Recent increases in global HFC-23 emissions and the contribution of HFCs and HCFCs to radiative forcing.

S. Montzka [1], L. Kuijpers [2], M.O. Battle [3], M. Aydin [4], K. Verhulst [4], E.S. Saltzman [4], D. Fahey [1] B. Miller [5], L. Miller [6], C. Siso [5], and B. Hall [1]

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Why the interest in HFC-23 (CHF_3):

* Longest-lived, highest GWP of HFCs (τ=270 yr; GWP_{100yr}=14800)
* Most emissions from over fluorination during HCFC-22 production

* Substantial efforts are in place to limit HFC-23 releases during HCFC-22 production:
  - *in developed countries:* incineration and process optimization.
  - *in developing countries:* incentive to incinerate HFC-23 is provided by the Kyoto Protocol's Clean Development Mechanism:

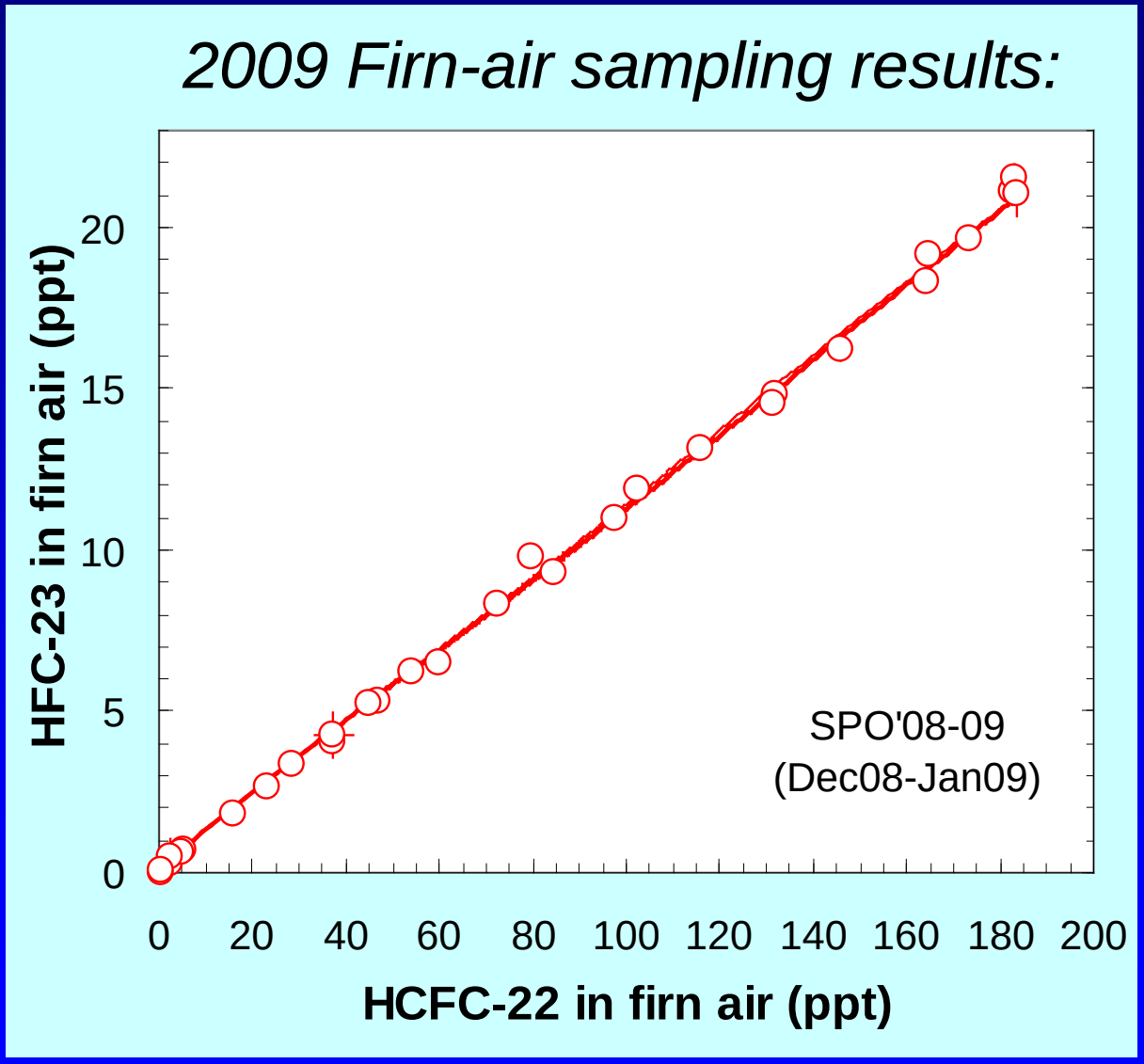
    carbon emission credits are earned by developing countries from incineration of HFC-23 associated with "grandfathered" HCFC-22 production. Credits are sold to developed countries to offset their GHG emissions; value ~$1 billion/yr.

