

Global emissions of CFCs and other ODS due to processes not controlled under the Montreal Protocol

Luke Western

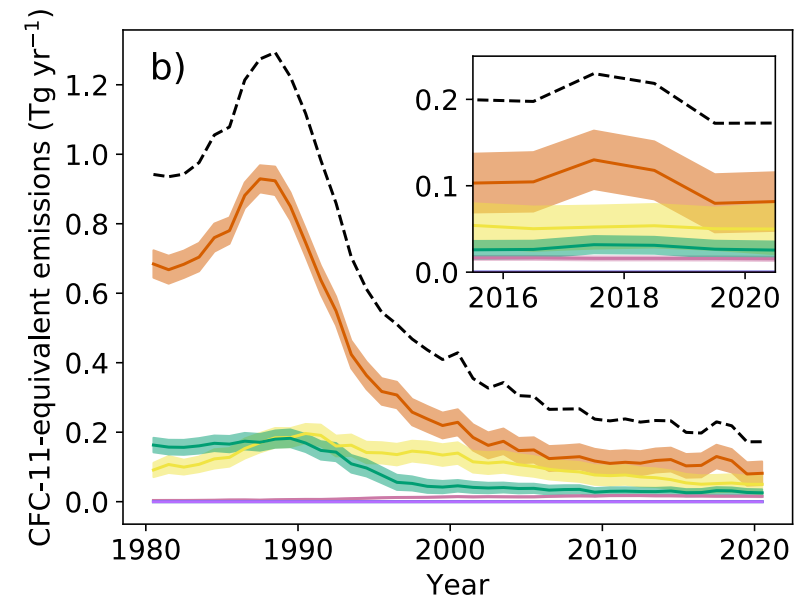
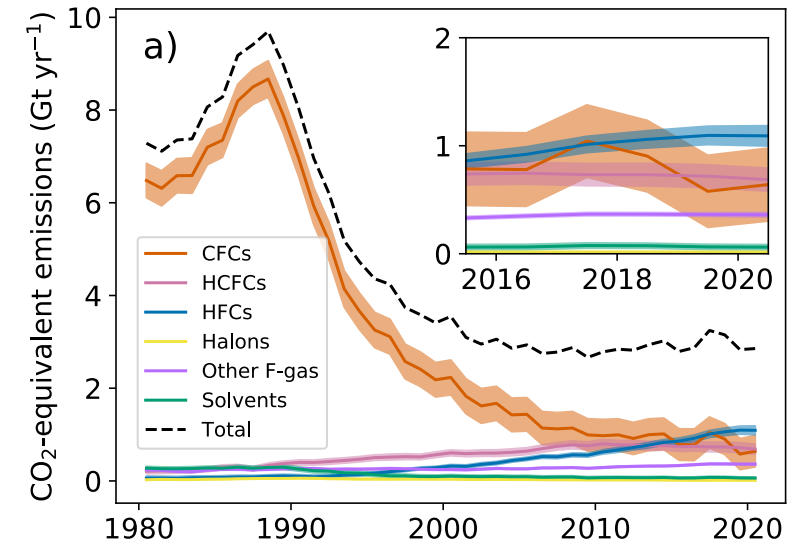
School of Chemistry, University of Bristol, UK

