

European PFC emissions inferred through atmospheric measurements

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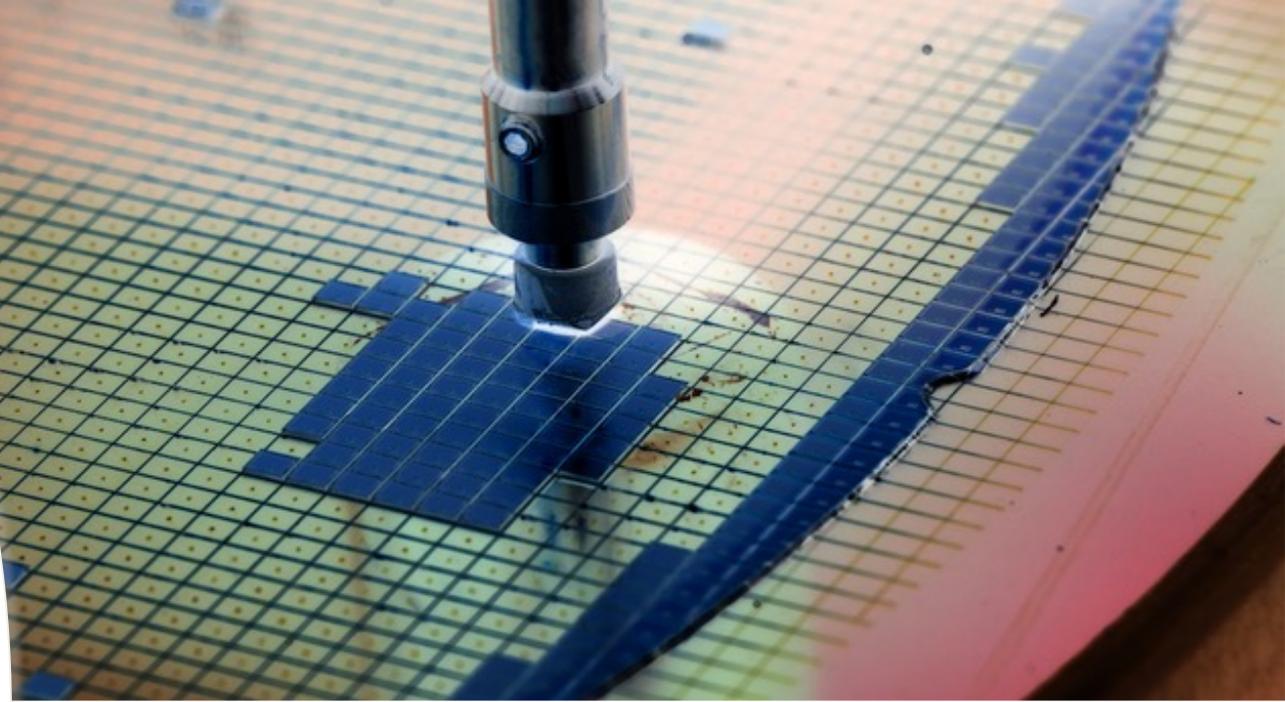


Outline

- Background
- Global PFC trends
- European PFC emissions
- PFC-218 as a potential tracer

Background

- PFCs are fully fluorinated hydrocarbons
- Emitted from aluminum smelters during 'anode events'
- Consumed industrially as etchant gases in the manufacture of semi-conductors/electronics



