

Observational constraints on U.S. emissions of halocarbons from multiple NOAA sampling networks

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Sample collectors, pilots*

M. Trainer (CSD), D. Blake (UCI), E. Atlas (Univ. of Miami)

Goal: use atmospheric data to assess greenhouse gas emissions and their change over time...

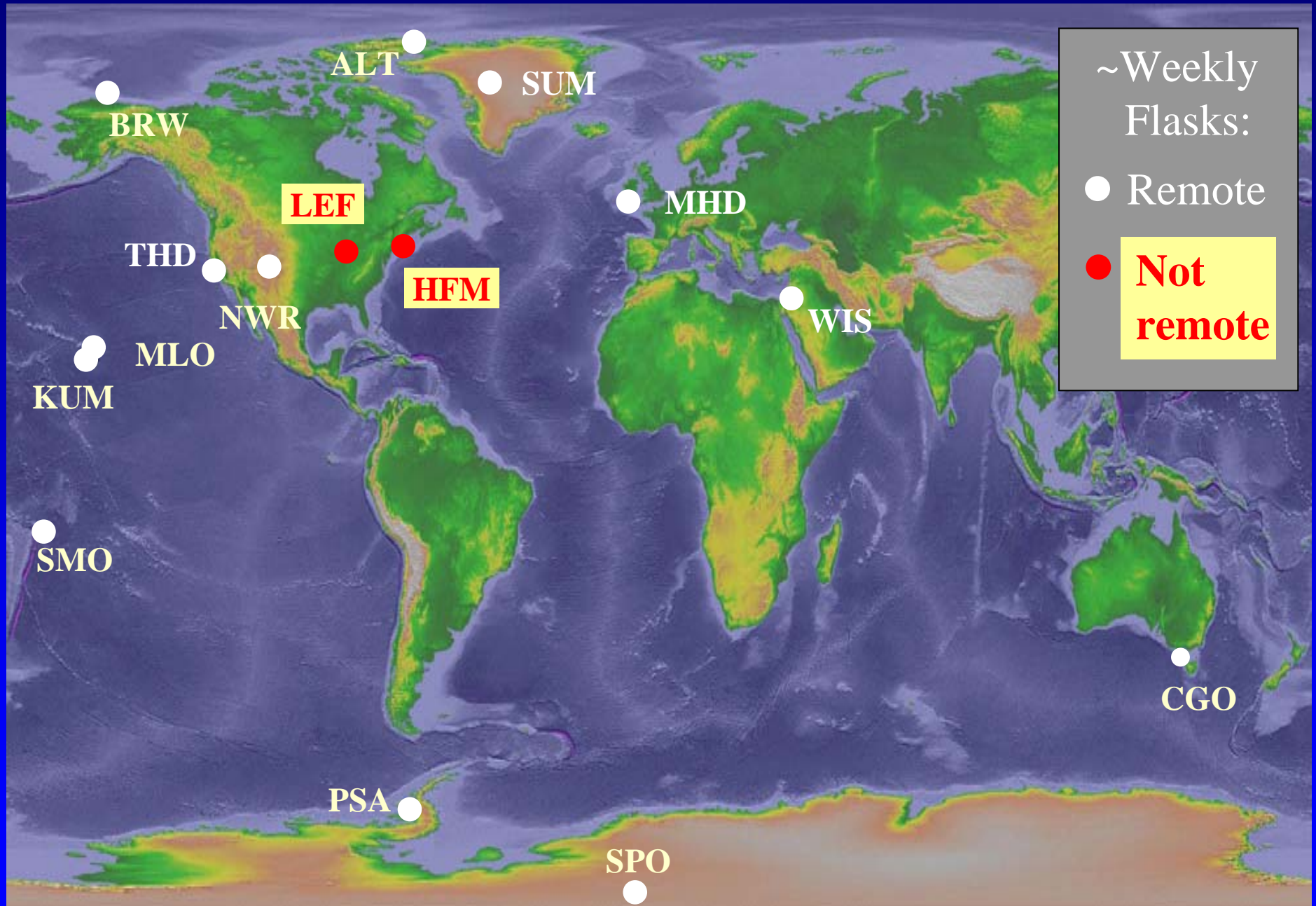
For today, a progress report on emission signals in data

- Mixing ratio enhancements in the US continental boundary layer

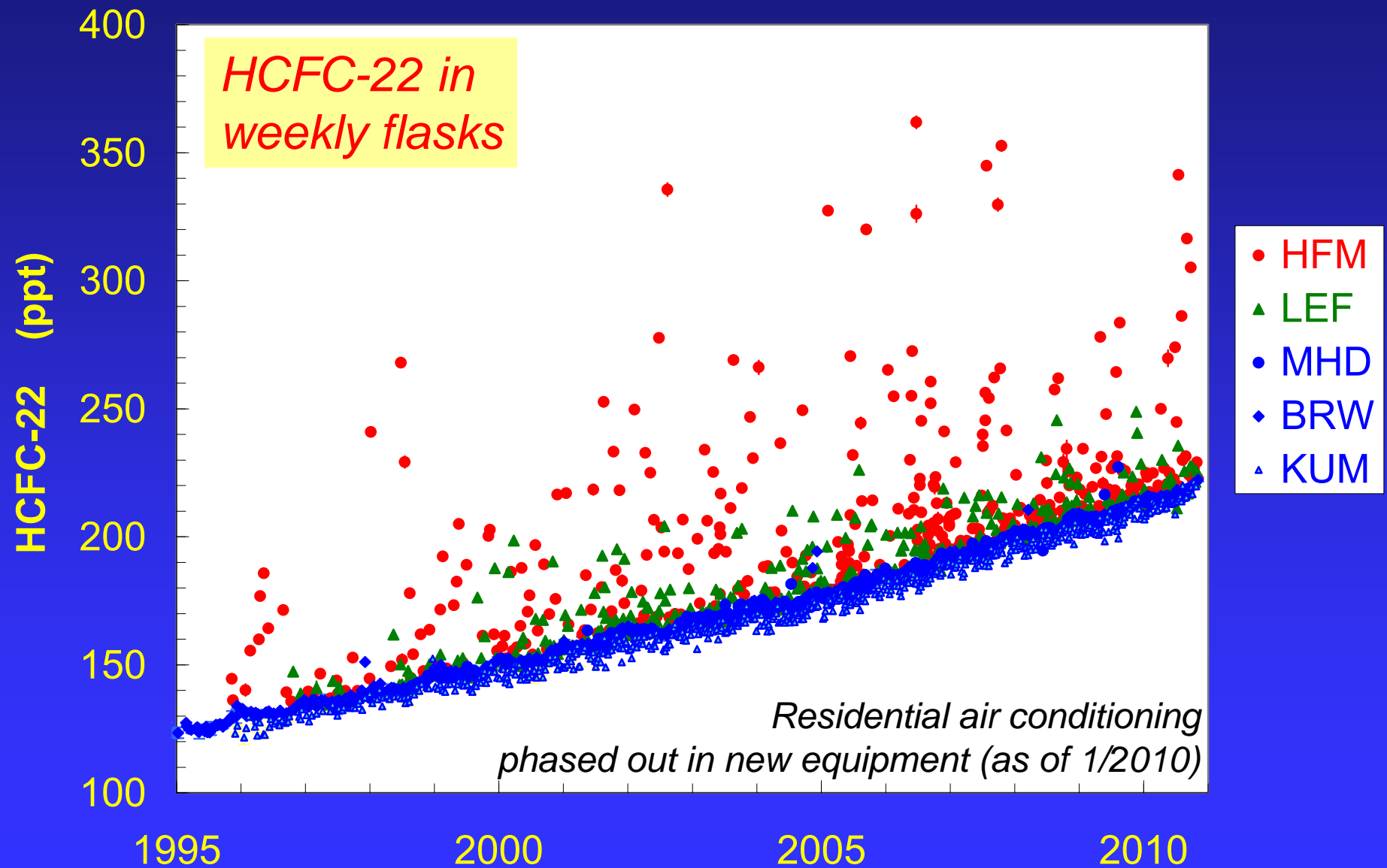
→ HFC-134a vs. HCFC-22

- correlated enhancements
- the results suggest emissions that *vary over time, space, and season*