luke.western@bristol.ac.uk

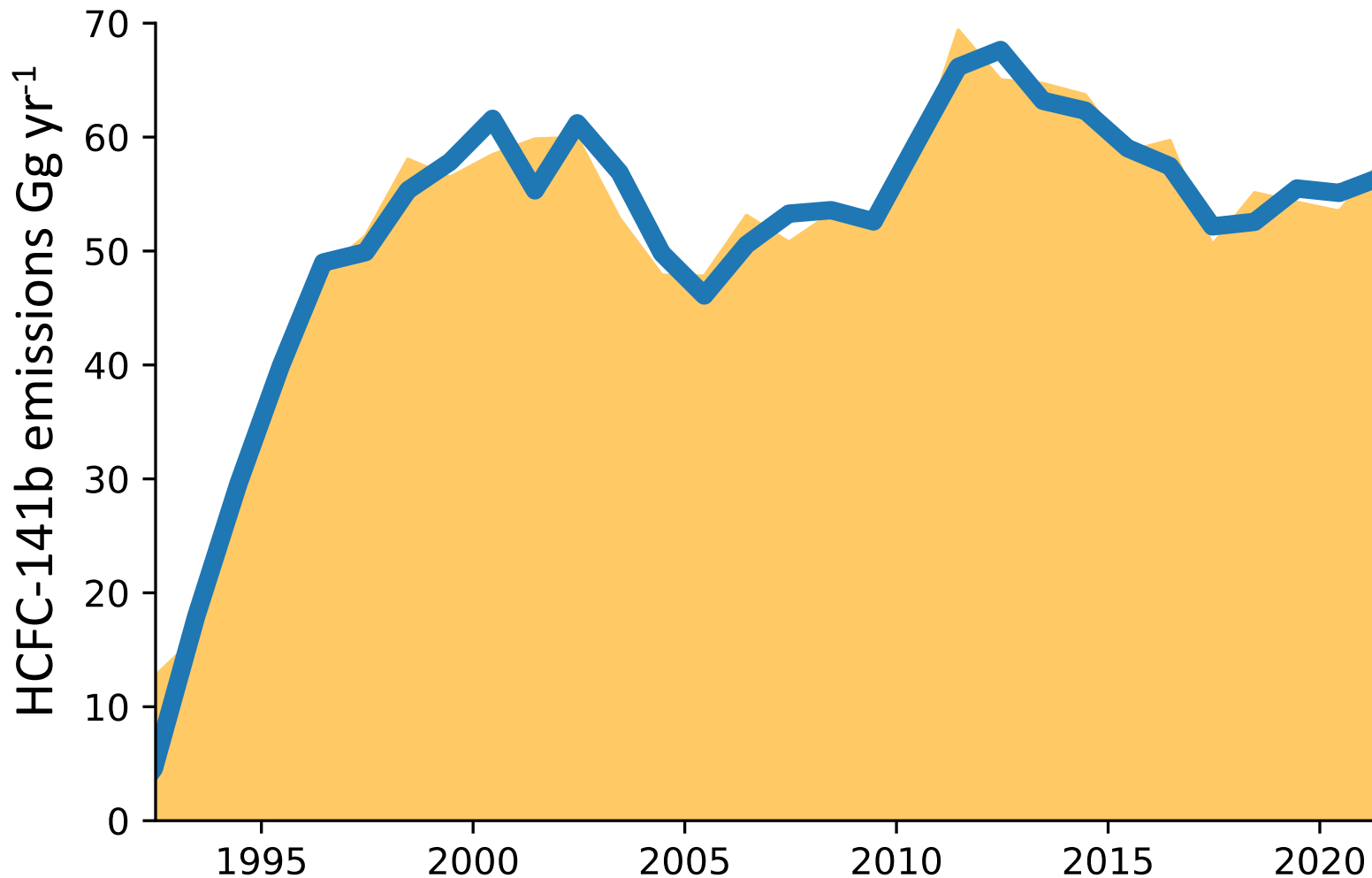
MOP35

Emissions of individual ODSs have not always decreased with production

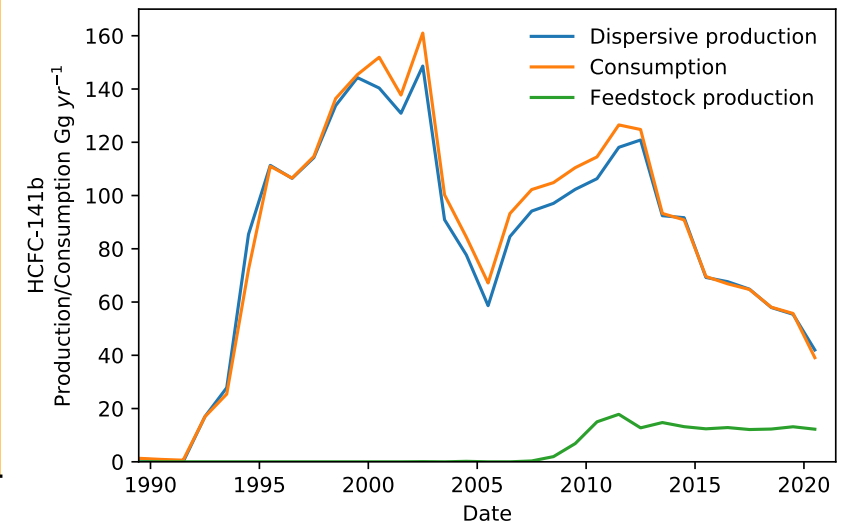
- Emissions of ODS are falling
- Now emissions from banks and use are small, we can see minor emissions sources
- Some increasing emissions are from processes not controlled under the Montreal Protocol



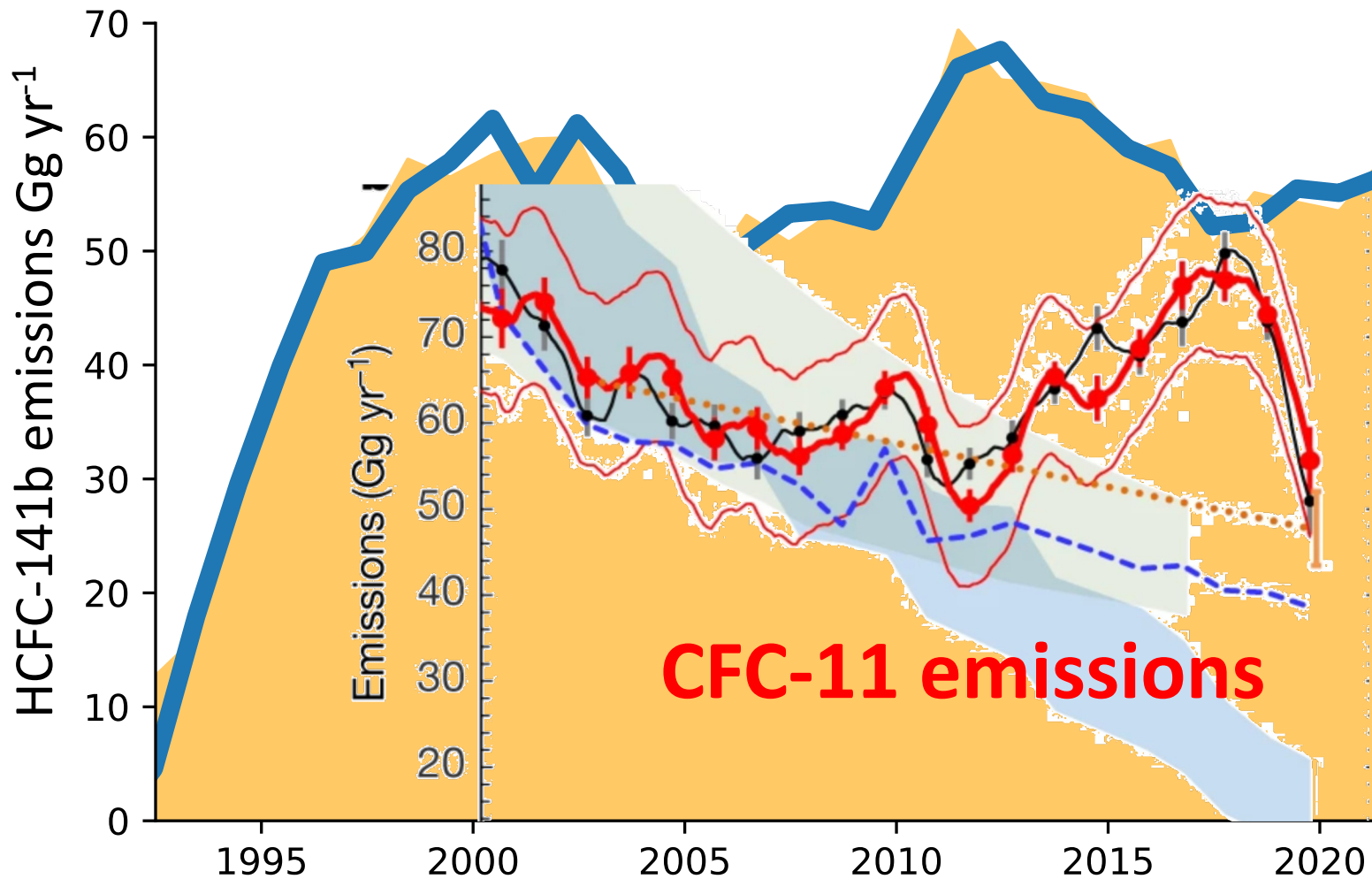
Emissions of HCFC-141b have been rising since 2017



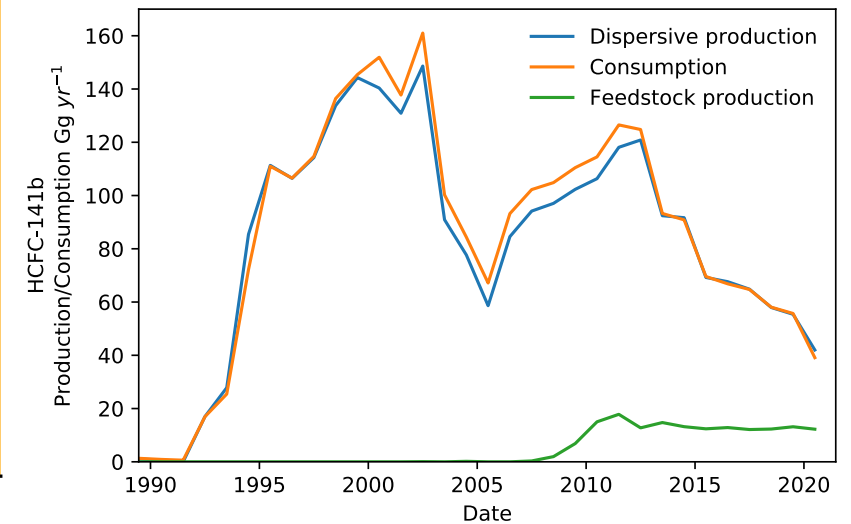
- Emissions aren't directly proportional to production
- Emissions are delayed as they are emitted from the banks



Emissions of HCFC-141b have been rising since 2017



- Emissions aren't directly proportional to production
- Emissions are delayed as they are emitted from the banks

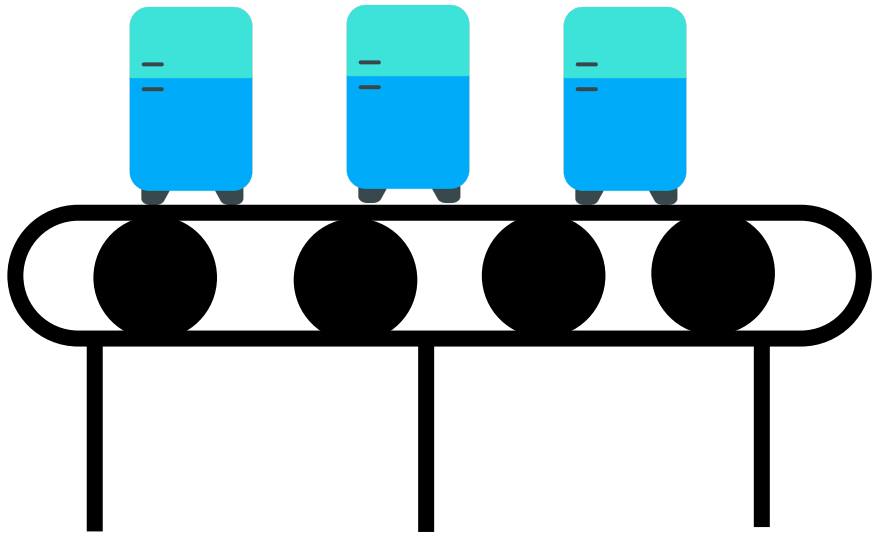


Have we seen a switch from CFC-11 to HCFC-141b?

