

# **CHE call on PFASs (aka PFCs)**

## **20 December 2016**

**A brief discussion of exposure & human health effects of PFAS**

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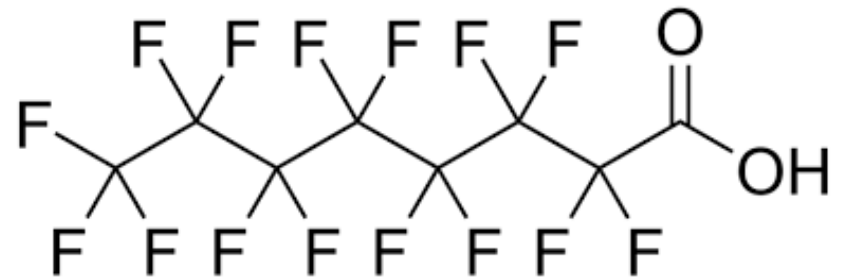
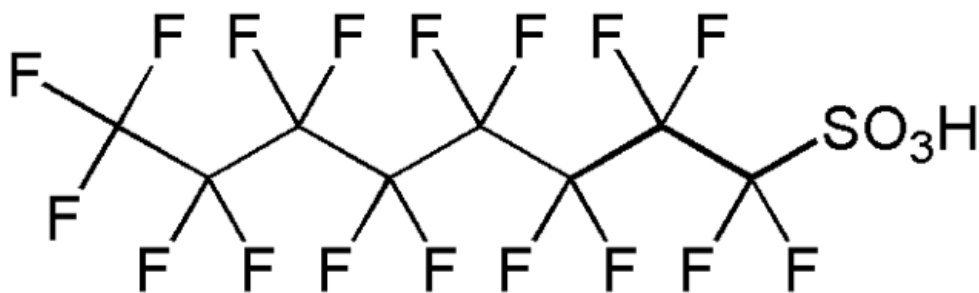
**I am an environmental epidemiologist & exposure scientist.**  
**Experience with this class of compounds, e.g.,**

- C8 studies (WV/OH)**
- a MA study of children of exposed mothers (birth cohort)**
- indoor & water exposure**

# What are PFAS?

PFAS = “Per- and polyfluorinated alkyl substances”  
formerly called PFCs

- *large & complicated* class of compounds
- moving target (changing regulations & production -> shorter chain)
- PFOS & PFOA (“C8”) are the best known

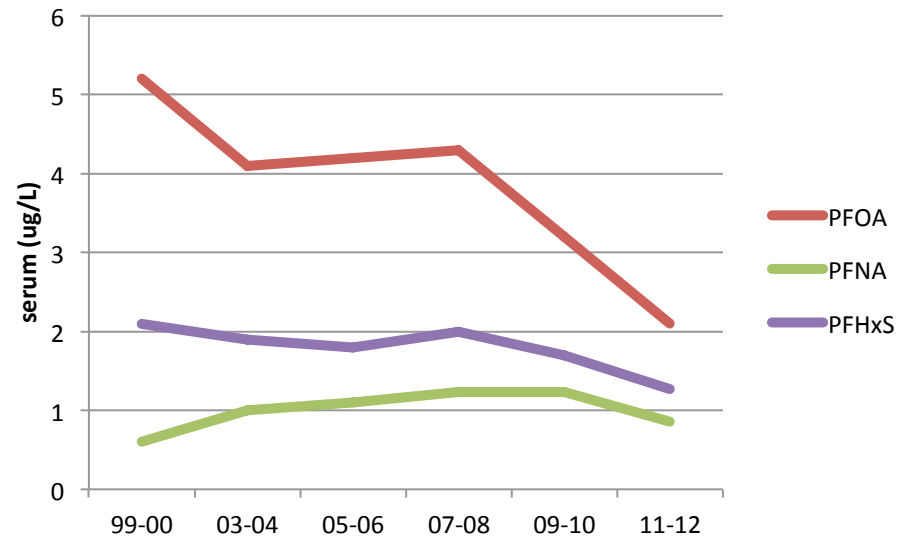
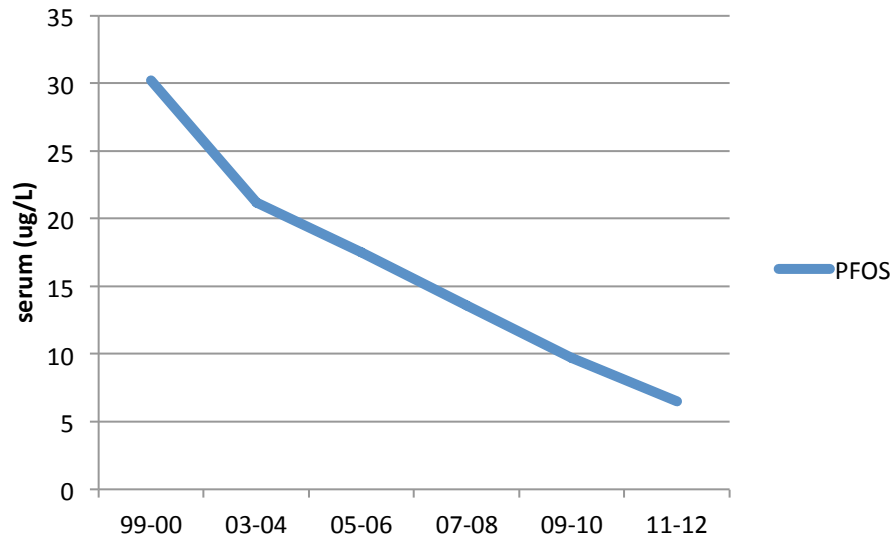