* As of summer 2009: no published data available to gauge the effectiveness of these programs.

Our approach: in the absence of ongoing measurements, derive atmospheric trends and emissions from Antarctic firn air samples.

published in Geophys Res. Lett., 37, L02808, 2010.

Measurements of HFC-23 from air trapped in Antarctic snow in 2001, 2005, 2009.



A HFC-23 history was derived from this relationship becase we have a good understanding of past changes for HCFC-22 (Montzka et al., 1993; 2010; Miller 1999).

HFC-23 histories are derived that are consistent with all 3 samplings…

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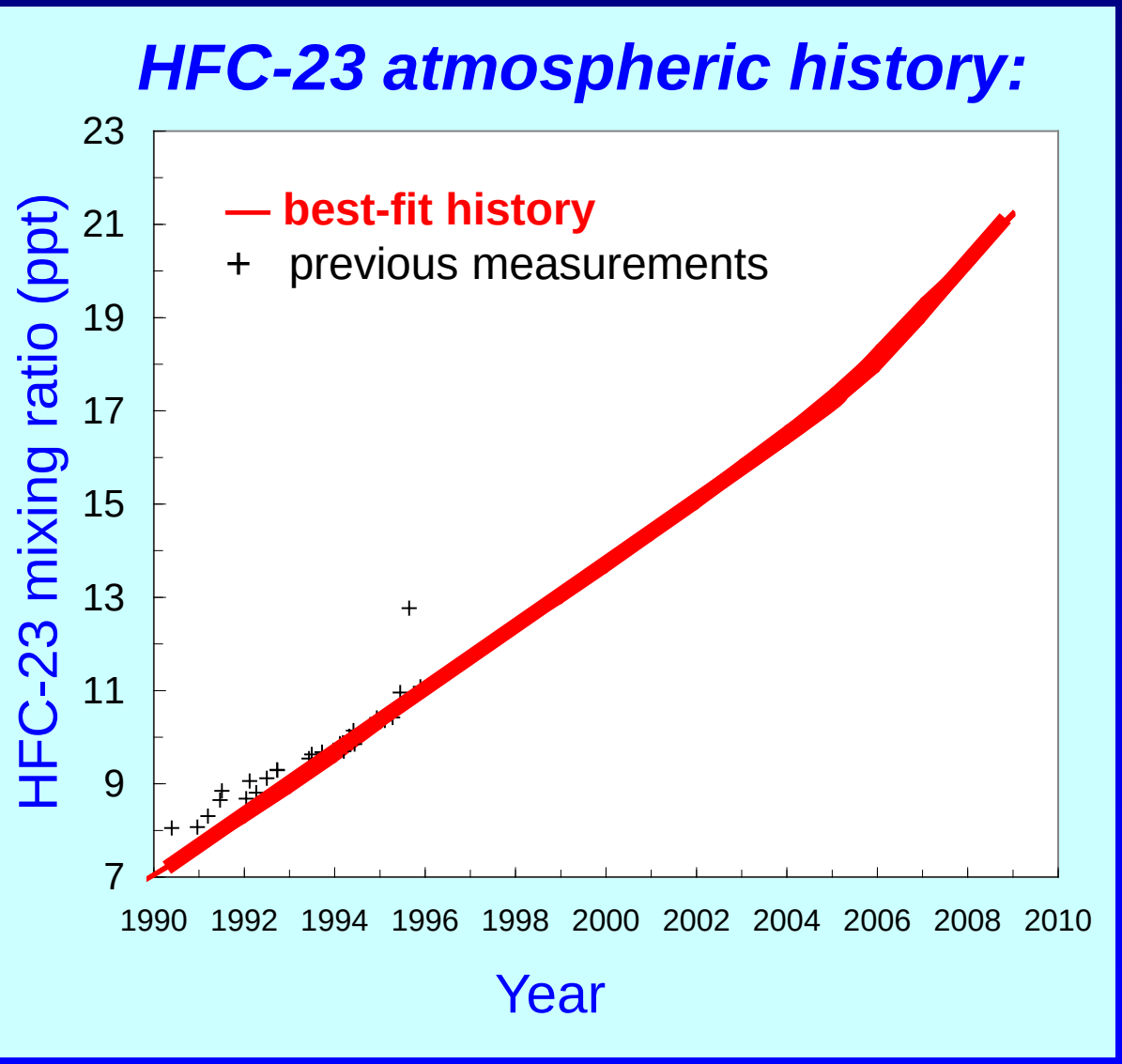