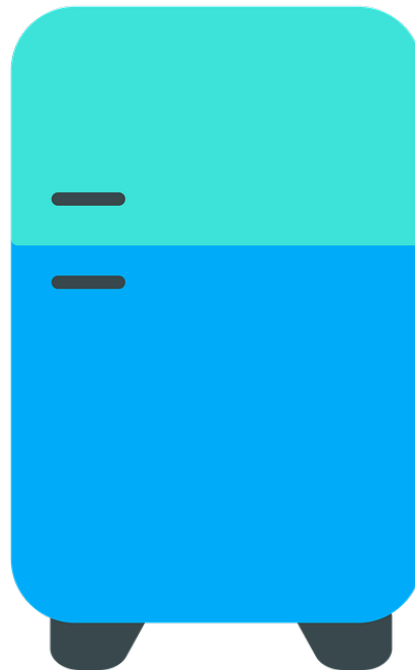
Not so clear cut as we might think...

...emissions occur at various stages

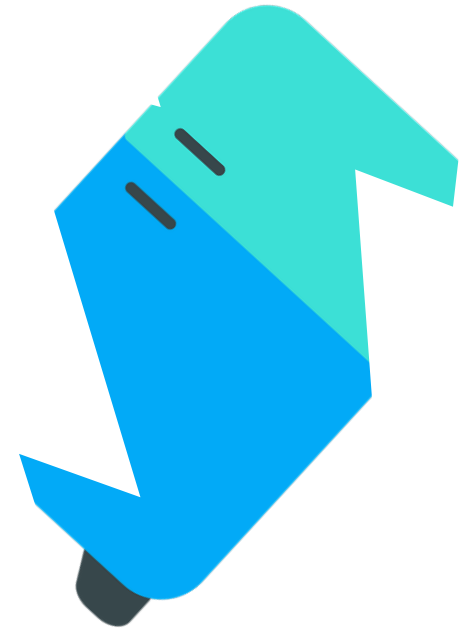
1. Production and installation



2. Leakage during use



3. Leakage during disposal



HCFC-141b emissions are, at least in part, coming from the bank

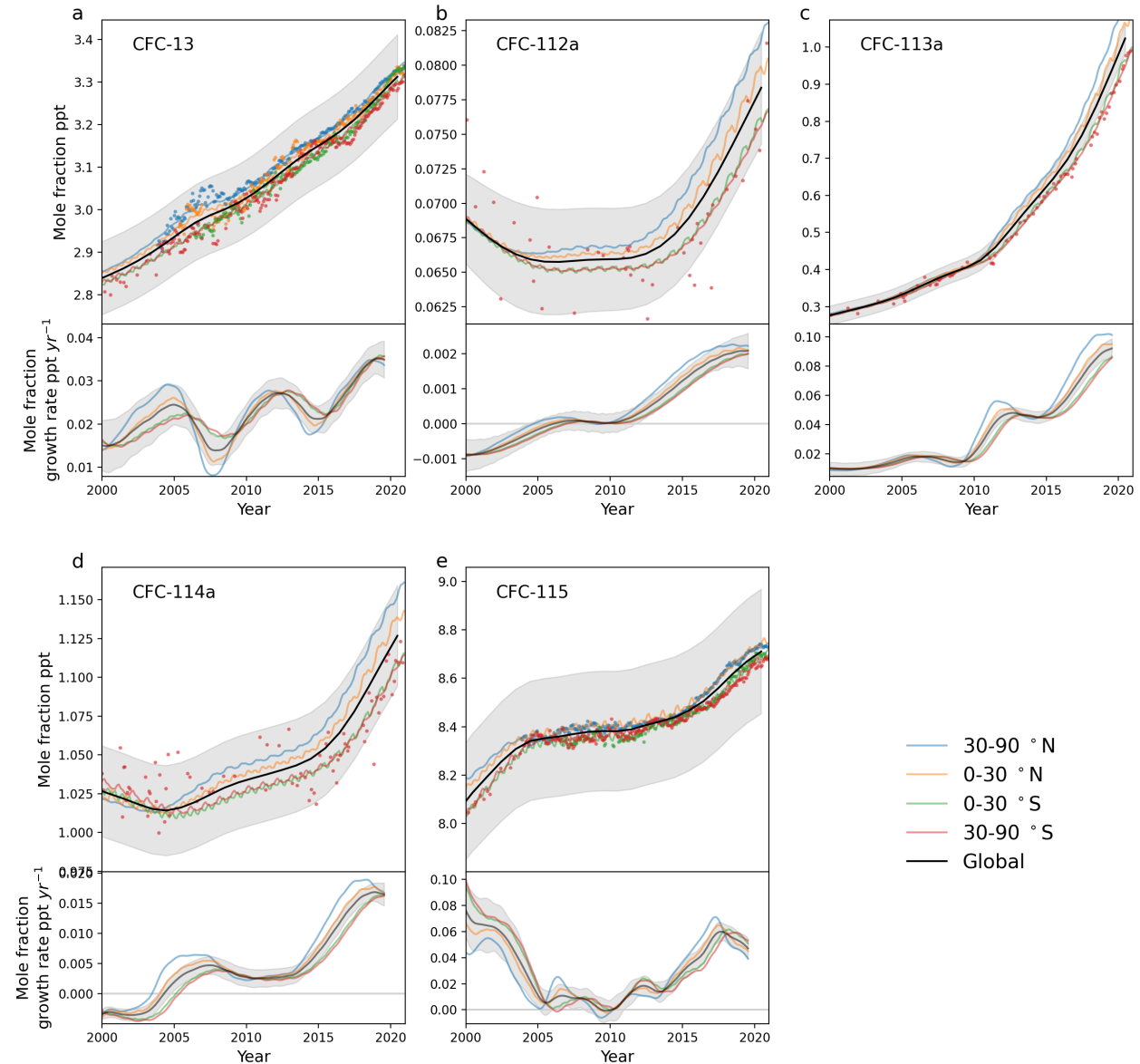
- The timing of the increase is similar to a fall in CFC-11 emissions (the main precursor to HCFC-141b for foam blowing) following a period of unreported production
- Available regional emissions only account for around 30% of global increase
- Higher emissions following the disposal of appliances with HCFC-141b containing foams may be partially responsible
- We can likely rule out emissions from feedstock usage

HCFC-141b emissions are, at least in part, coming from the bank

- The timing of the increase is similar to a fall in CFC-11 emissions (the main precursor to HCFC-141b for foam blowing) following a period of unreported production
- Available regional emissions only account for around 30% of global increase
- Higher emissions following the disposal of appliances with HCFC-141b containing foams may be partially responsible
- We can likely rule out emissions from **feedstock** usage

