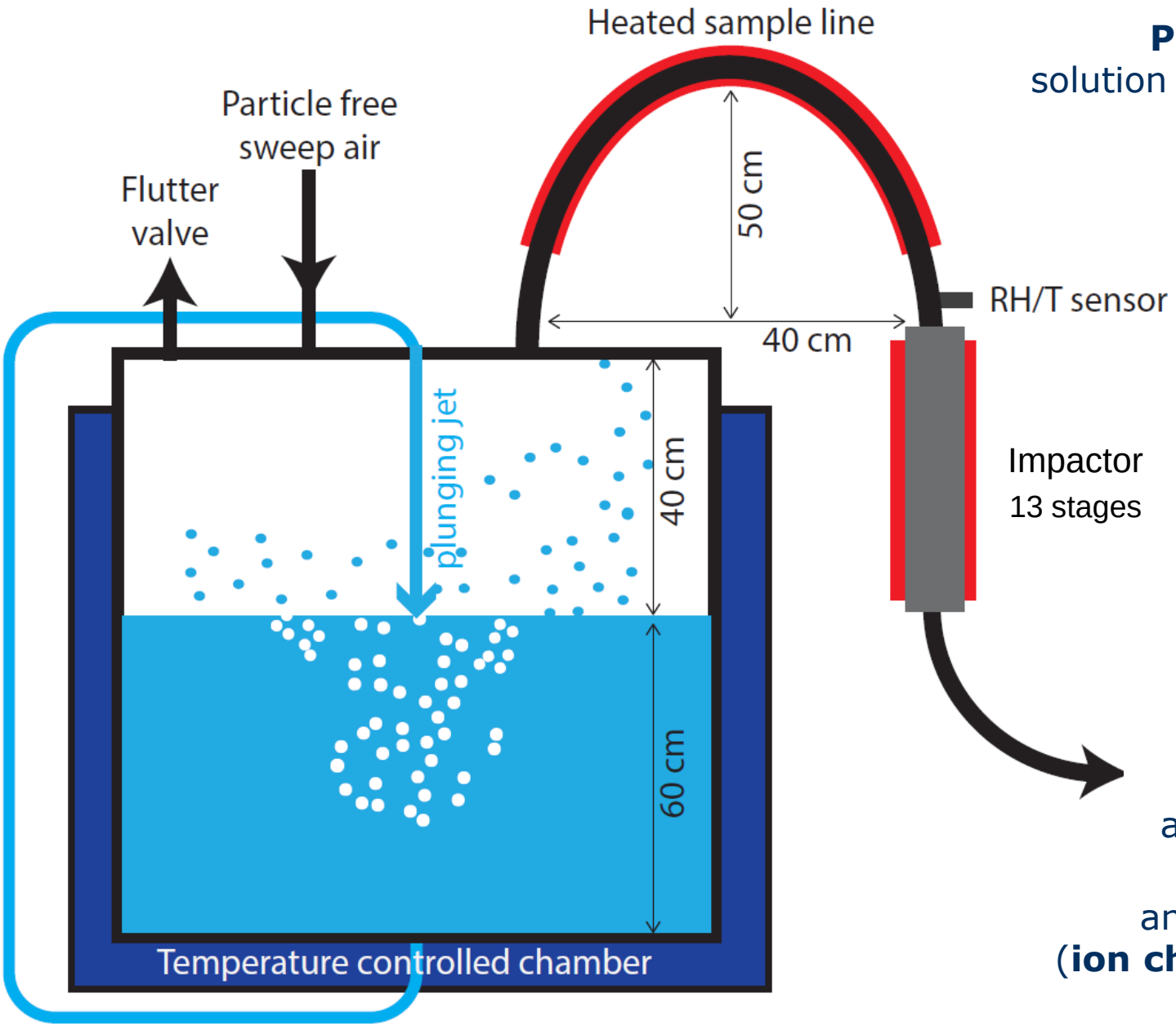
Direct emissions to waters

Riverine discharge

Oceanic transport

Long-range atmospheric transport





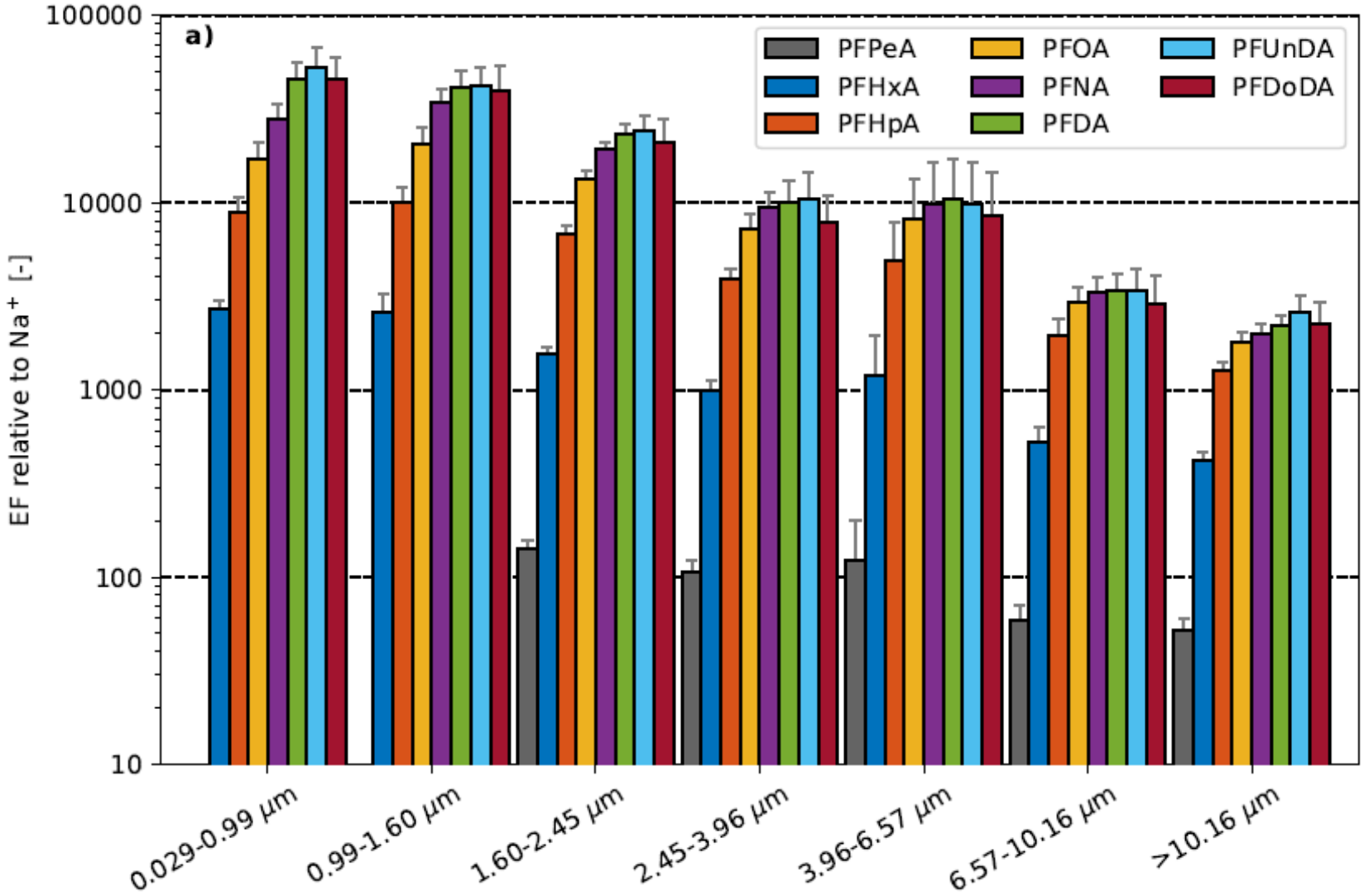
PFAAs spiked to solution of artificial **sea salt** (35 psu).

Impactor
13 stages

Aerosol and water analysed for PFAAs (**UPLC-MS/MS**) and sea salt content (**ion chromatography**).

Measured aerosol enrichment factors

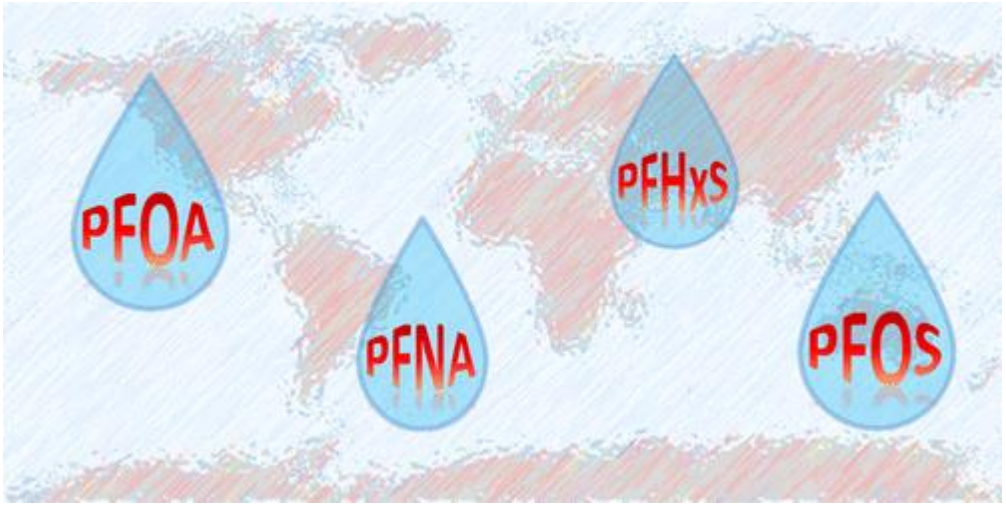
Normalised to mass of sea salt tracer Na+



Conclusions

- PFAS cycle in the global hydrosphere
  - coastal drinking water resources especially threatened
- Long-chain PFAAs phased out, but not declining notably in the atmosphere
  - prevents health advisories/guidelines from being attained
- Beware of other PFAS doing the same
- Let’s finally understand the problems with highly persistent substances

Thank you for your attention!



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