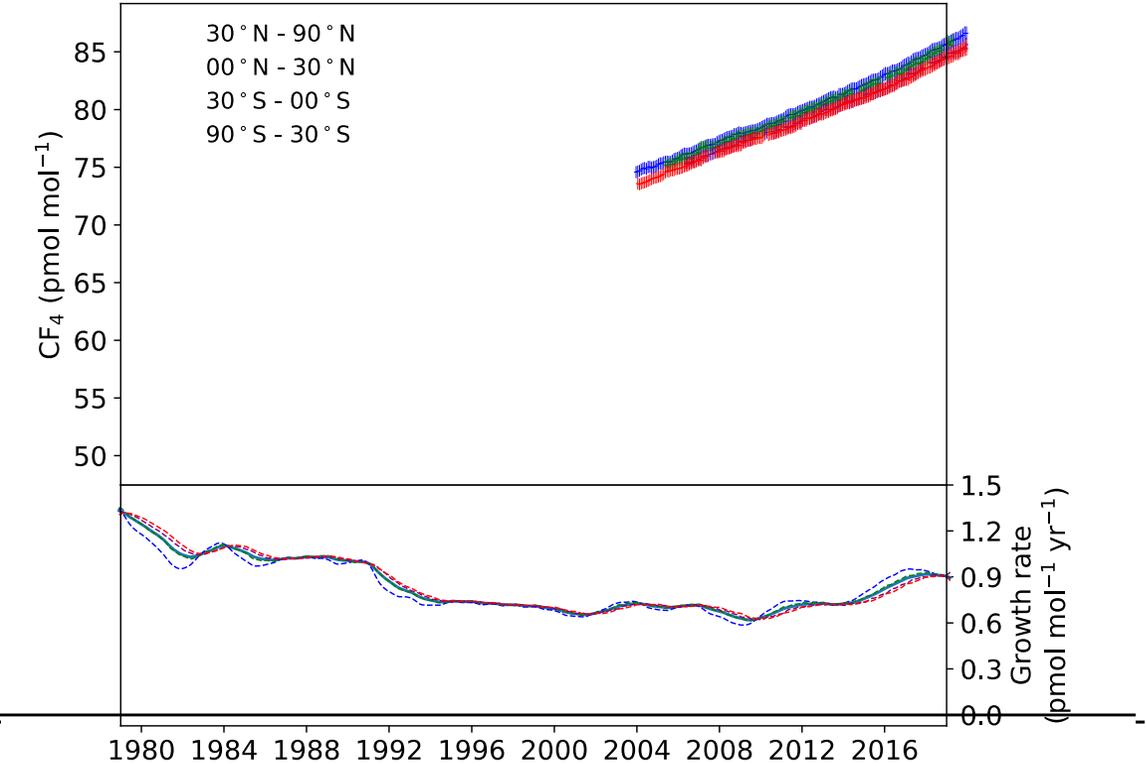
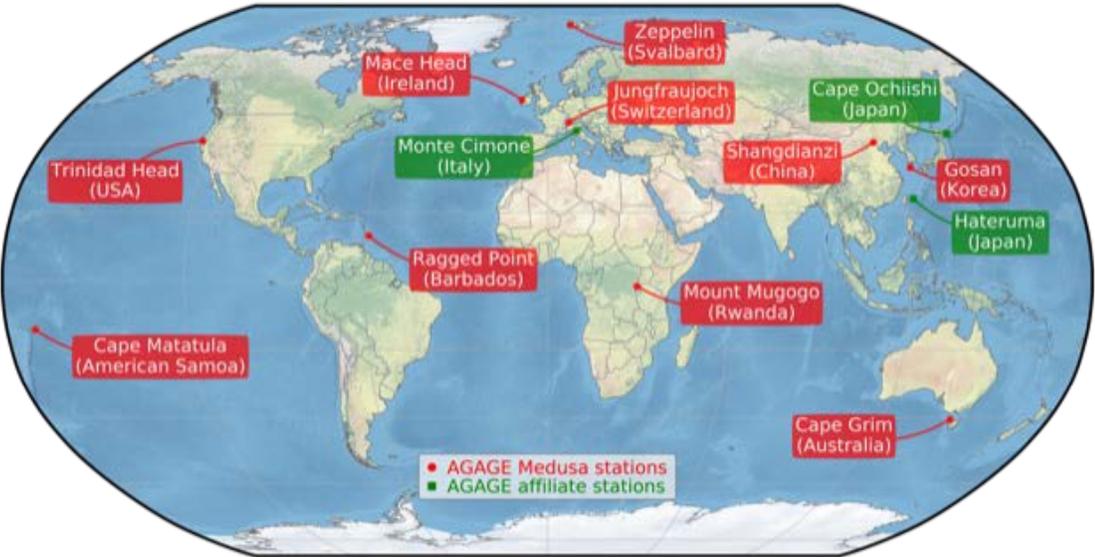
Background