- many are persistent organic pollutants (POPs)
- unusually for POPs, many are water soluble

# Human serum levels

- widely found in human serum
- North America ~ Europe
- men > women
- time trends

USA NHANES medians of 4 common PFAS (scales differ)

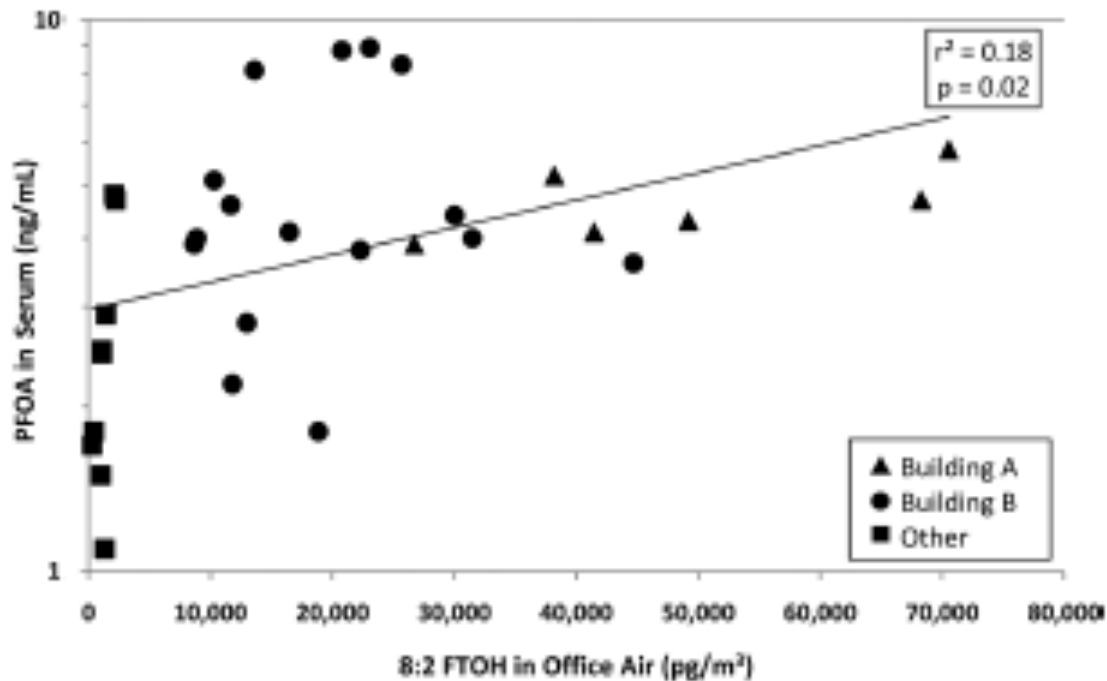


Kato et al 2011, CDC 2015

- **plus *unidentified* organofluorine compounds in human blood:**  
Quantifiable PFAS accounted for 31-100% of total extractable organic fluorine, with a trend towards more unidentified compounds (German & Chinese samples)(Yeung & Mabury 2016)

# Exposure

- PFAS used in manufacture of polymers, firefighting foams, stain/water resistant coatings, food packaging, etc.
- exposure pathways include ingestion (food, water, dust), inhalation
- Major complication: exposure to compounds & *precursors*, e.g. **FTOH → PFOA in blood**  
inhalation + metabolic conversion to stable PFOA