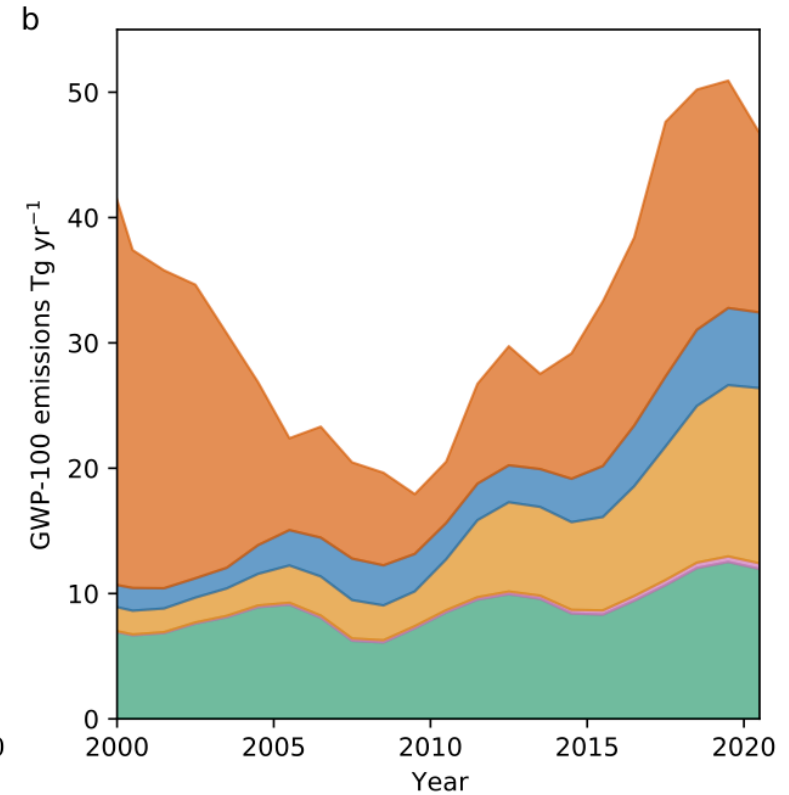
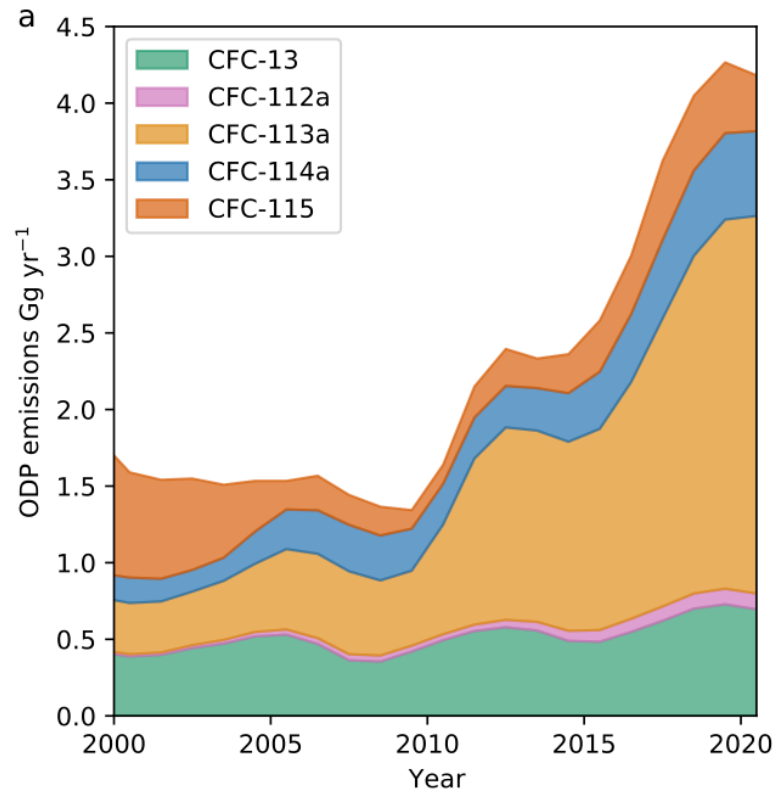
Abundances of several CFCs have increased since 2010

- Abundances of CFC-13, -112a, -113a, -114a and -115 are increasing
- Global mean abundances <10 ppt (50-500 ppt for 3 major)
- Few or no known uses or banks



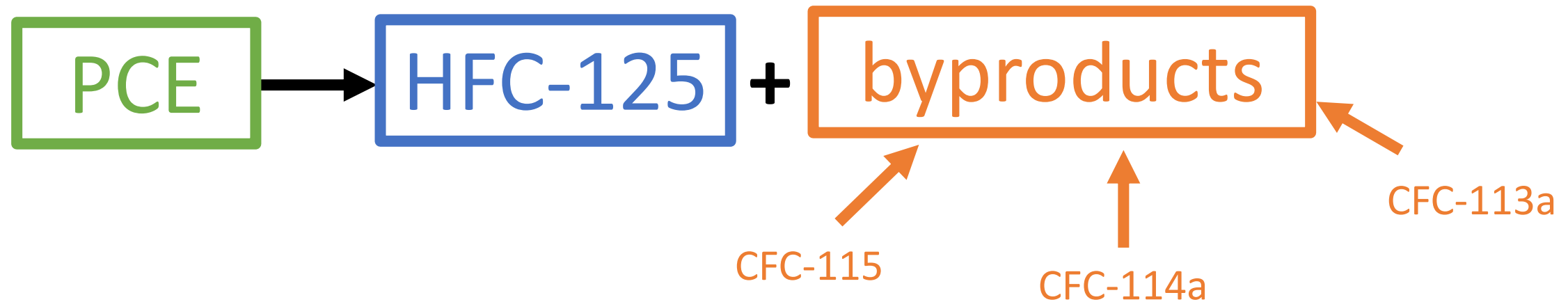
Abundances of several CFCs have increased since 2010

- 10-year increase is around a fifth of CFC-11
- As well as being ODSs, they also have very high global warming potentials
- CO₂-eq emissions around the size of Switzerland in 2020



Some CFC emissions are likely due to HFC production

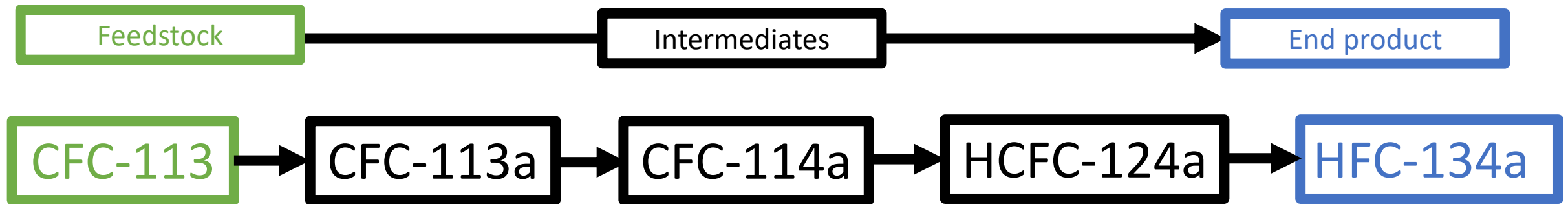
CFC-115, CFC-113a and CFC-114a are 'undesirable by-products' of HFC-125 production