- PFCs have exceedingly long lifetimes - emissions represent a permanent alteration to the atmosphere on human time-scales
- And very high Global Warming Potentials (GWP)
- The main destruction pathway is via accidental thermal decomposition

	PFC-14	PFC-116	PFC-218
Formula	CF ₄	C ₂ F ₆	C ₃ F ₈
Lifetime (y)	~50000	~10000	~2600
GWP (100 y)	6500	9200	7000

* Lifetime/GWP estimates taken from the 2018 Scientific Assessment on Ozone Depletion

Global trends

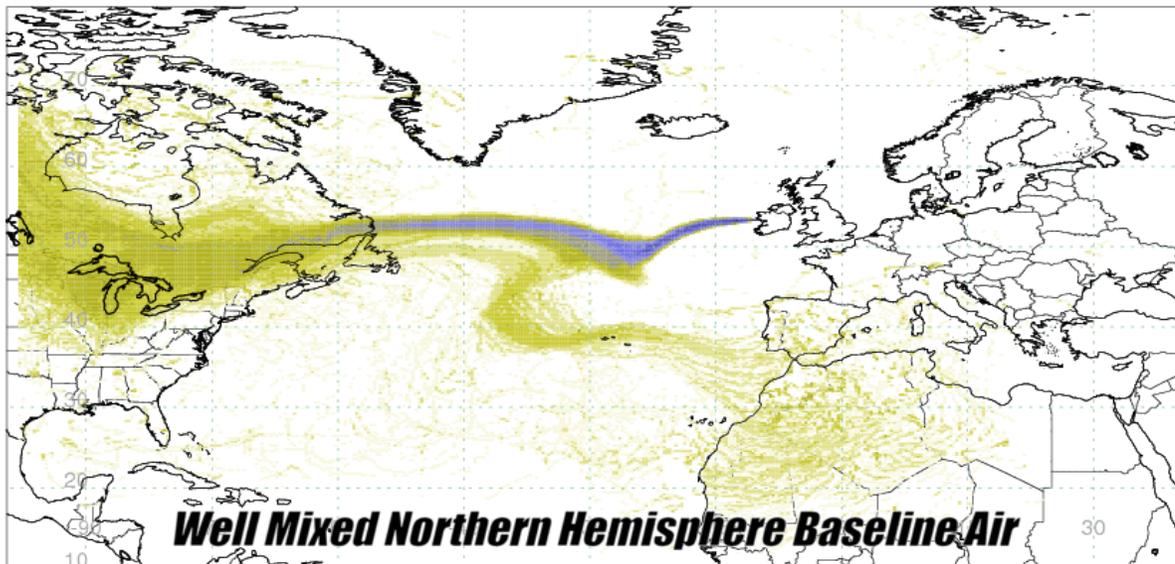


European emissions estimation

$$\text{cost} = (Me + b - y)^T R^{-1} (Me + b - y) + (e - e_p)^T B^{-1} (e - e_p)$$