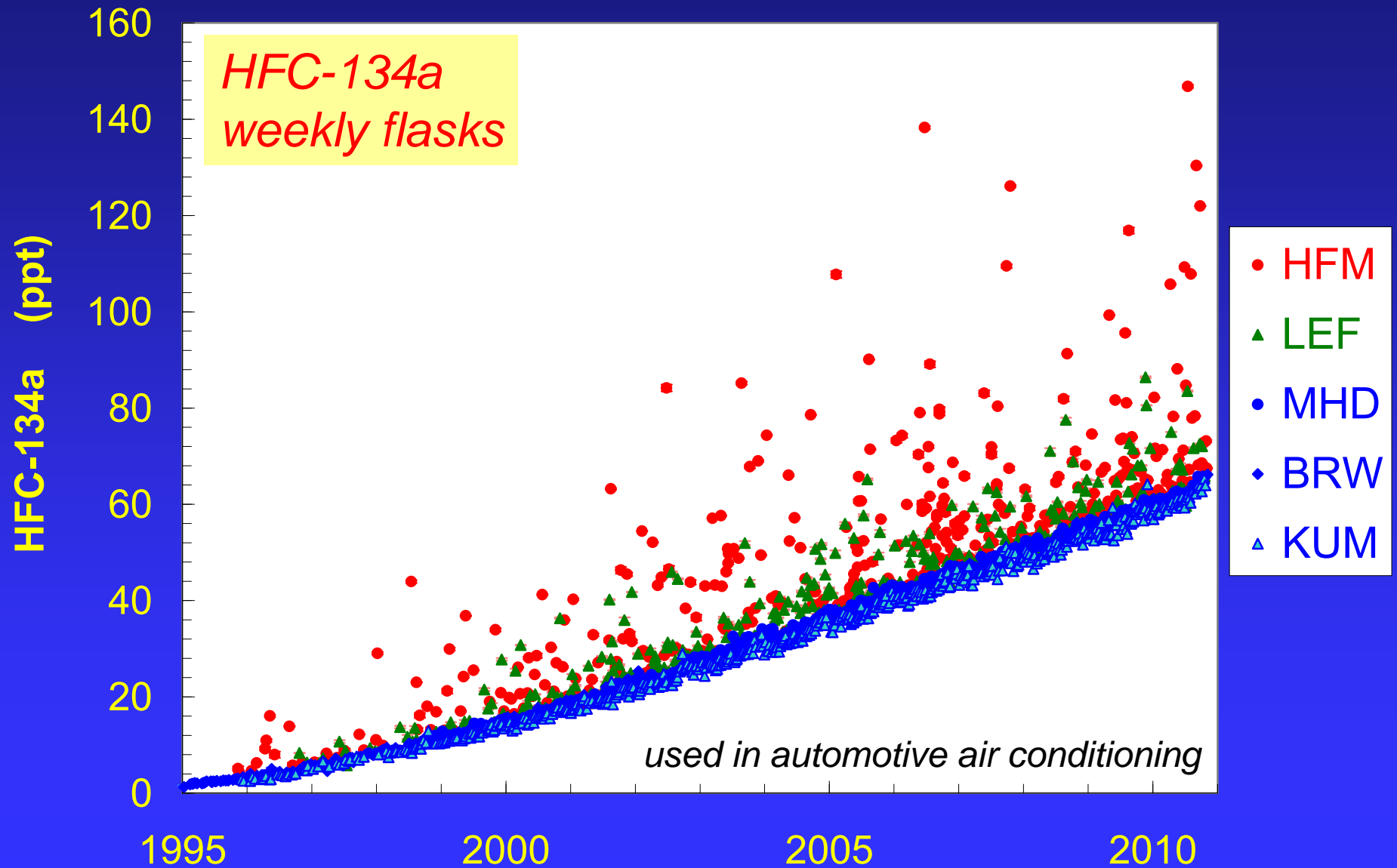
NOAA's Cooperative Global Sampling Network



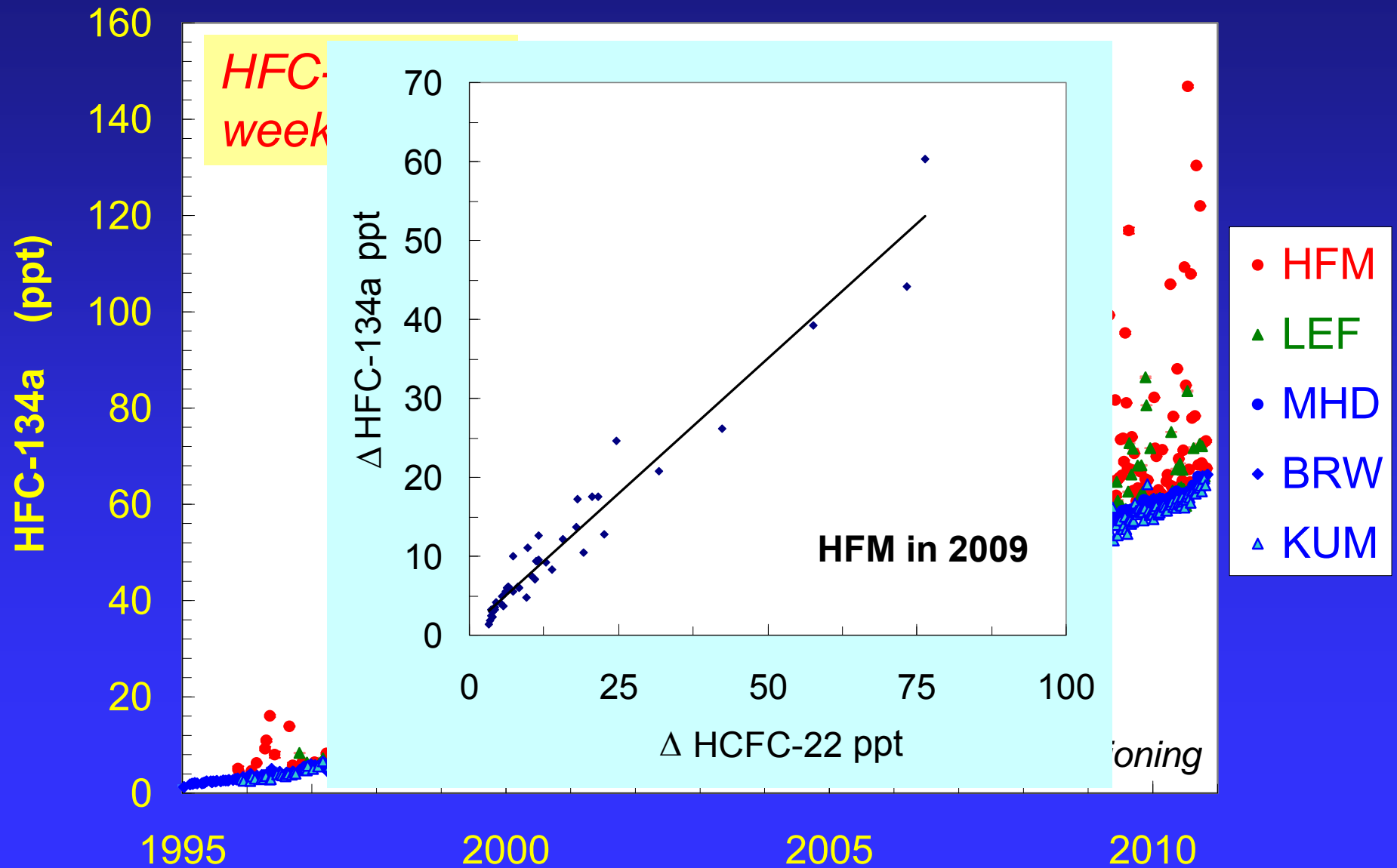
Mixing ratios at mid-western and eastern continental U.S. sites are enhanced above background