The CFCs may not be being destroyed properly

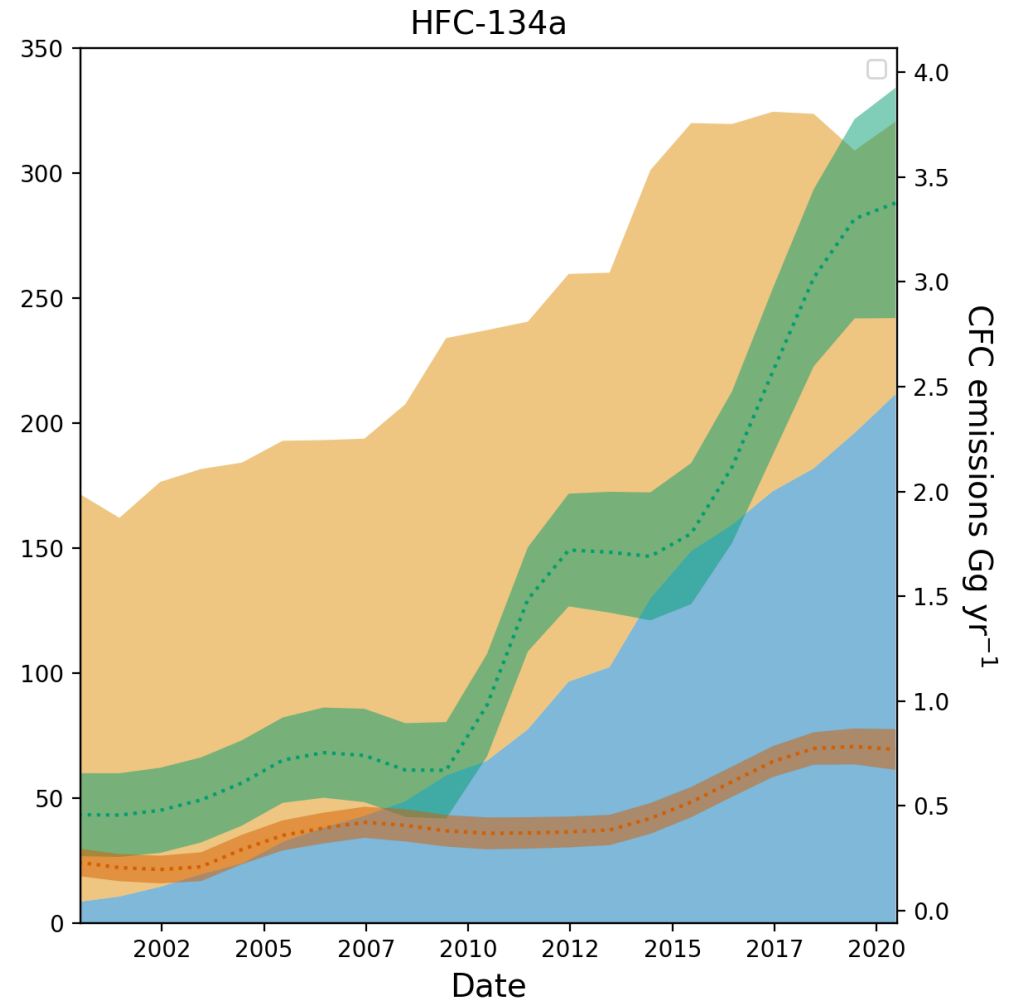
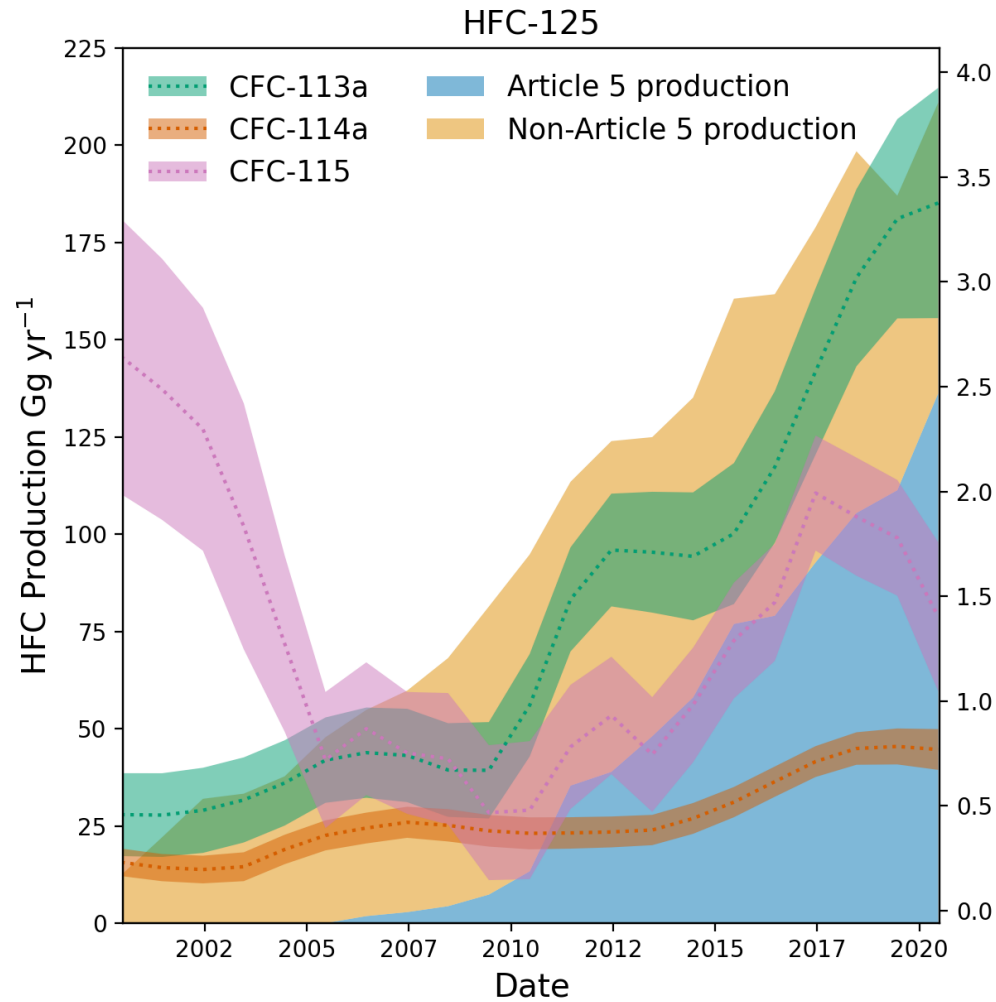
CFC-113a and CFC-114a are intermediates of HFC-134a production

Production of HFC-134a:

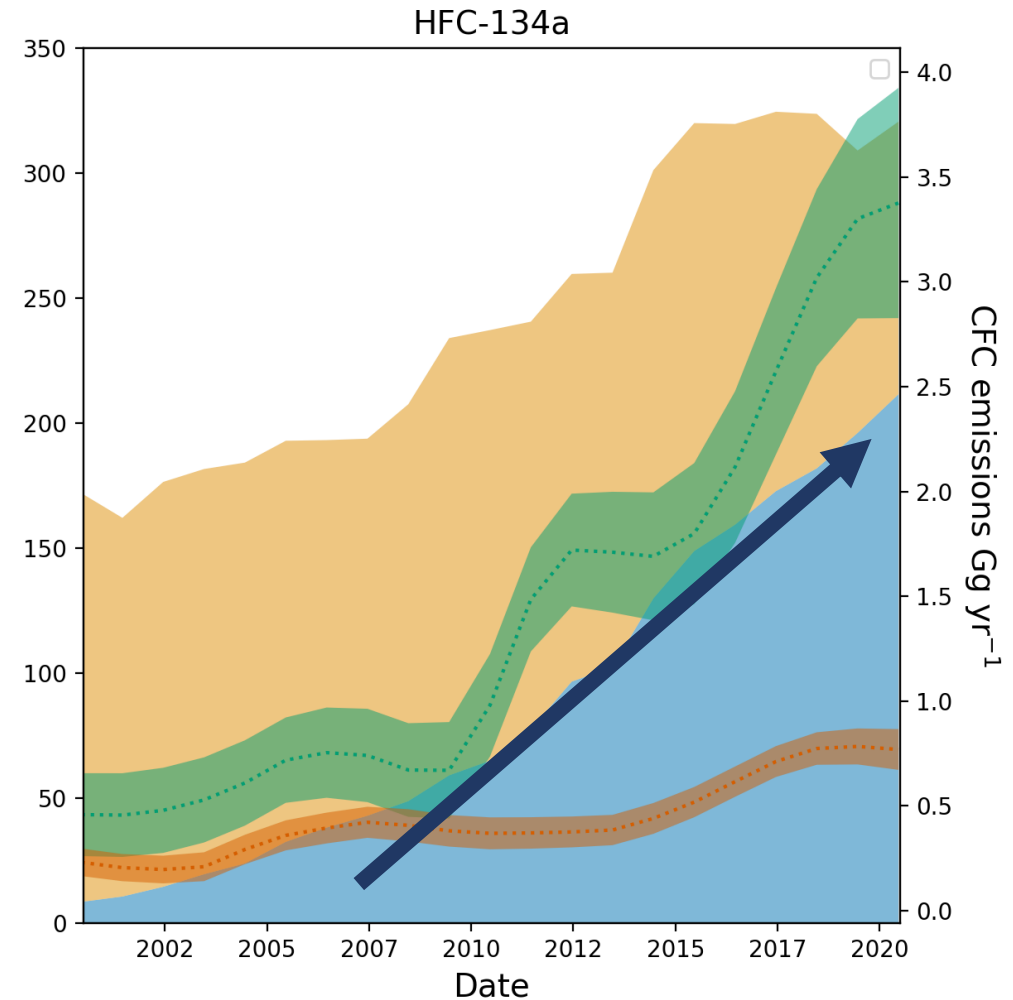
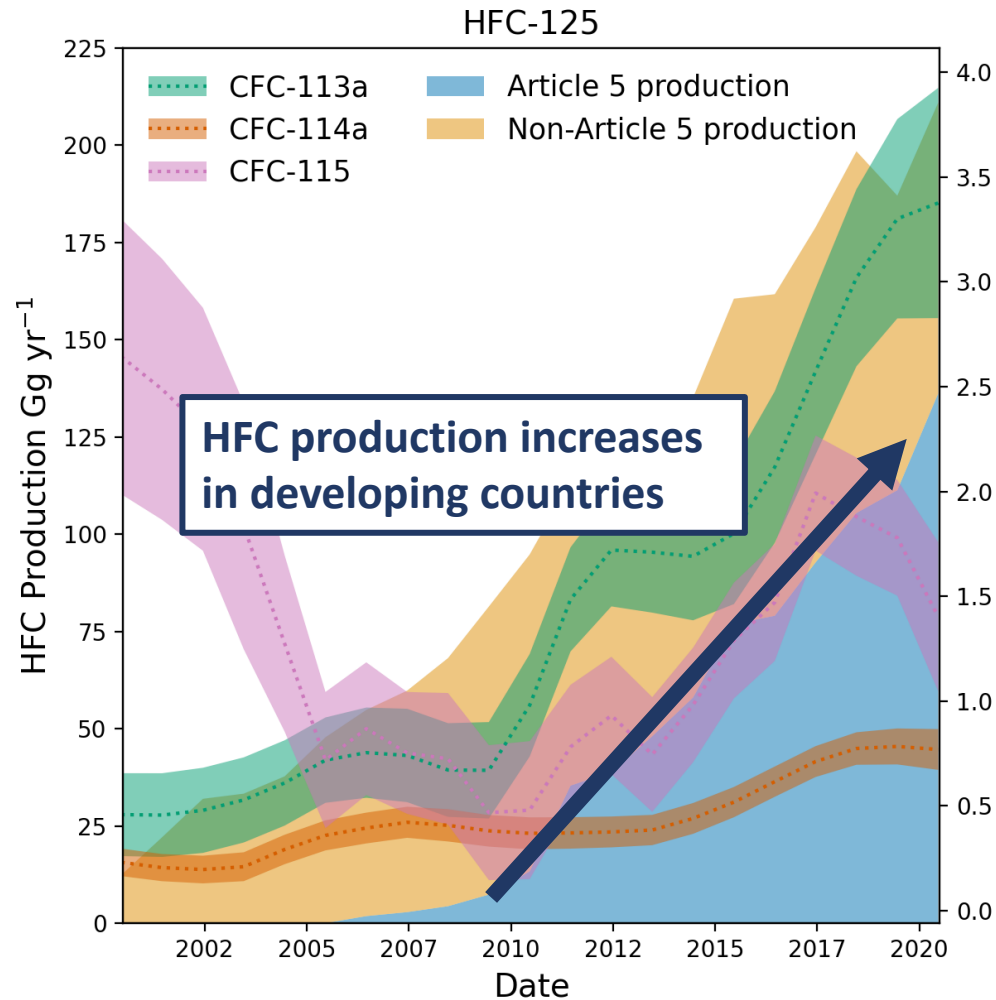