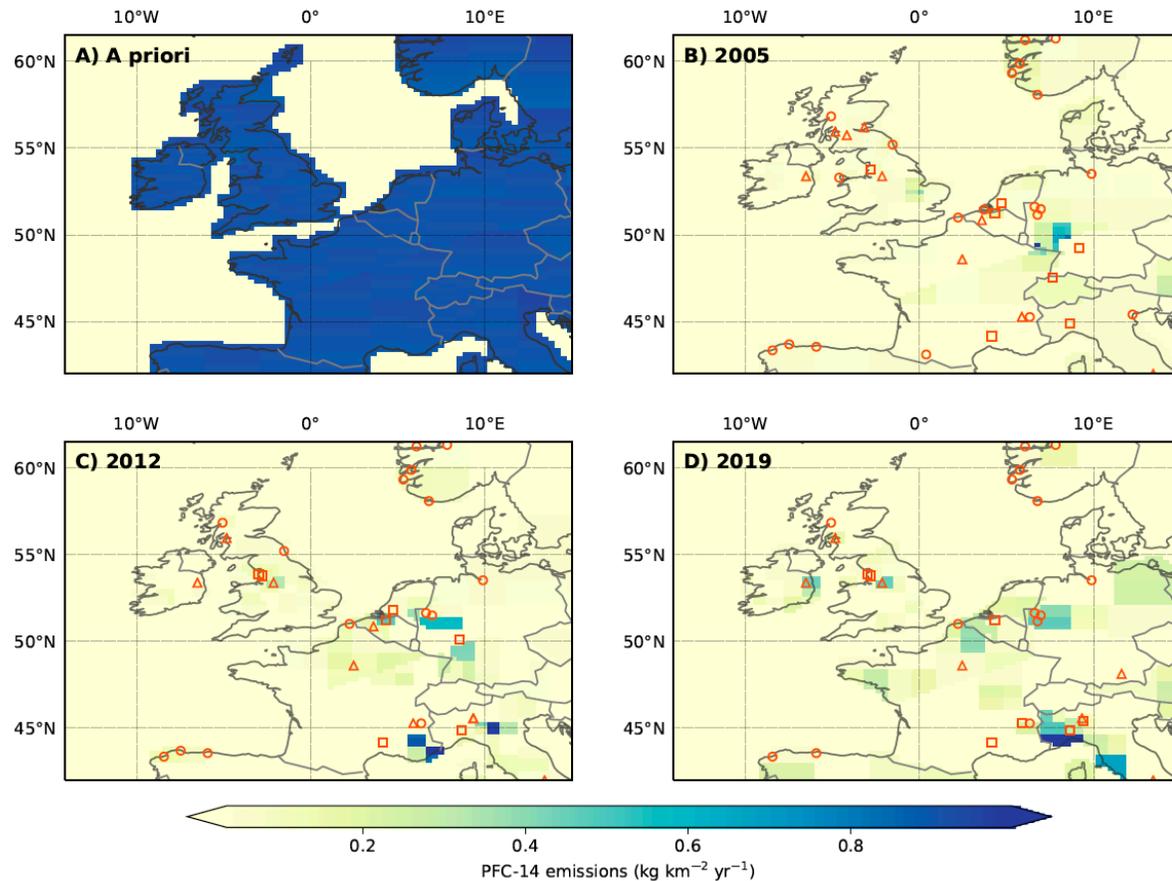


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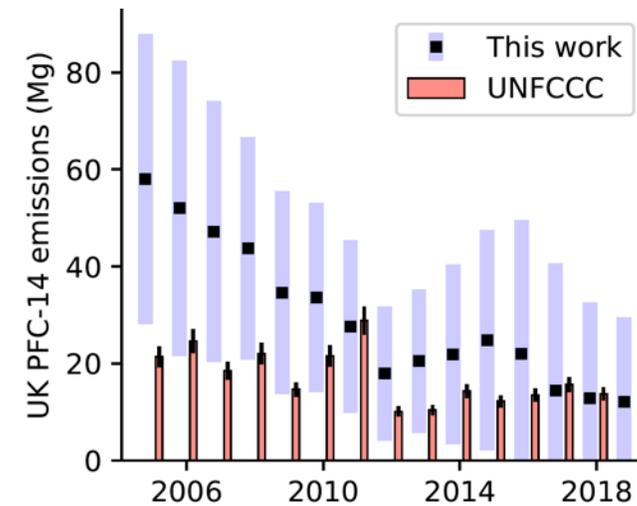


- M** = Dilution matrix
- e** = emission map (solution)
- e_p** = emission map (prior)
- y** = time-series of observations
- b** = baseline
- B** = prior uncertainty
- R** = model mismatch uncertainty