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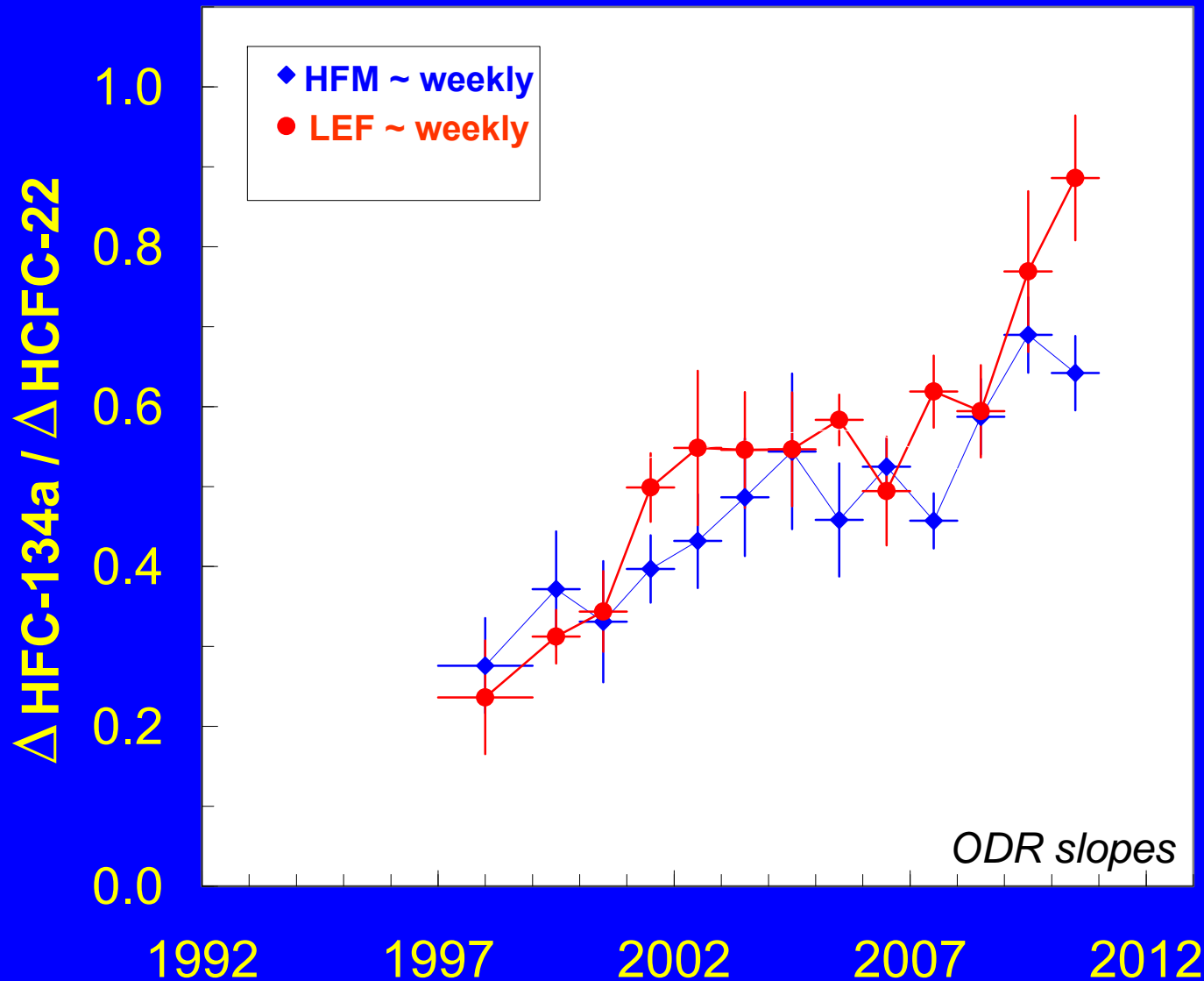


Mixing ratios at mid-western and eastern continental U.S. sites are enhanced above background



Enhancements are correlated and change over time

Annual mean correlation slopes from measured enhancements



Results from both sites suggest increasing emissions of HFC-134a relative to HCFC-22 over time...

Average annual r^2 :