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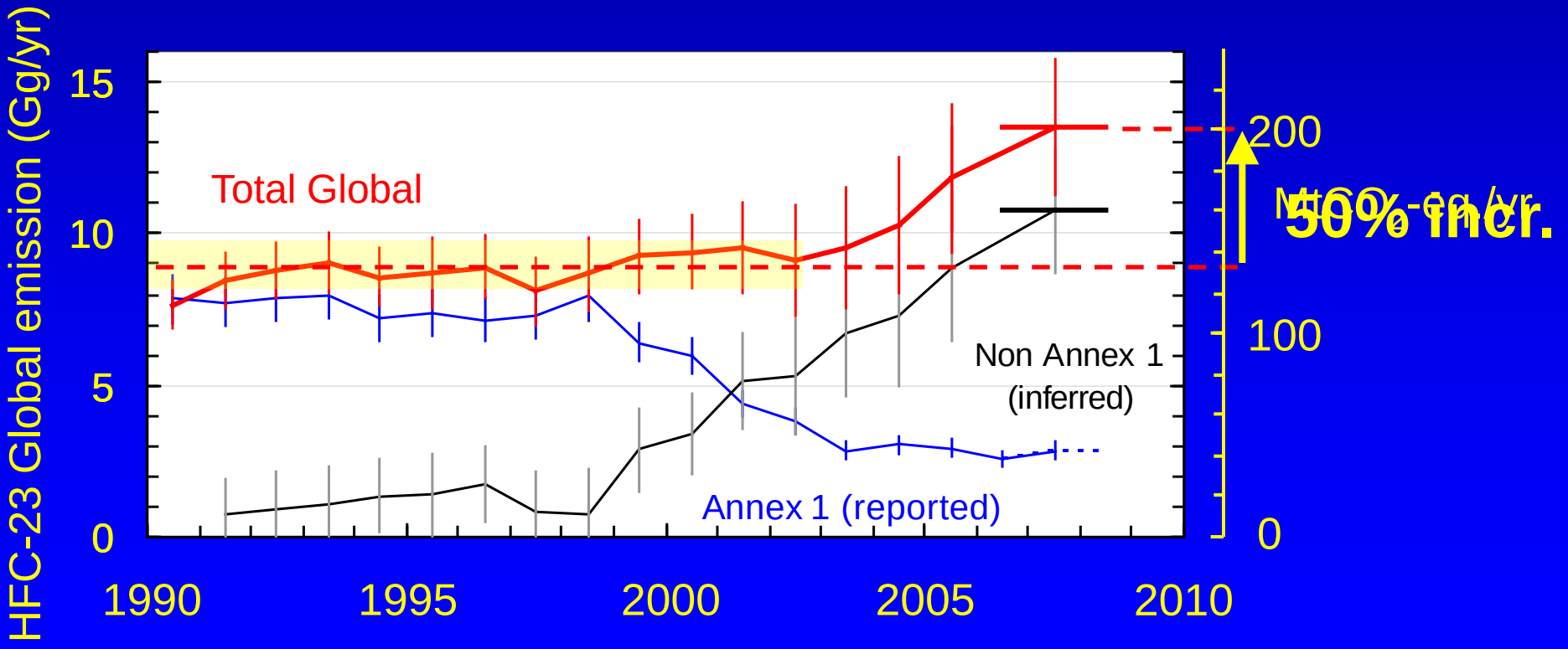