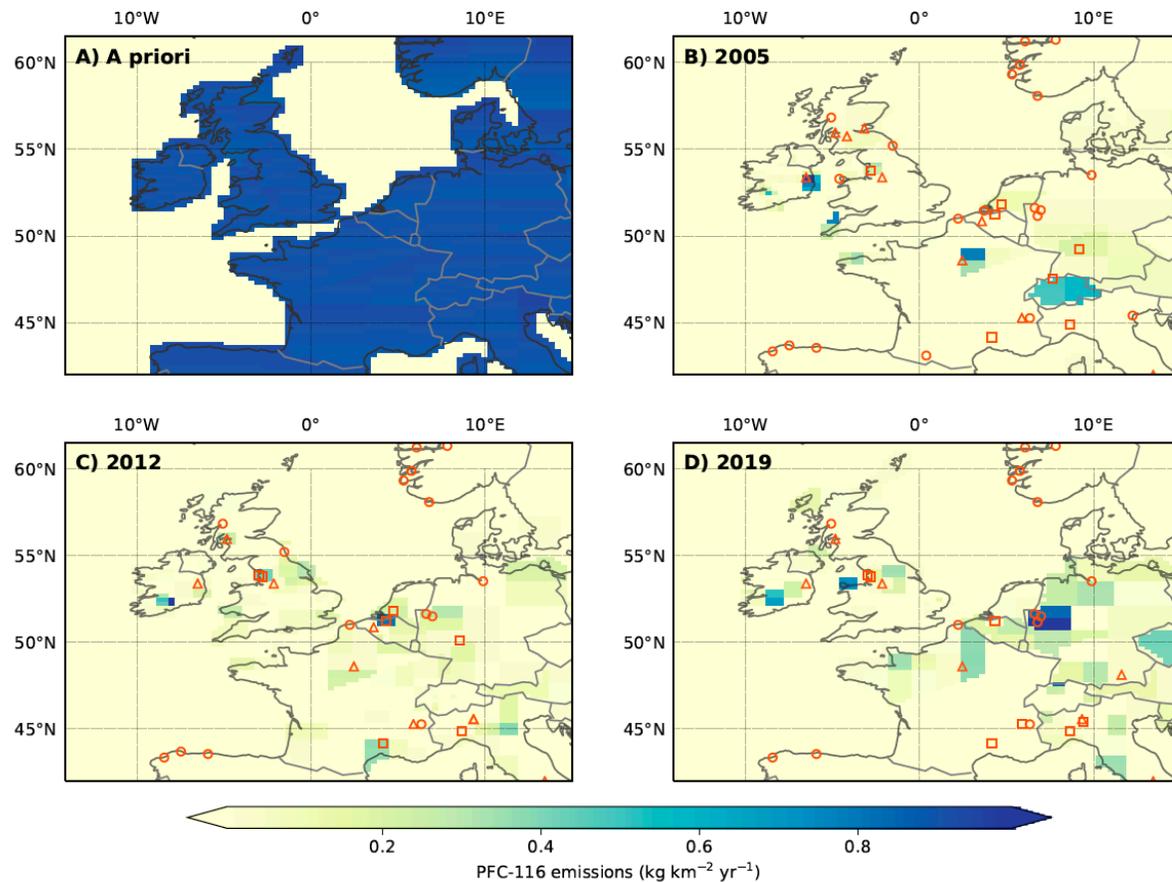
European emissions – PFC-14



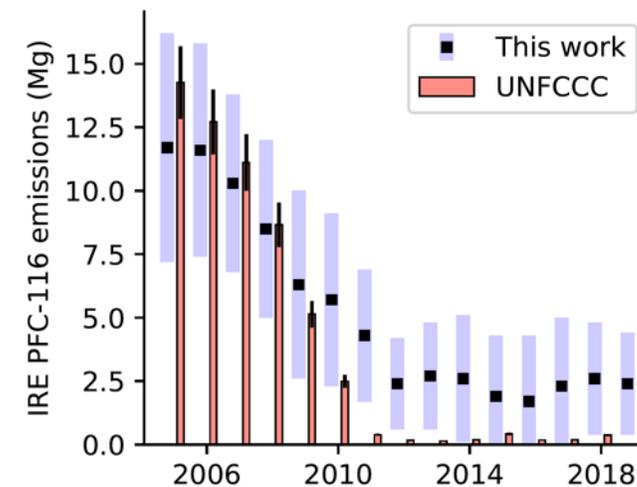
- PFC-14 emissions have declined over the measurement period
- Strongest source(s) located in northwest Italy