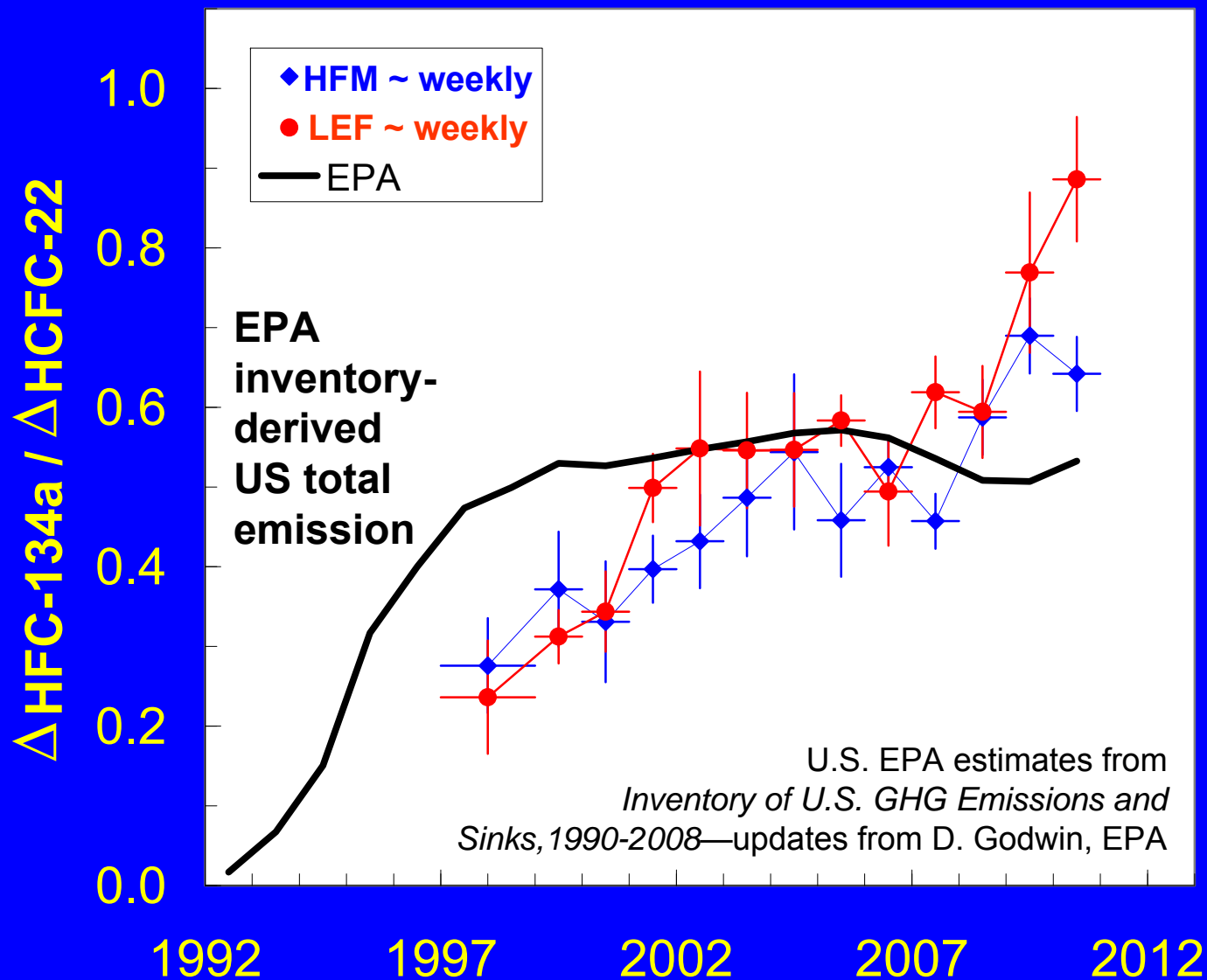
HFM: 0.9 ± 0.04

LEF: 0.9 ± 0.05

$n = 30$ to 40 /yr

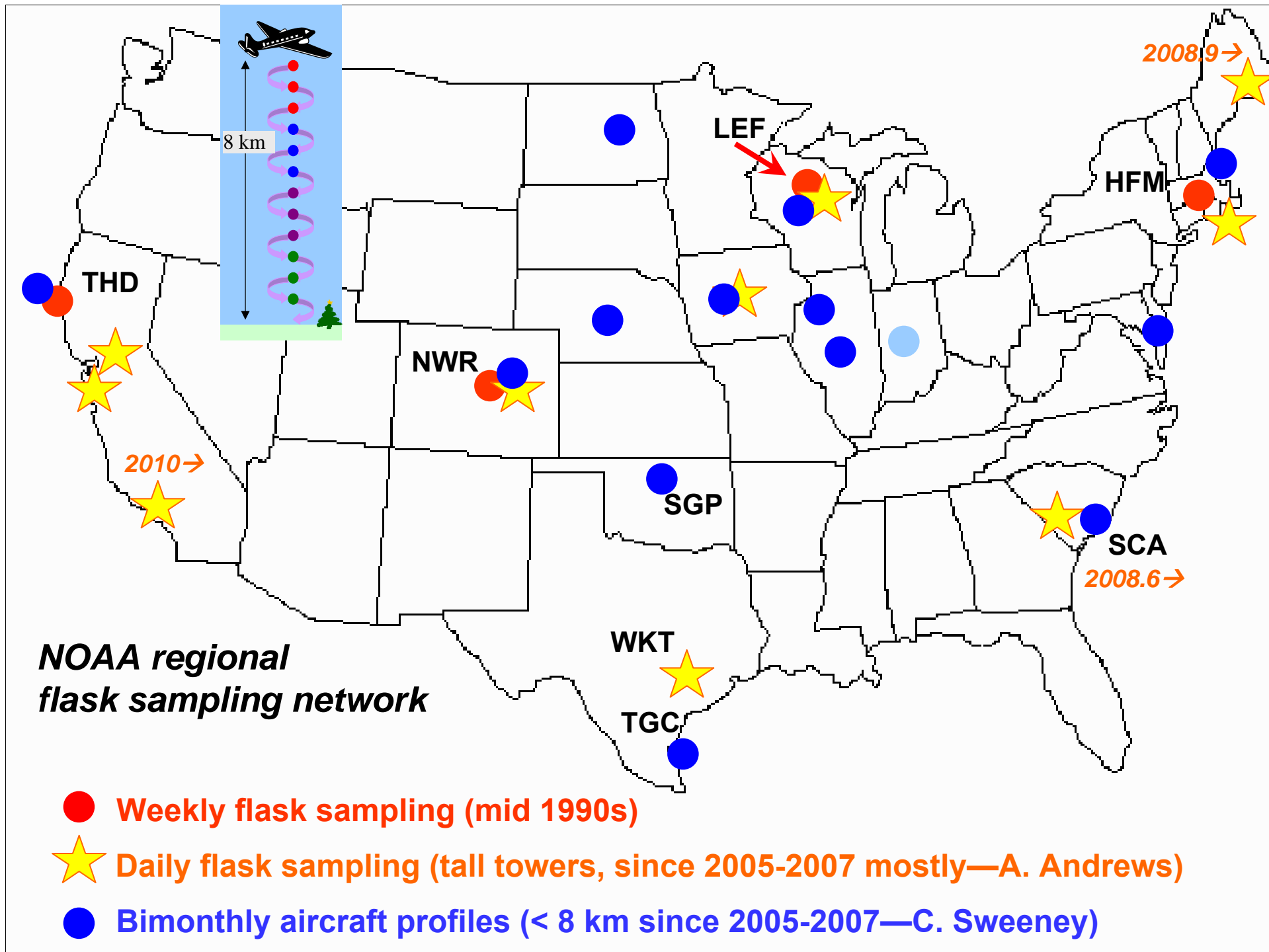
Correlated enhancements compared to US emissions

Annual mean correlation slopes from measured enhancements

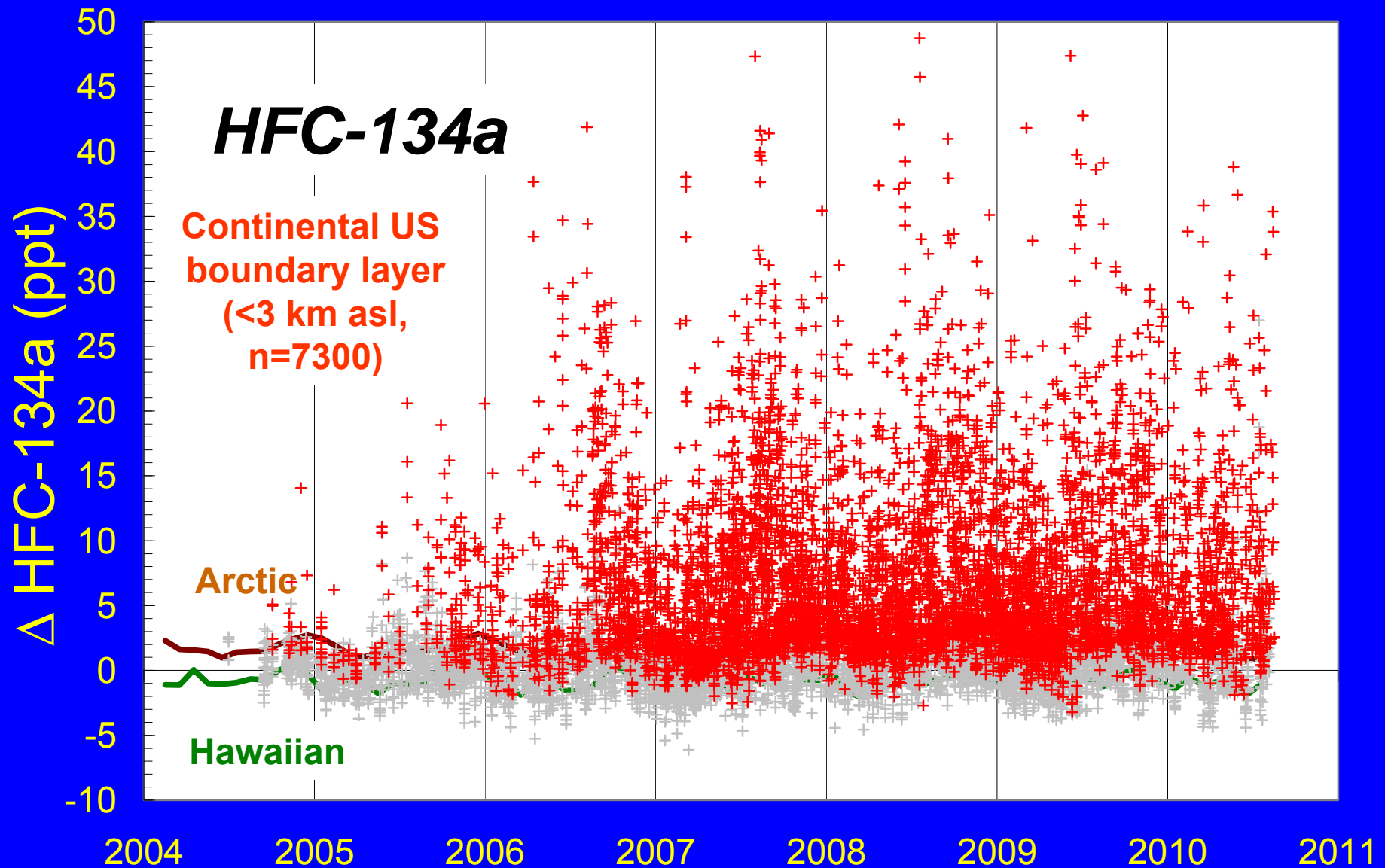


Do enhancements provide information about total US emissions?

How accurate and representative are these results (two sites & 30-40 samples/yr)?