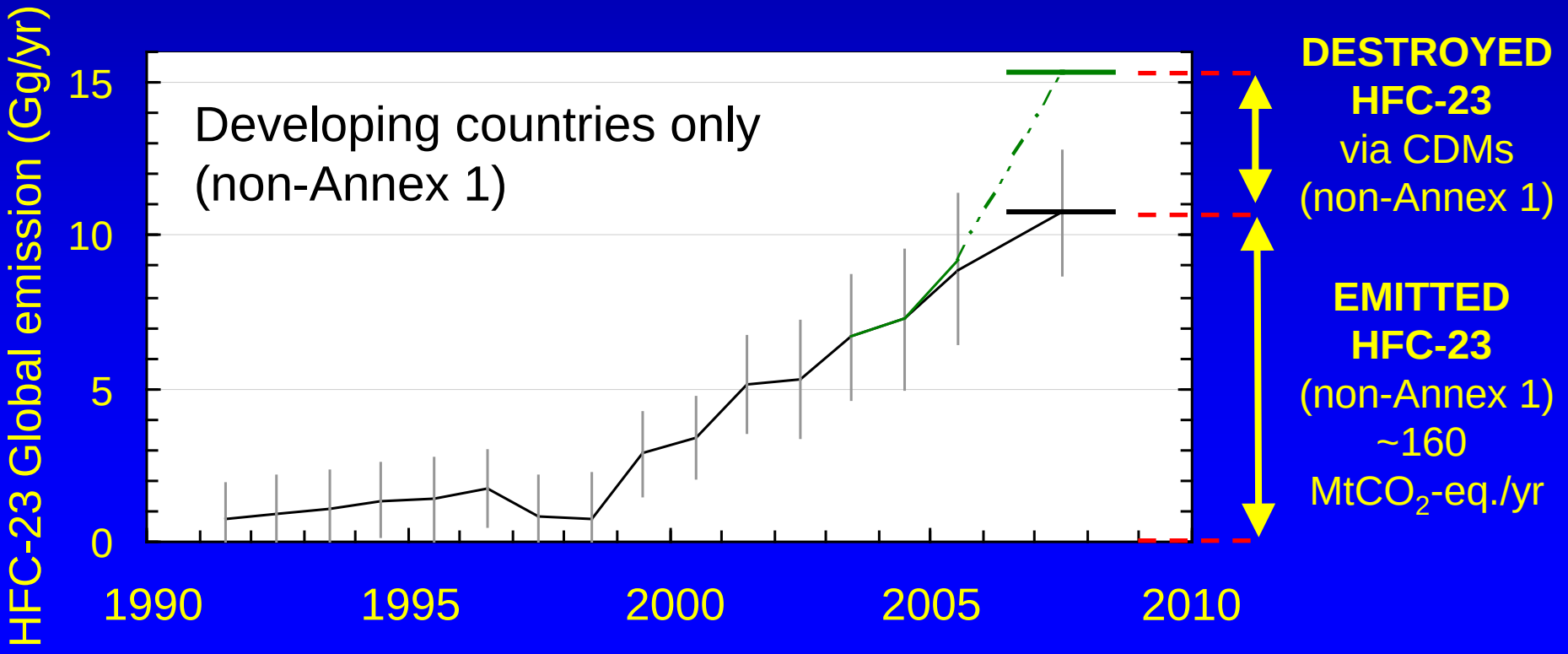
Derived Global HFC-23 emission:

- *Global increases (~50%)*
  …but reported decreases from Annex 1 (developed)
- *Imply increasing emissions from non-Annex 1 (developing)*

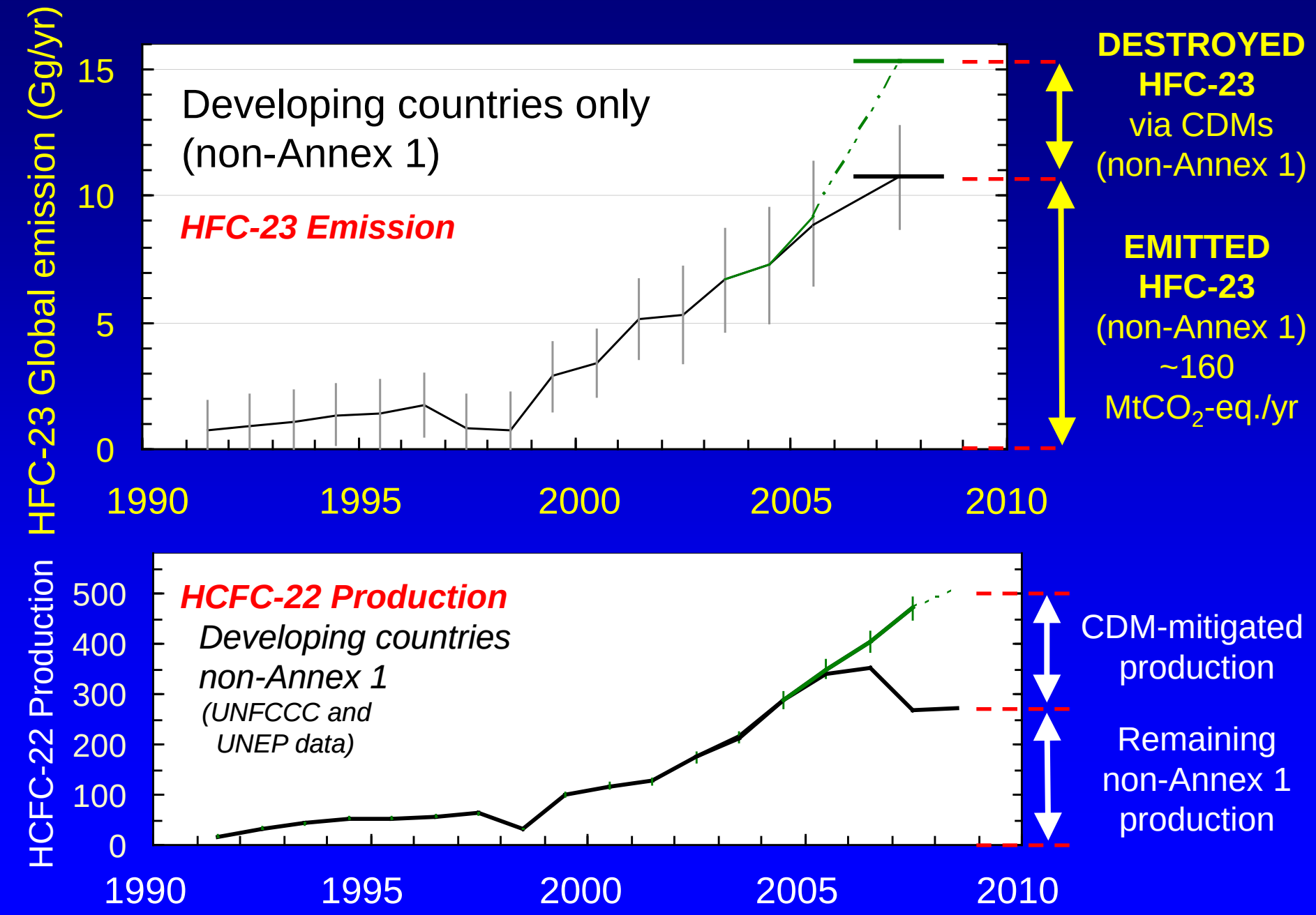


Derived Global HFC-23 emission:

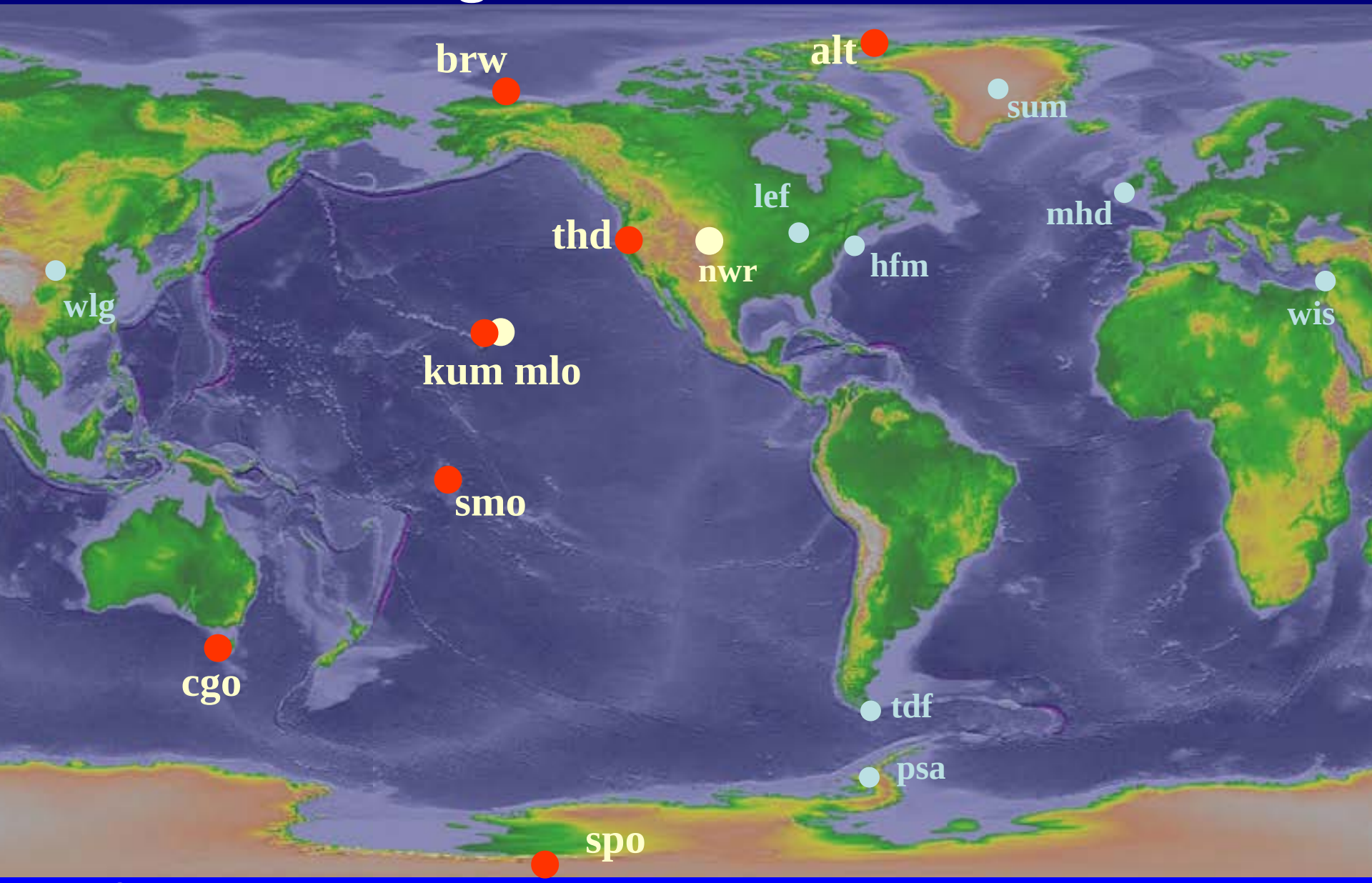
- *Global increases (~50%)*
  …but decreases from Annex 1 (reported to UNFCCC)
- *Imply increasing emissions from non-Annex 1*
  → *even as some HFC-23 was destroyed in developing countries by Clean Development Mechanism projects (~100 $MtCO_2$-eq./yr in '07-'08; **worth ~$1 billion/yr**)*



Derived HFC-23 emission and HCFC-22 production:



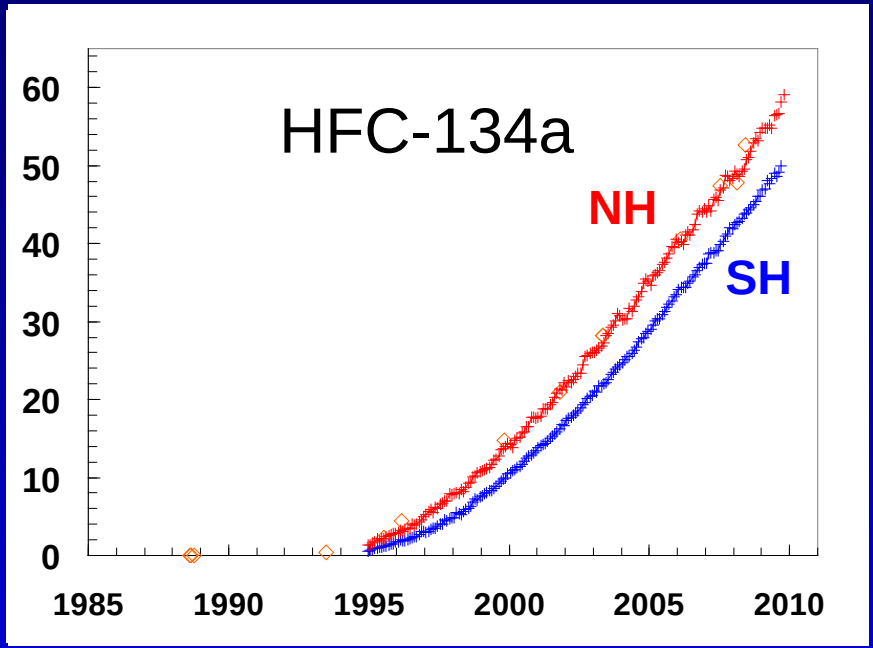
Measured changes for other HCFCs and HFCs:

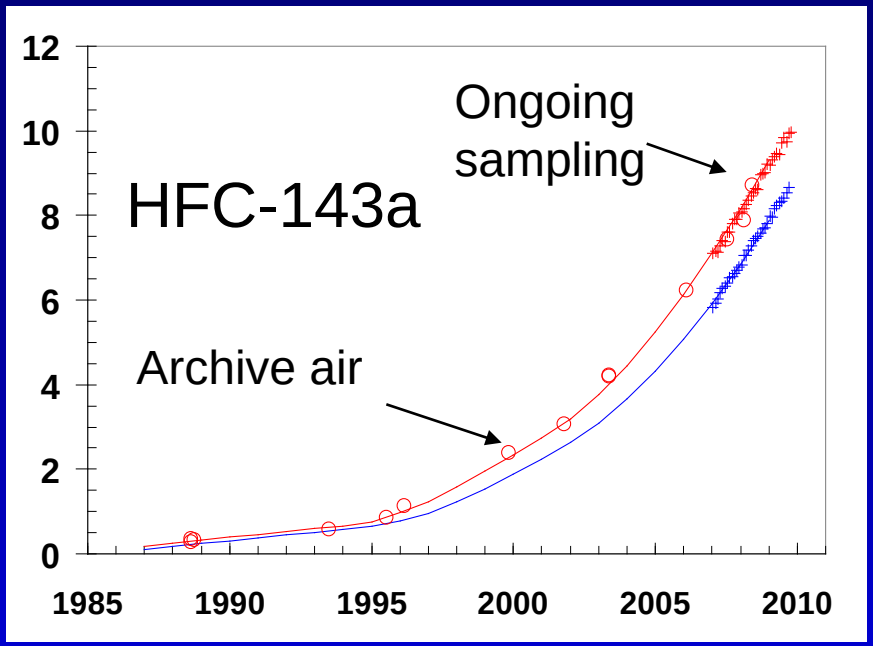


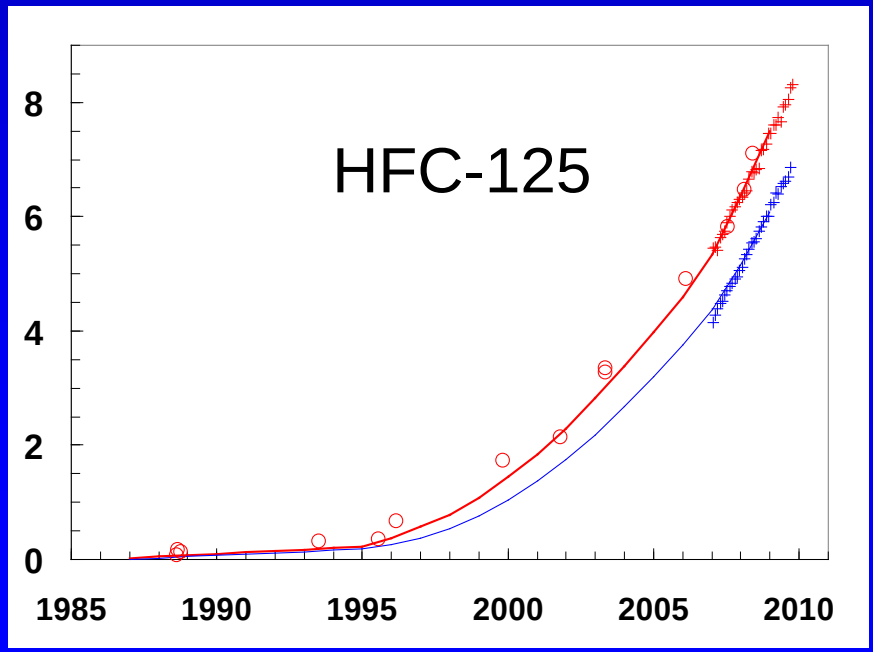
High Altitude
Marine Boundary Layer
non-background
Regional tower sites, aircraft sampling not shown