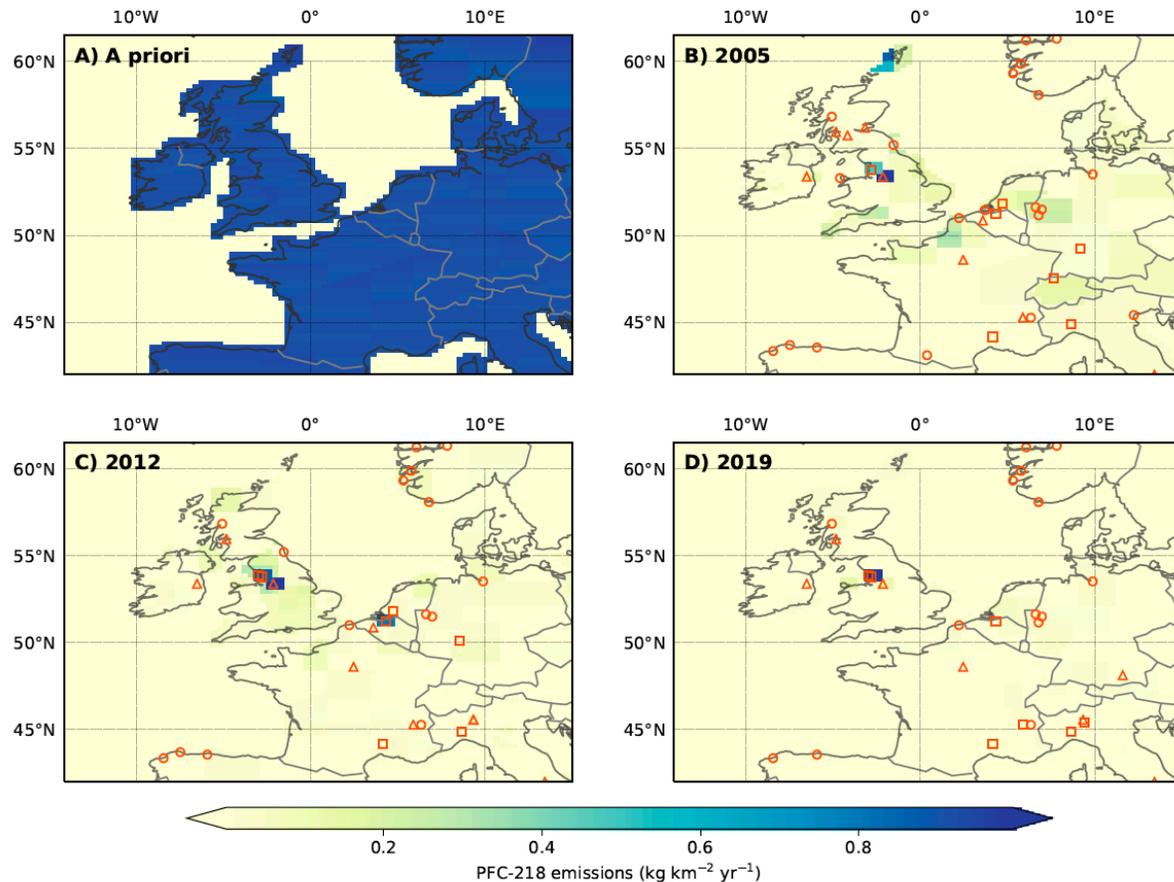
European emissions – PFC-116



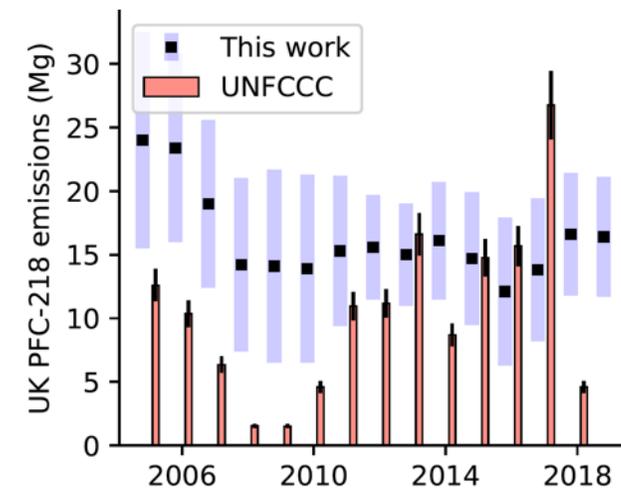
- PFC-116 emissions have not declined significantly over the measurement period
- For countries with few sources, single factories can have a large influence



European emissions – PFC-218



- No trend in northwest European PFC-218 emissions