Some of the intermediates could be leaking during production

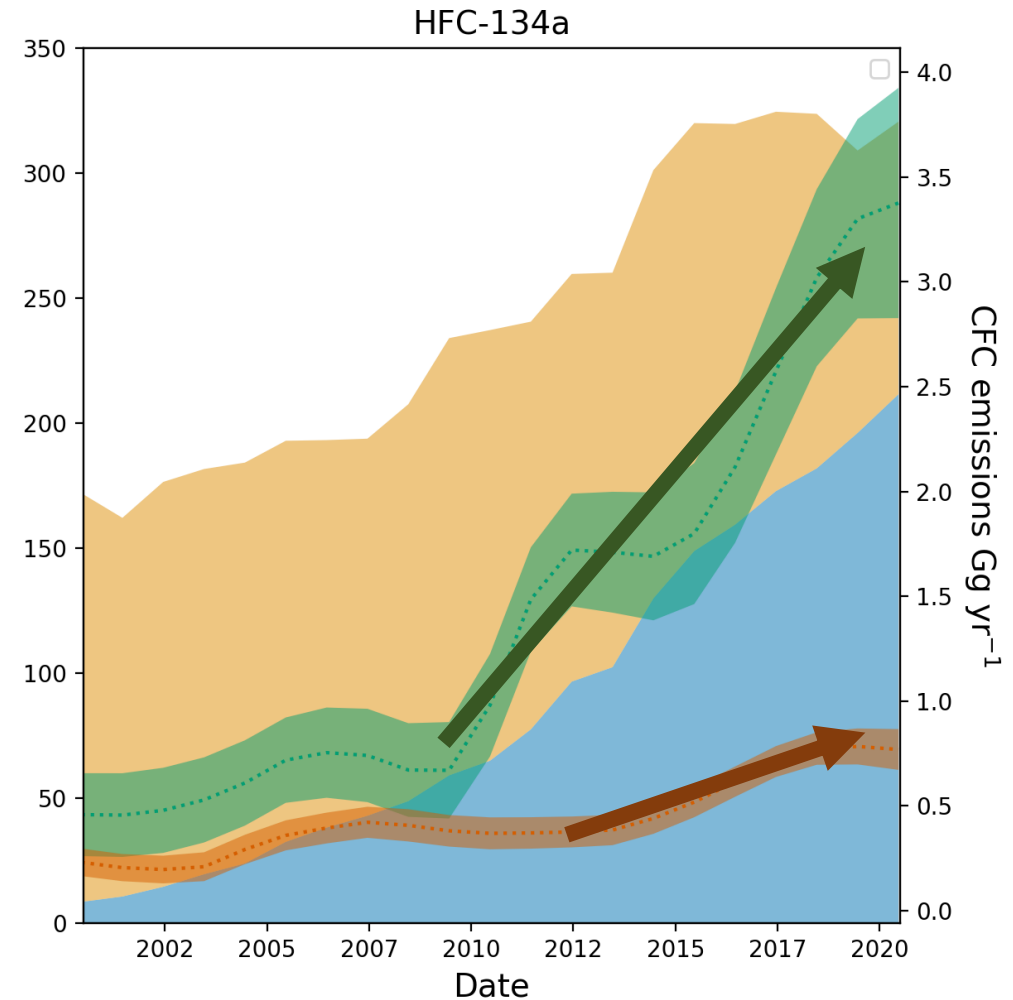
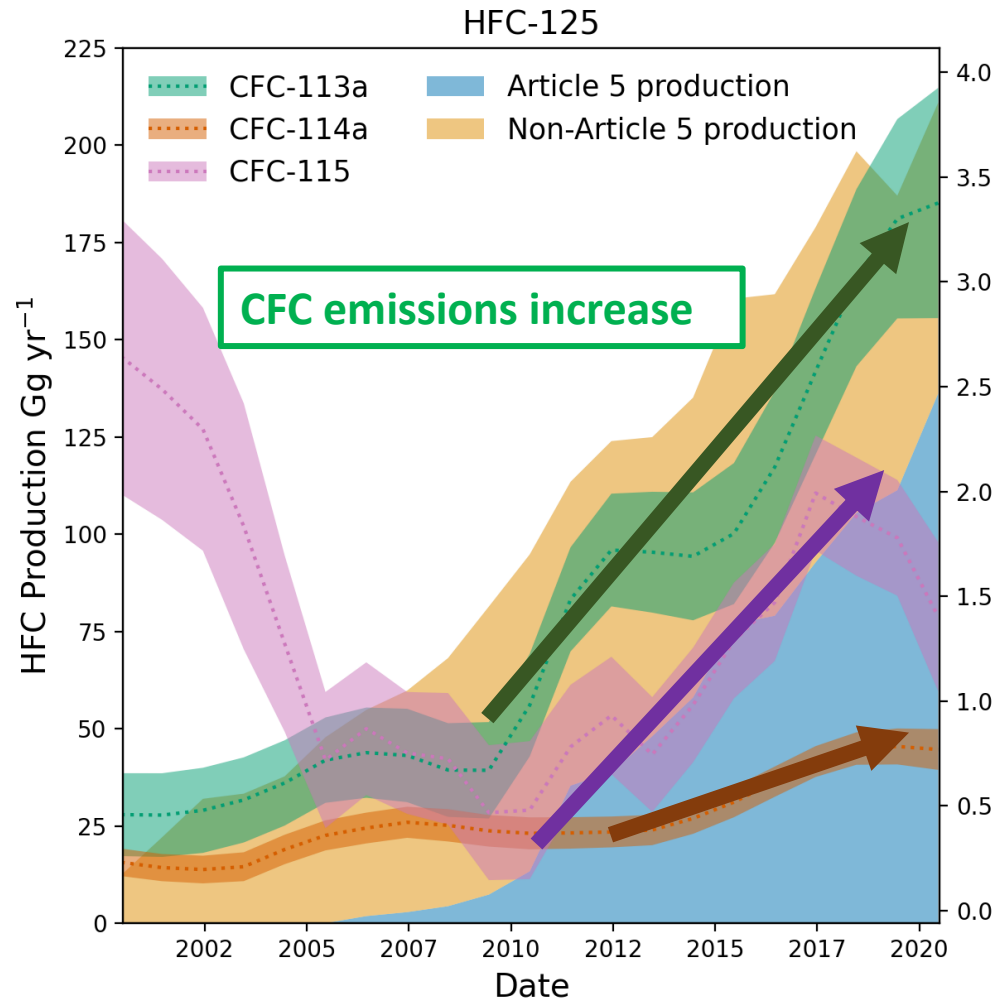
HFC production has massively increased since 2000 in developing countries