Boston office workers

e.g., Fraser et al 2012

# Exposure

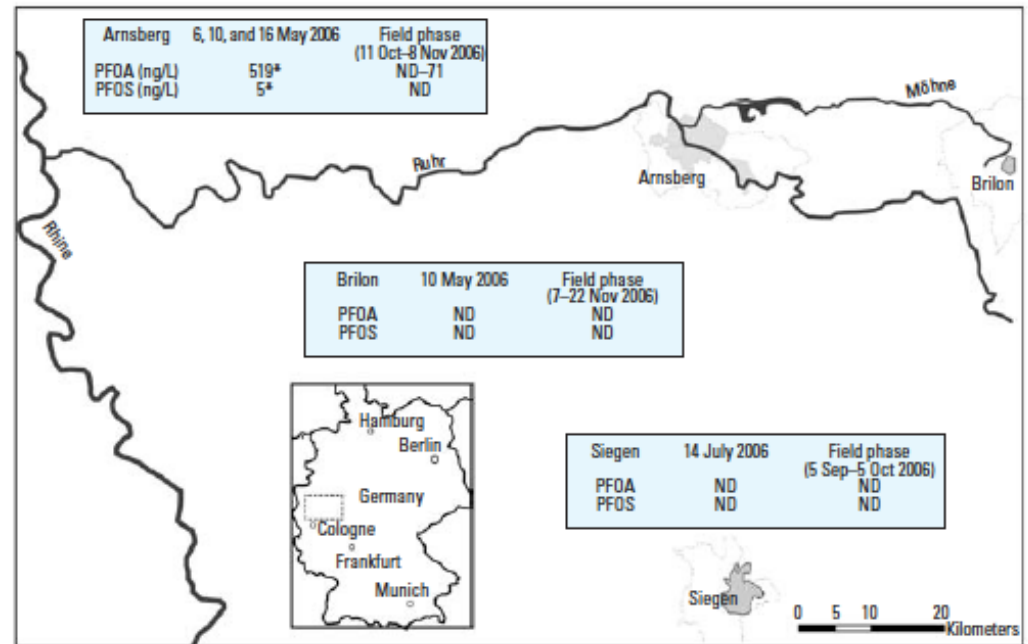
- **IMPORTANT:** For most people, exposure is estimated to be predominantly via diet followed by indoor exposure with water small (e.g., Gebbink et al 2015)
- For some populations, water may be an important (or dominant) source of exposure.

# Water contamination (early studies)

Elevated blood levels associated with elevated water levels for PFOA serum  $\sim 100 \times$  water (e.g., Hoffman et al 2011)