- An *isolated* source situated in northwest England



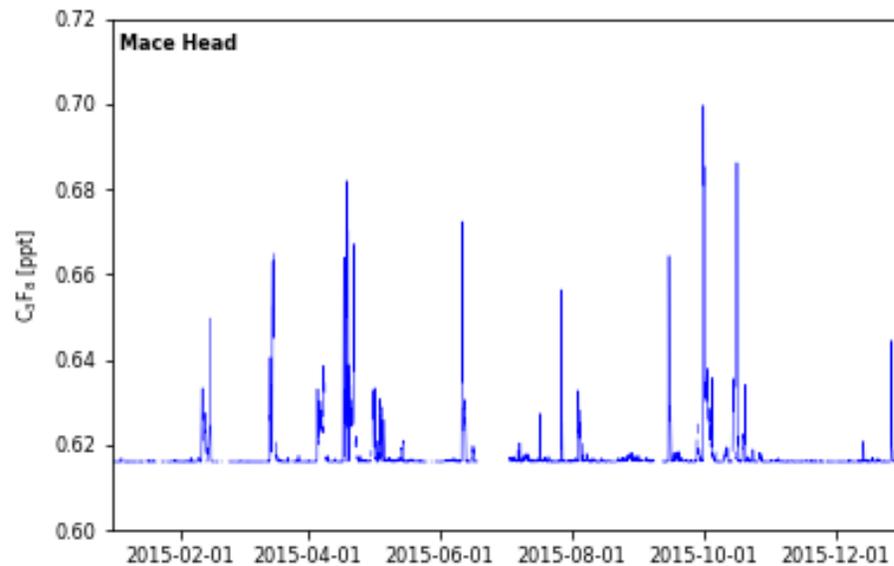
PFC-218 as a potential tracer

What makes a good tracer?

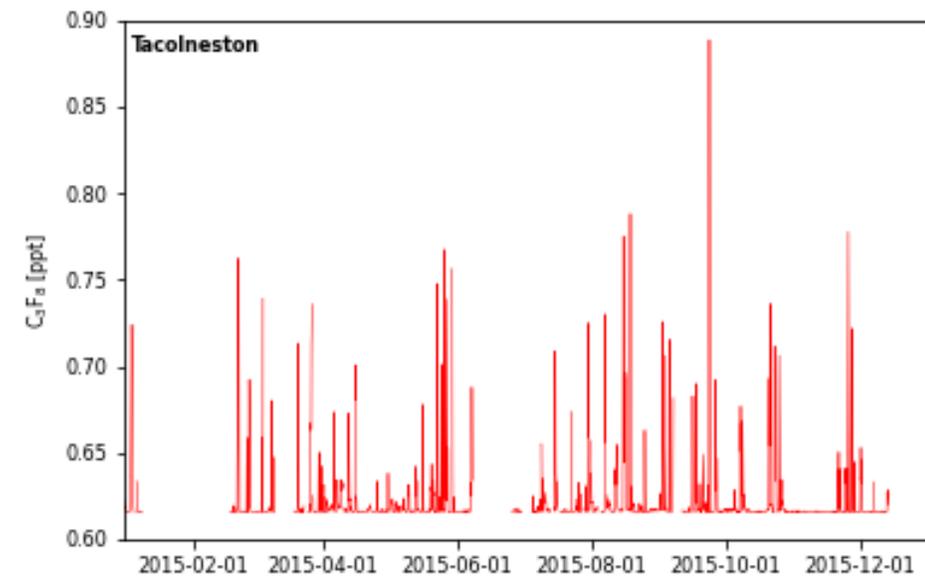
- Chemically inert
- Known distribution of sources
- Regularly 'seen' by existing observatories
- Well-defined emissions