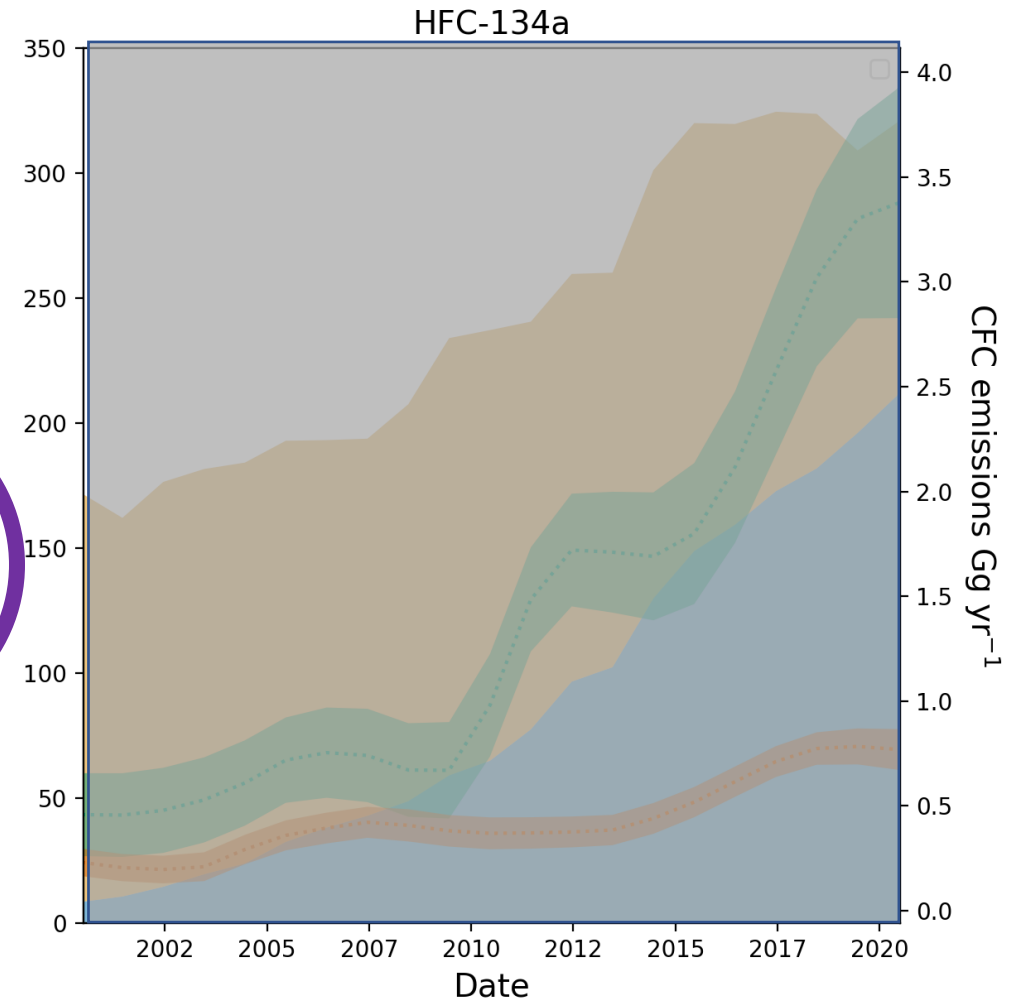
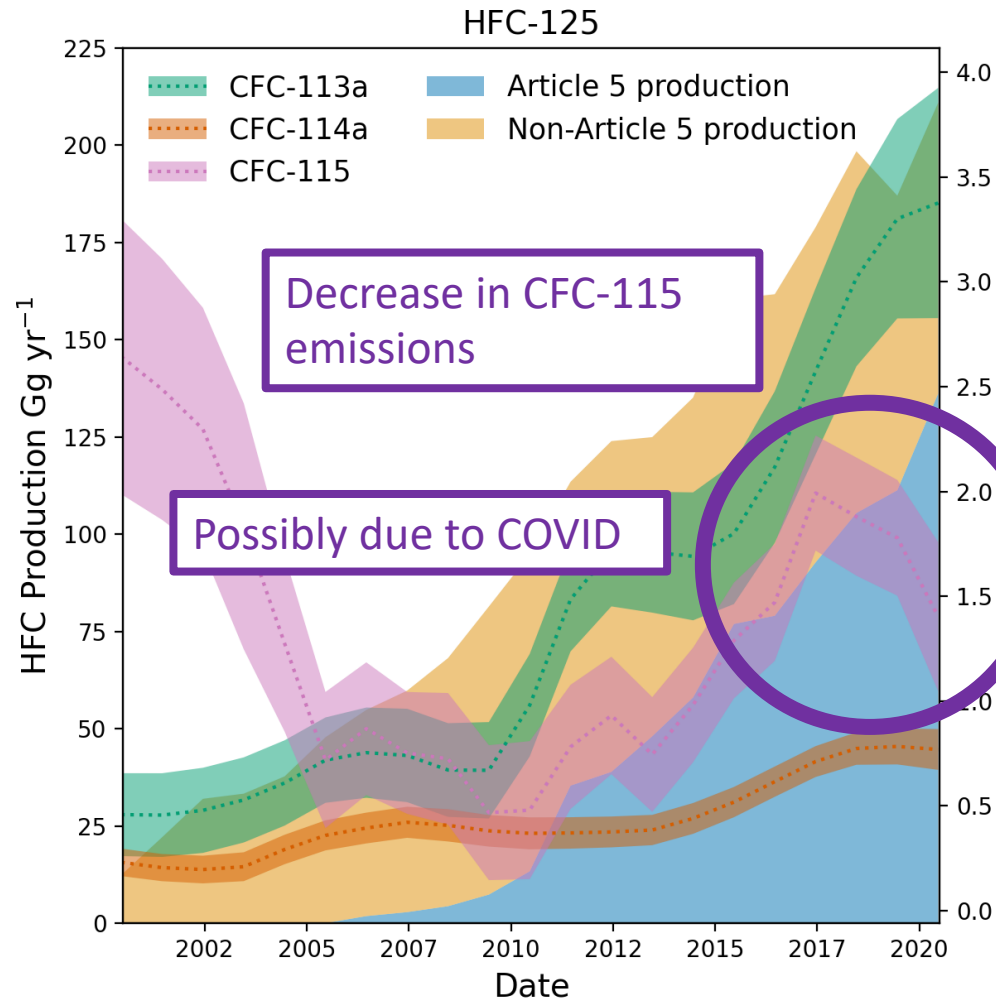
HFC production has massively increased since 2000 in developing countries



HFC production has massively increased since 2000 in developing countries



HFC production has massively increased since 2000 in developing countries



CFC-13

- Unknown

CFC-112a

- Unknown

CFC-113a

- HFC production
- HFO production
- TFA production
- Pesticides

CFC-114a

- HFC production

CFC-115

- HFC production

CFC-13

- Unknown

CFC-112a

- Unknown

CFC-113a

- HFC production
- HFO production
- TFA production
- Pesticides

CFC-114a

- HFC production

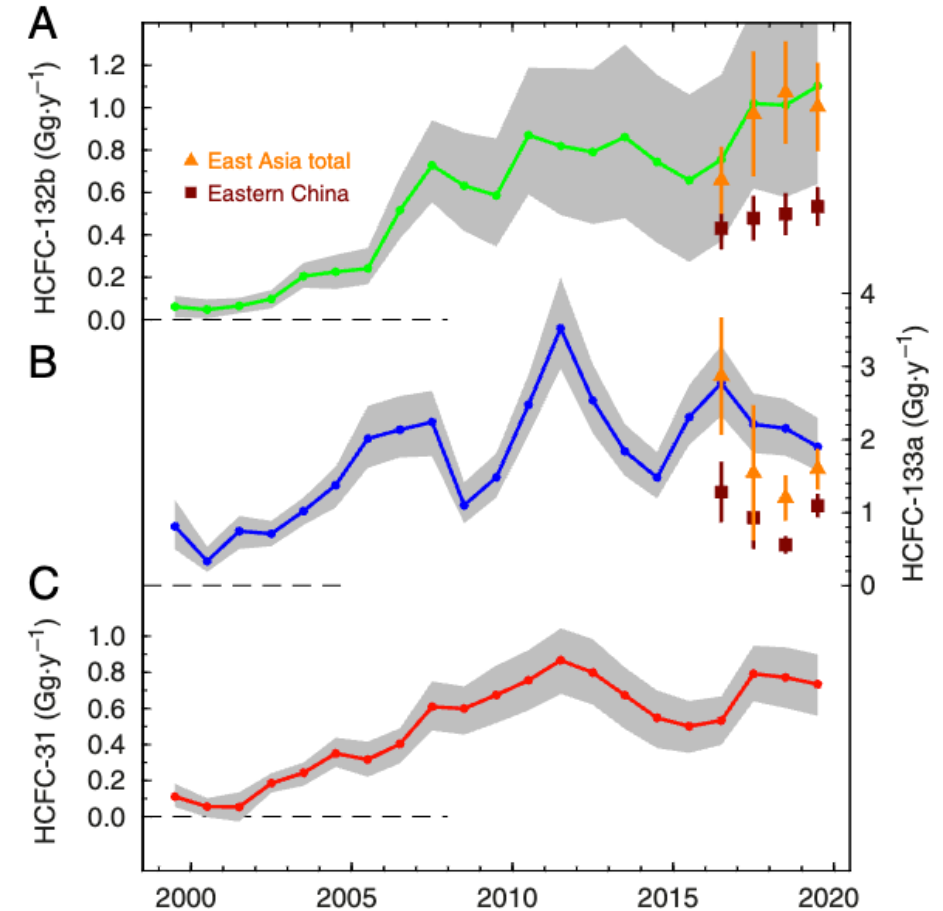
Emissions are likely coming from processes allowed under Montreal Protocol

CFC-115

- HFC production

Many other cases ODS emissions not falling

- [emissions of minor HCFCs are] believed to derive from current industrial production processes (Vollmer et al., 2020)
- CFC-113 emissions ... are much larger than expected, raising questions about its sources. (Lickley et al., 2020)
- The atmospheric abundance of CCl_4 continued to decrease at slower rates than expected, which could be due to underestimated emissions from feedstock production and usage. (Ozone Assessment 2022)



Vollmer et al., (2020)

Summary

- Emissions of ODSs have fallen and we can now detect ‘unusual’ emissions
- Emissions from banks may increase long after production declines
- Net-zero carbon targets likely don’t consider these things
- Production processes for HFCs and HFOs likely emit ODSs

Other ODSs and controlled substances increasing:

HCFCs, HFCs, VSLS....