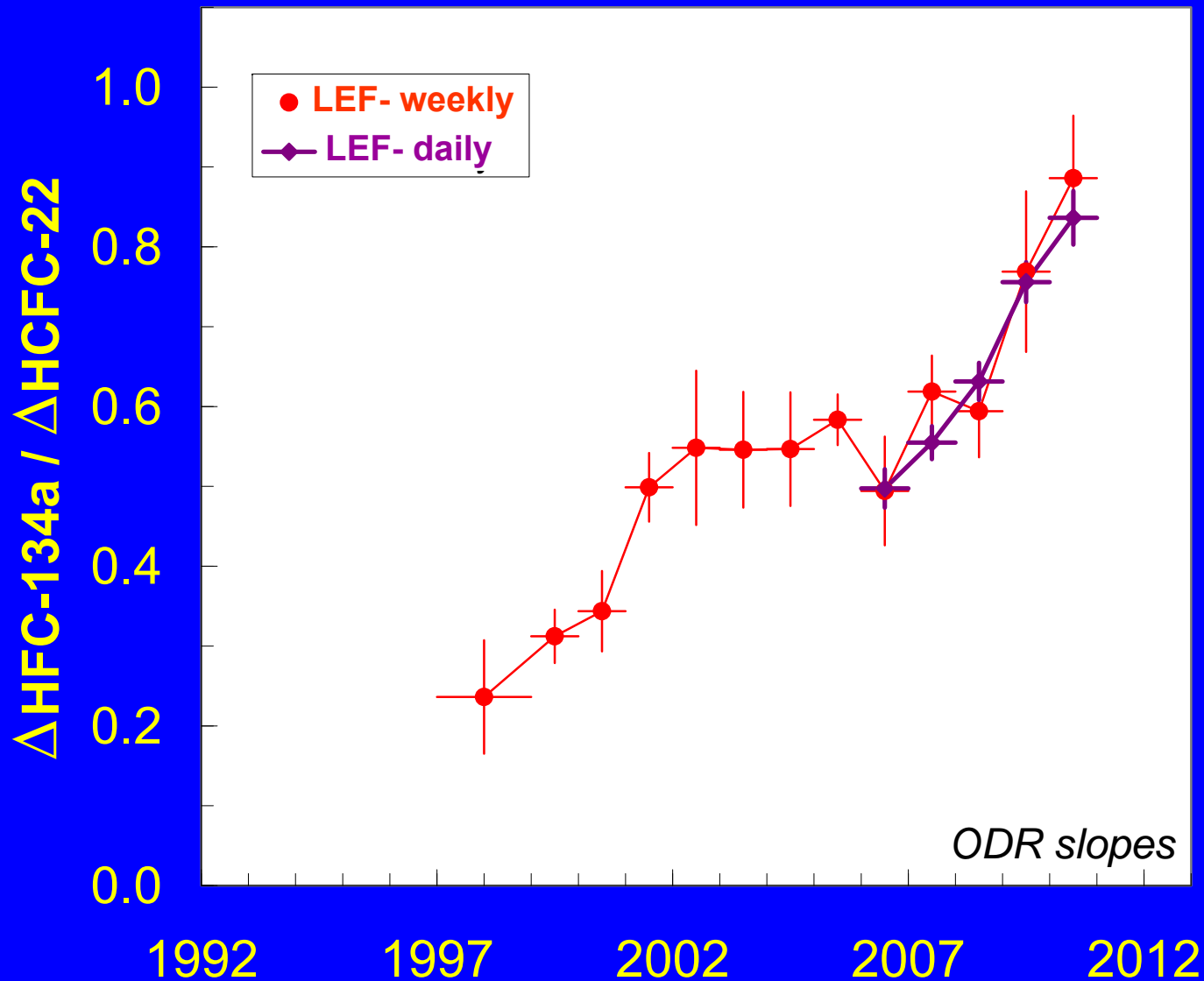


Additional data from pfp sampling program



Enhancements are correlated and change over time

Additional samples add robustness to slopes



Daily flasks from tower network:

more samples yield a smoother inter-annual change and reduced error in slopes

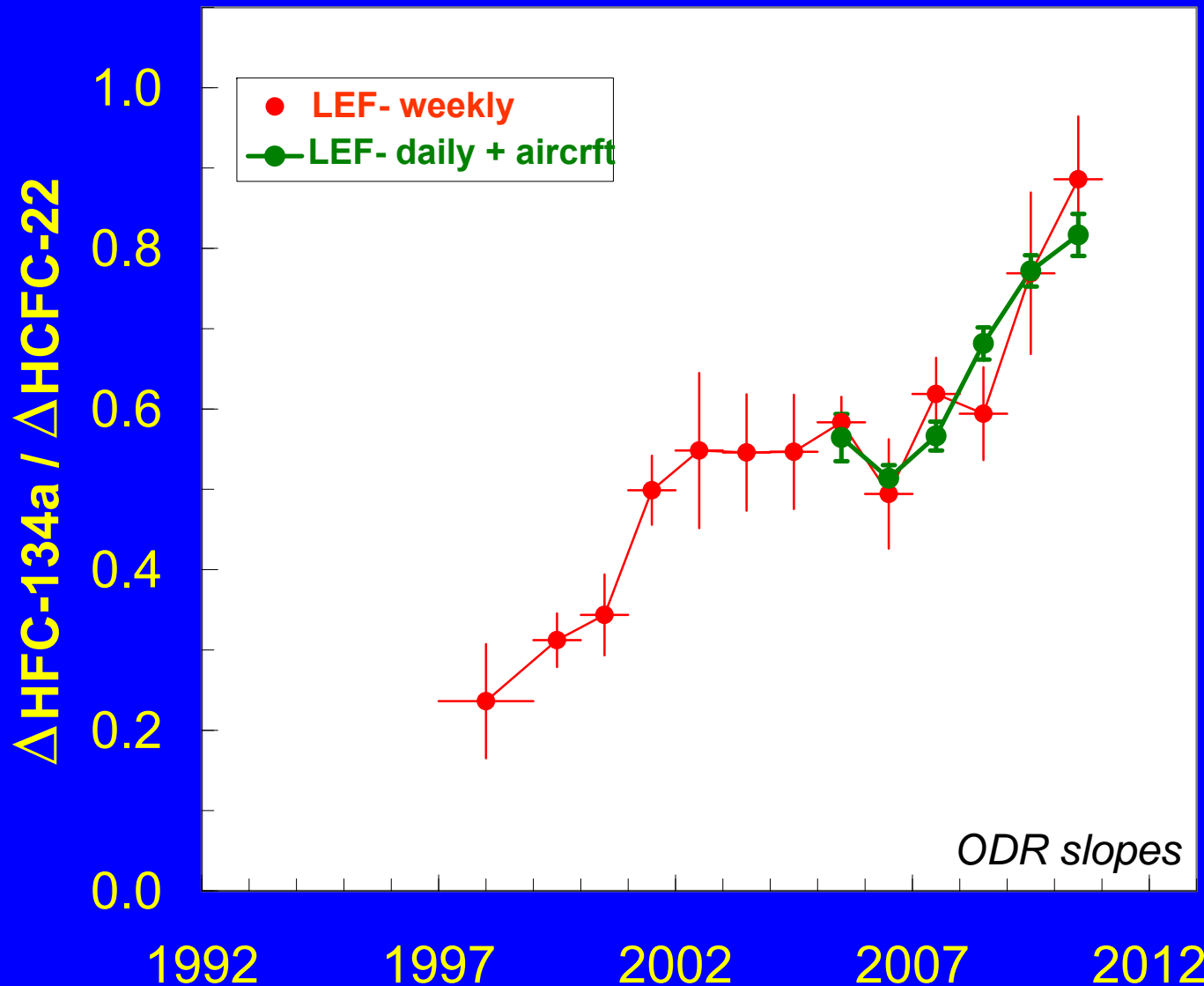
In daily samples:

ave. $r^2 = 0.9 \pm 0.02$

$n = 100$ to 370 /yr

Enhancements are correlated and change over time

Additional samples add robustness to slopes



Adding results from aircraft (< 3 km) reduces error additionally...