PFC-218 as a potential tracer

Regularly 'seen' by existing observatories



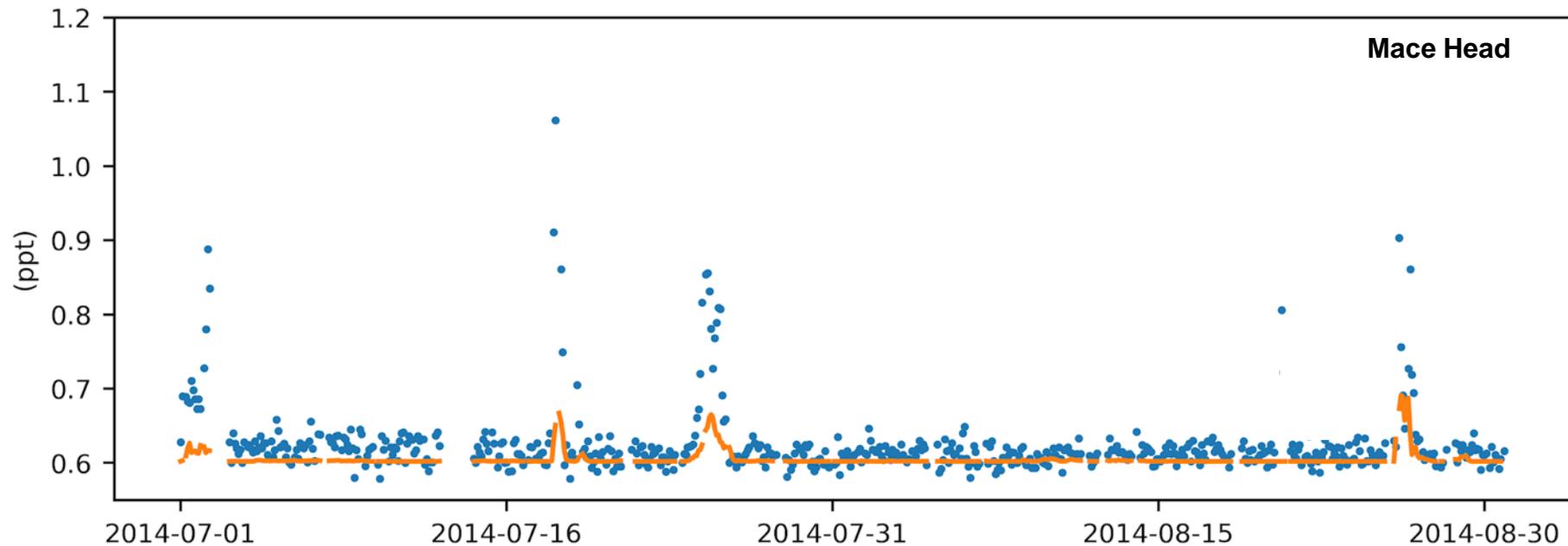
64% at MHD



81% at TAC

PFC-218 as a potential tracer

Well-defined emission  ...for now



Conclusions

- Accelerated growth in mean baseline mole fraction of PFC-14 post financial crash
- Decline in European emissions of PFC-14, no trend for PFC-116 and PFC-218
- In general, estimates agree well with emissions data reported to the UNFCCC
- Northwest European emissions of PFC-218 dominated by a single facility
 - Currently in the process of obtaining detailed emissions information that could make this facility a useful tracer release experiment

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