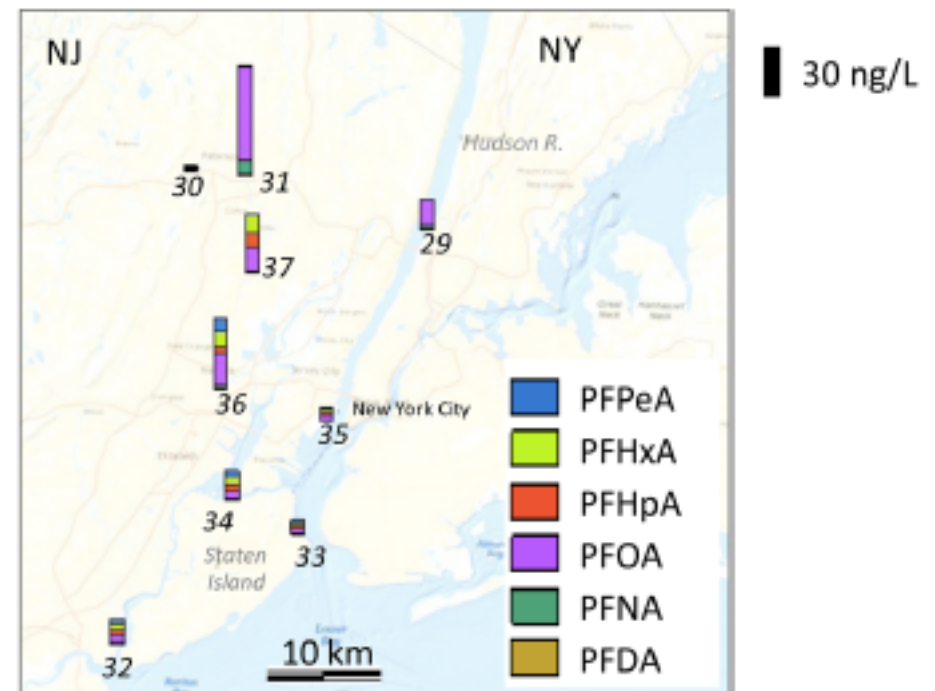
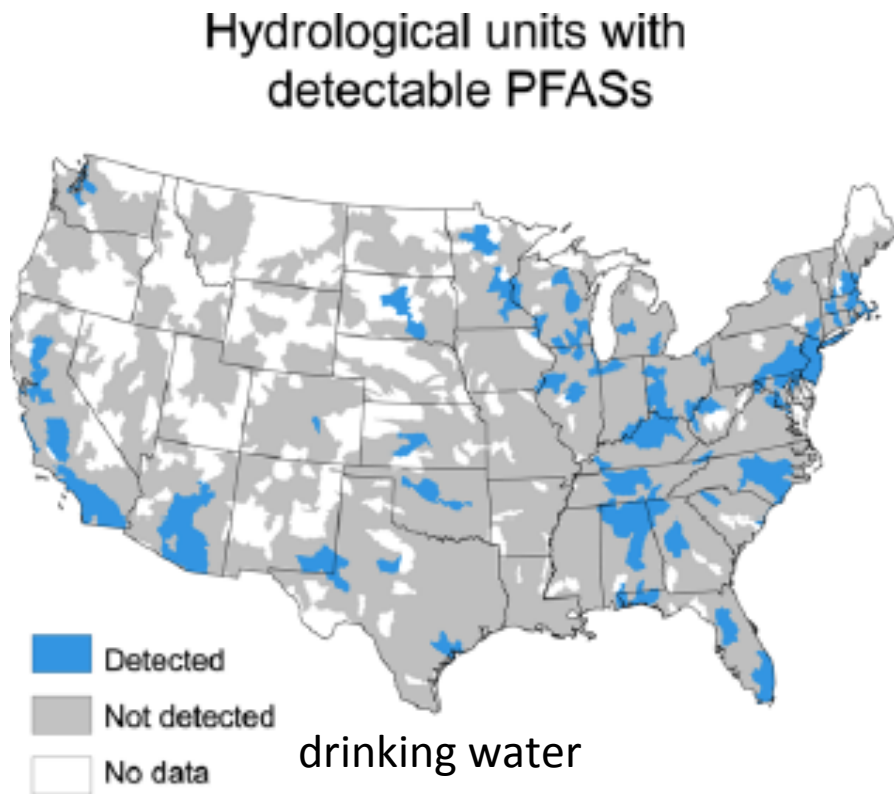


WV/OH  
near Dupont facility



Germany, Moehne River  
“use of soil conditioner, which had been mingled with industrial waste”

- Recent studies: water contamination more widespread than previously thought
- Related to waste water treatment plants, industrial sites, military fire training areas, textile mills, airports...
- CA: serum PFOA & PFOS higher where water had detected levels



surface water

Hu et al 2016  
 Hurley et al 2016  
 Zhang et al 2016

# Health effects of PFAS: toxicology

Effects seen in laboratory animals include

- neurobehavioral effects
- endocrine disruption
- effects on immune system
- tumors
- ...

See reviews: Lau et al 2007, Post et al 2012...



## **Health effects of PFAS: human epidemiology**

**Environmental epidemiology is difficult! Often requires a substantial body of evidence**

**~100+ epidemiology studies of various design, outcomes, exposures, quality, often conflicting—difficult to summarize**

**C8 Science Panel “Probable Links” for PFOA—2011-2, court-related standard of evidence**

- **high cholesterol**
- **thyroid**
- **ulcerative colitis**
- **testicular cancer & kidney cancer**
- **pregnancy-induced hypertension**

**Not a probable link for many other outcomes, e.g., neuro-developmental disorders in children, birth defects, low birth weight...**

## thyroid

- Recent review: “Although there is a small number of studies with comparable data, we found some consistency of a positive association between maternal or teenage male exposure to some PFAS and TSH levels “ (Ballesteros et al 2016)

## cholesterol

- One of the more interesting outcomes
- Several cross-sectional found increased cholesterol (LDL-“bad cholesterol”) associated with PFAS blood levels; other studies did not
- longitudinal study (strong design) in WV/OH after intervention: reduced serum PFOA (& PFOS) associated with decreased LDL (Fitz-Simon et al 2013)

**More epi underway**

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