Including aircraft data likely makes this result representative of a broader region

In these results

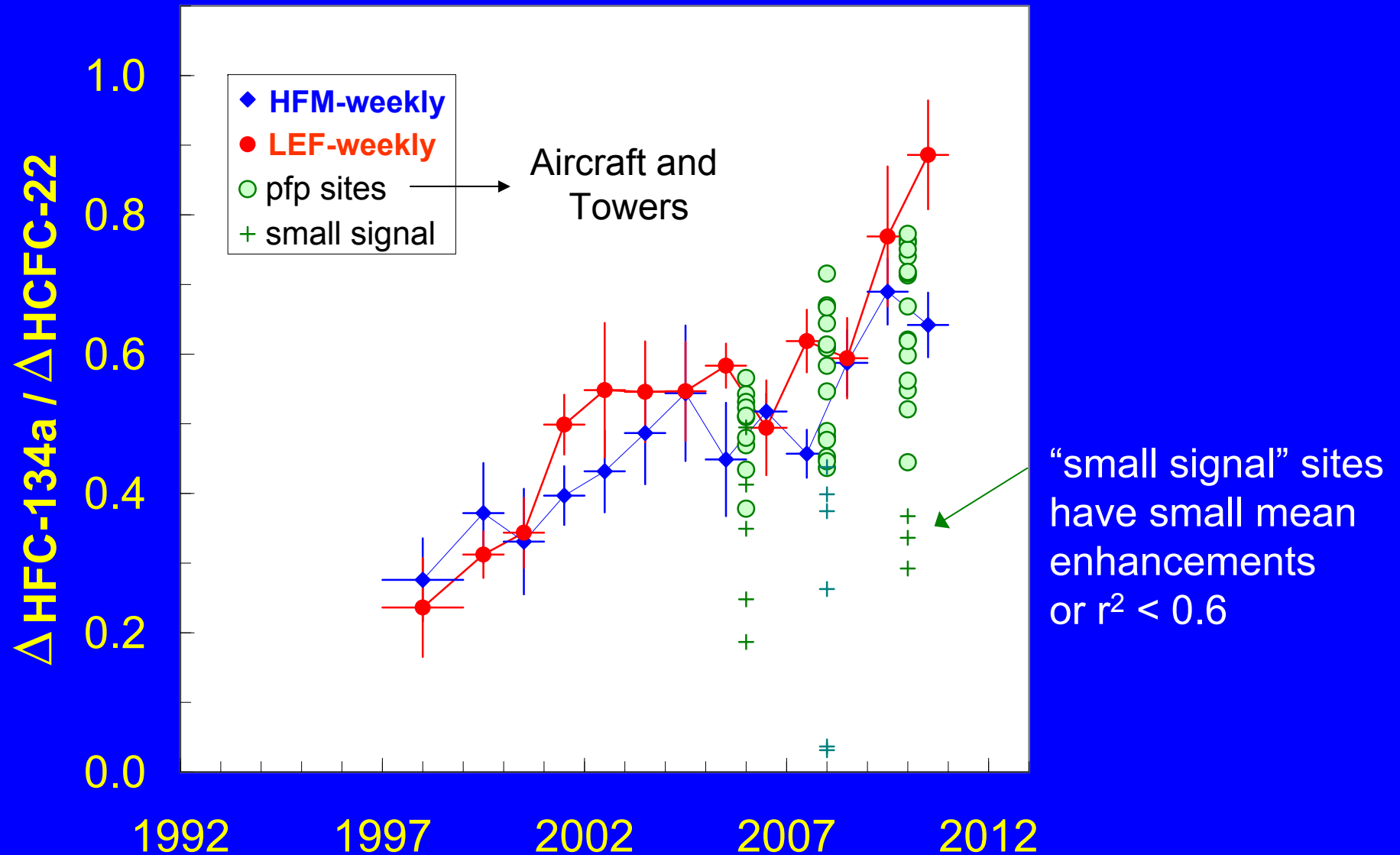
Ave annual $r^2 =$

0.93 ± 0.02

$n = 140$ to 740 /yr

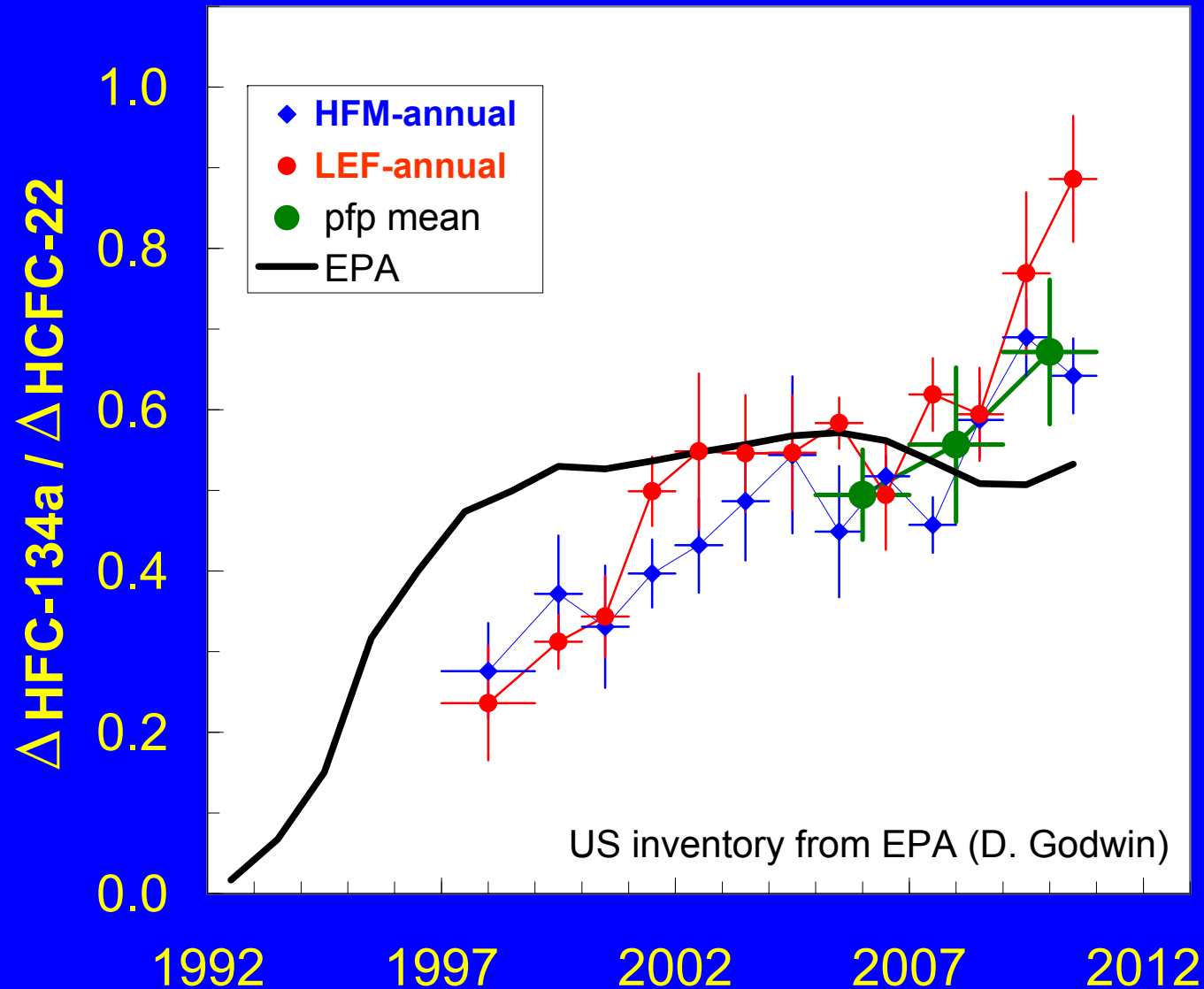
Enhancements are correlated and change over time

Results from all other aircraft (< 3 km alt.) and tower sites:



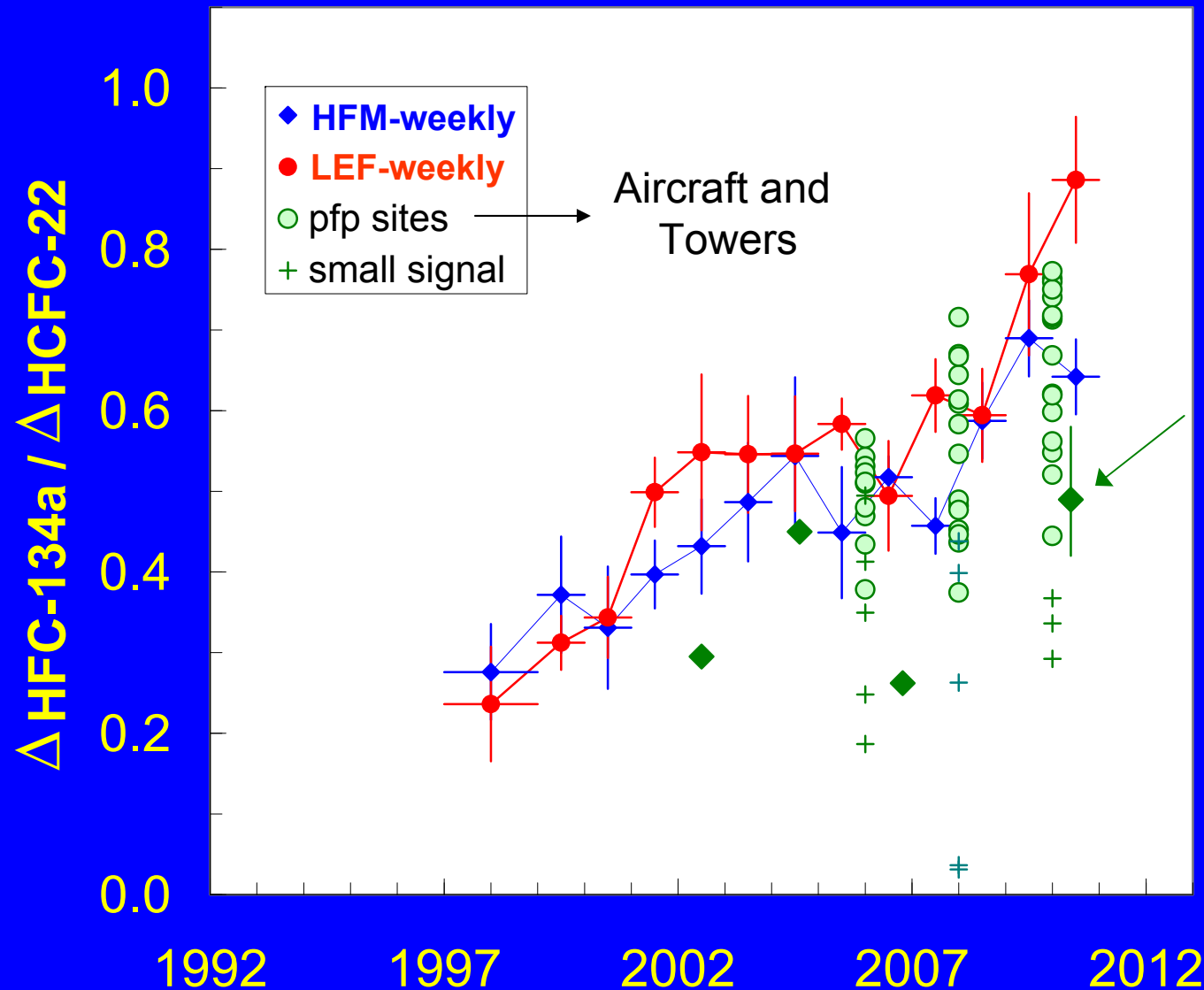
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Enhancements are correlated and change over time

Results from all other aircraft (< 3 km alt.) and tower sites:

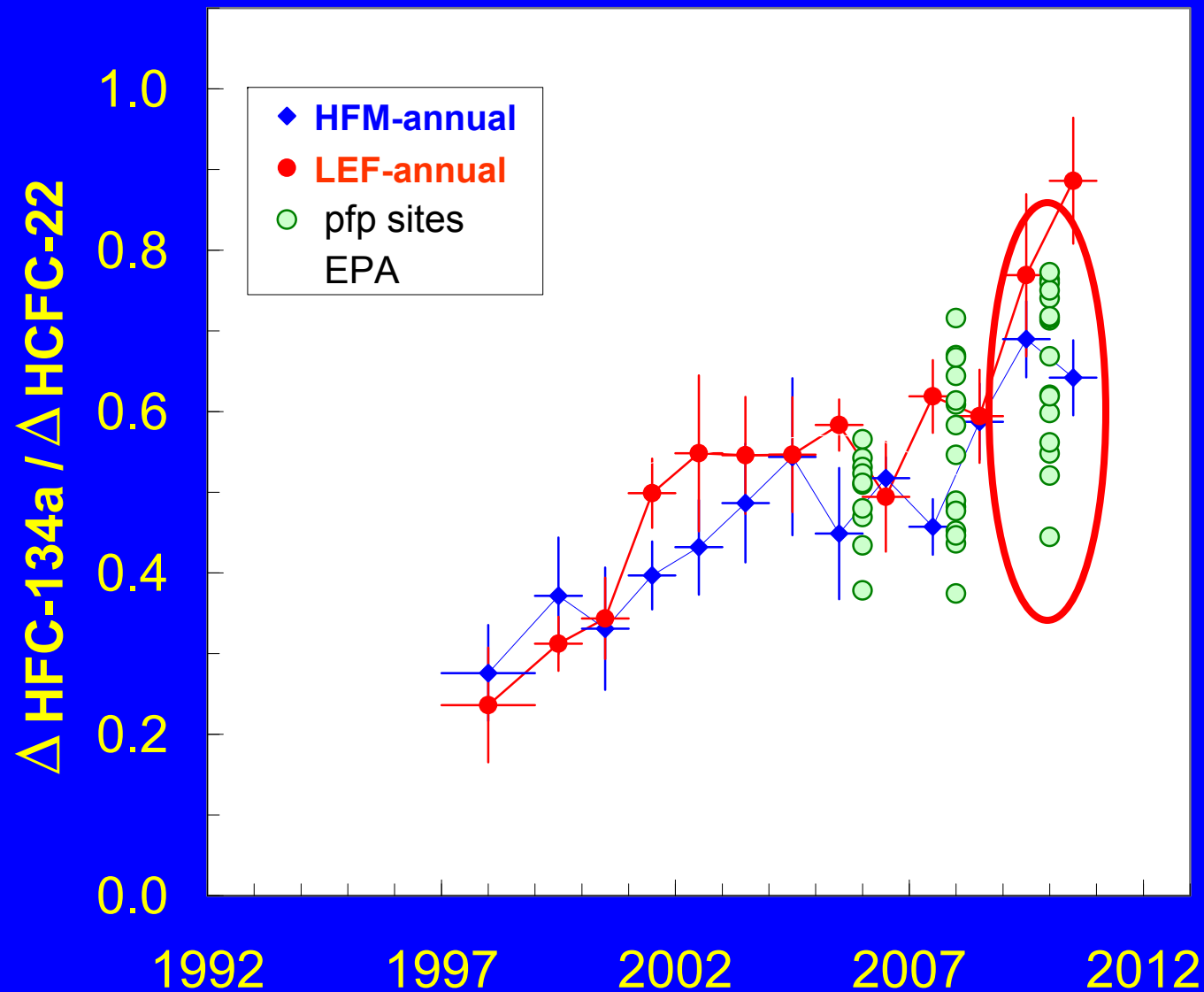


CSD/NOAA aircraft missions (Flask data from D. Blake @ UCI and E. Atlas @ Univ. of Miami)

NEAQS
TexAQS
CaINEX
1-2 month duration

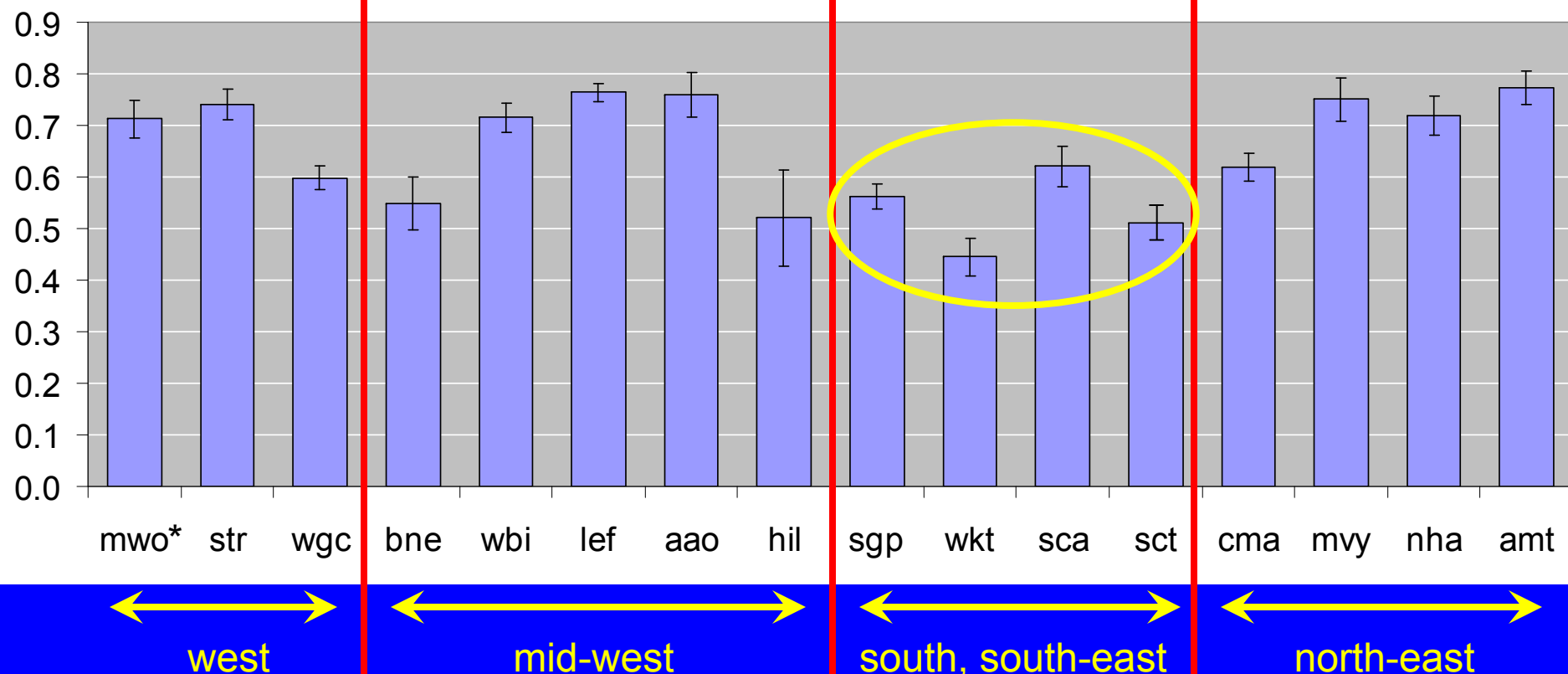
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Results from all other aircraft (< 3 km alt.) and tower sites:



What does this variability represent??

$\Delta\text{HFC-134a} / \Delta\text{HCFC-22}$ —at different sites, 2009-2010



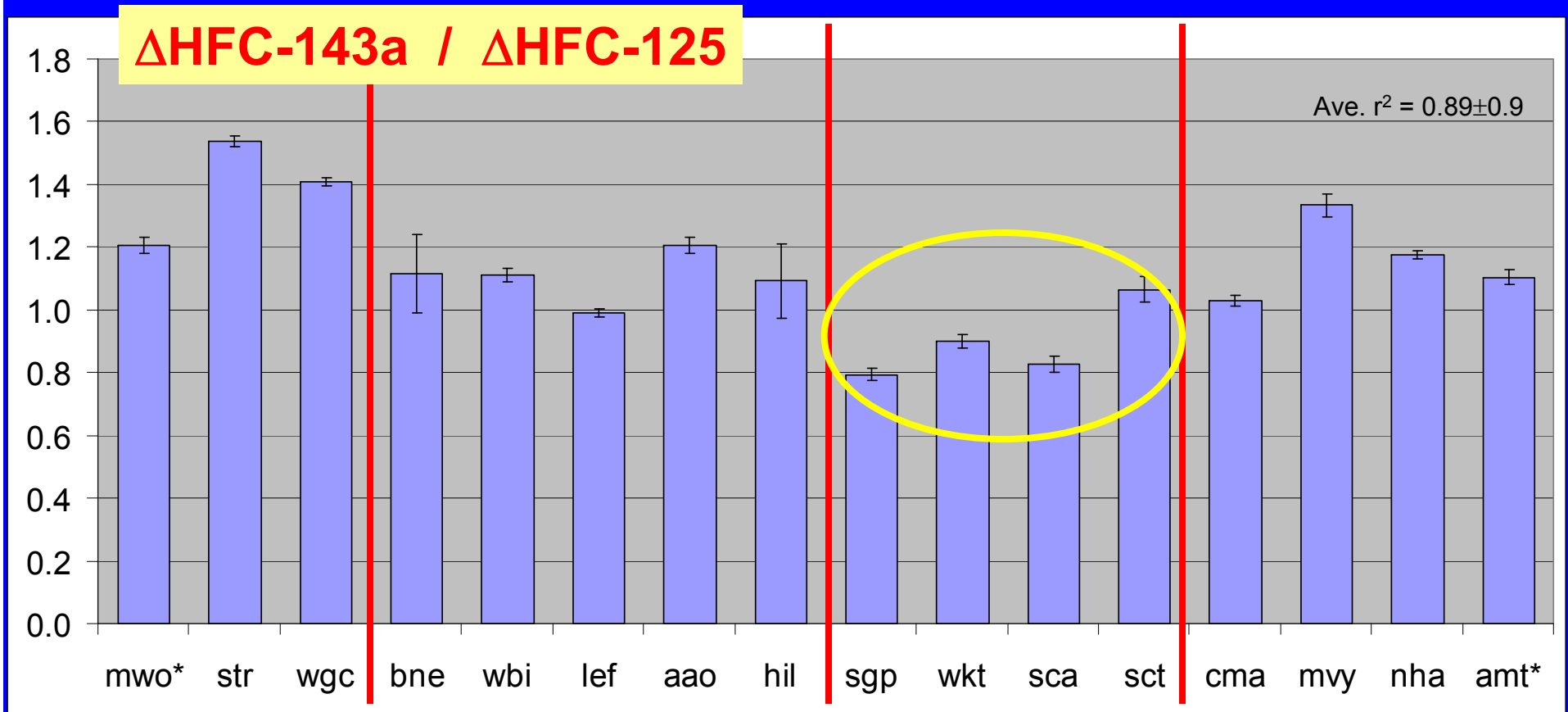
HFC-134a → mobile AC

HCFC-22 → residential AC

While all autos have AC (HFC-134a), not all houses do (HCFC-22).

→ Ratio is sensitive to residential AC penetration, which is higher in the southern US states...

Enhancement ratios at multiple sites -- 2009-2010



west

mid-west

south, south-east

north-east

HFC-125 is a replacement for HCFC-22 in residential AC
—its use is also likely higher in the South

Conclusion:

→ A “data only” analysis of results from a national-scale sampling network suggests:

- Weekly samples can provide useful information...
 - *but additional samples add robustness*
- U.S. emissions of HFC-134a are increasing relative to HCFC-22...
 - *and recent increases are not captured by inventories*
- Regional variations in emission patterns were observed...
 - *Sampling at more sites gives better information*
- Seasonal variations in emissions are observed (not shown)
 - *only year-round programs can provide an annual mean*