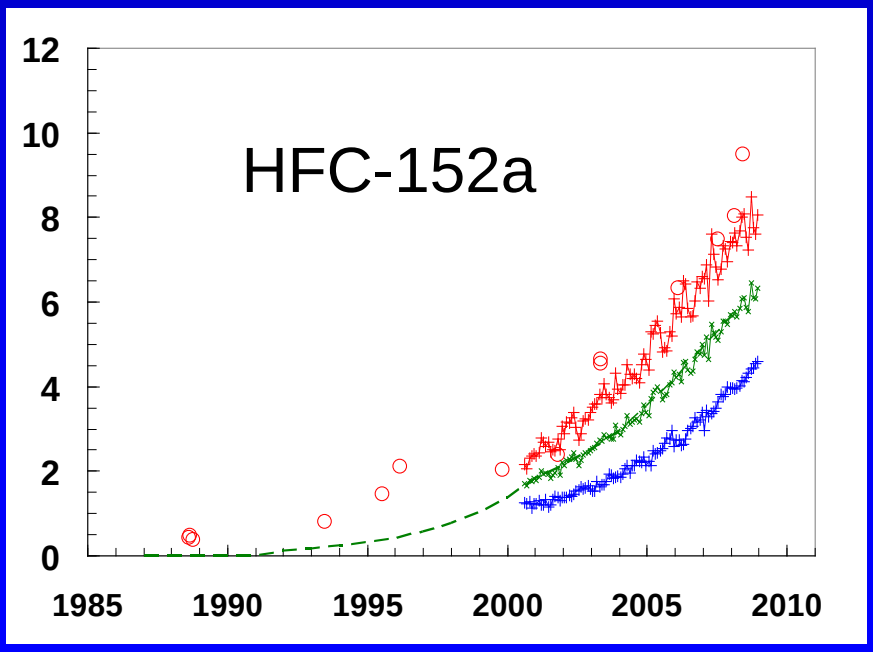
HFCs: Background atmosphere changes:

Hemispheric mean mixing ratio (ppt)









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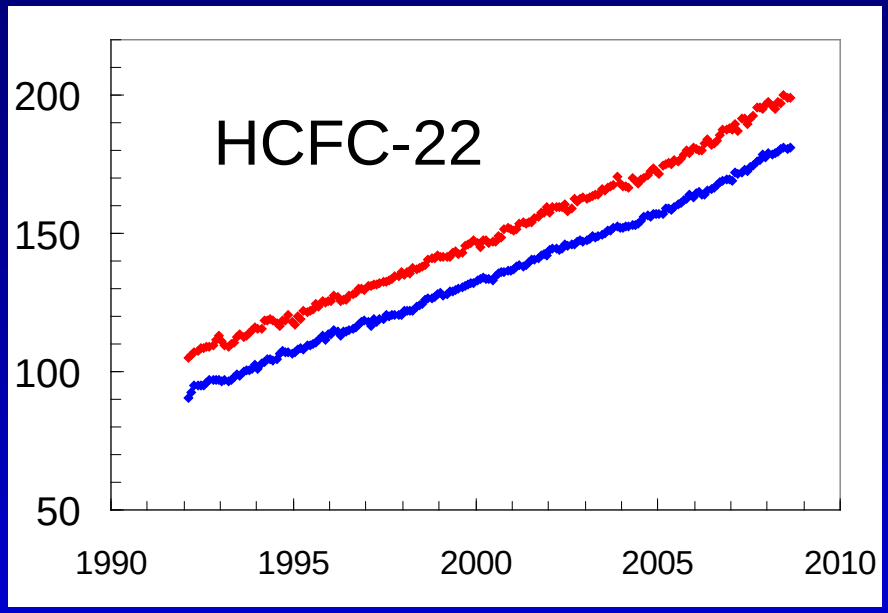
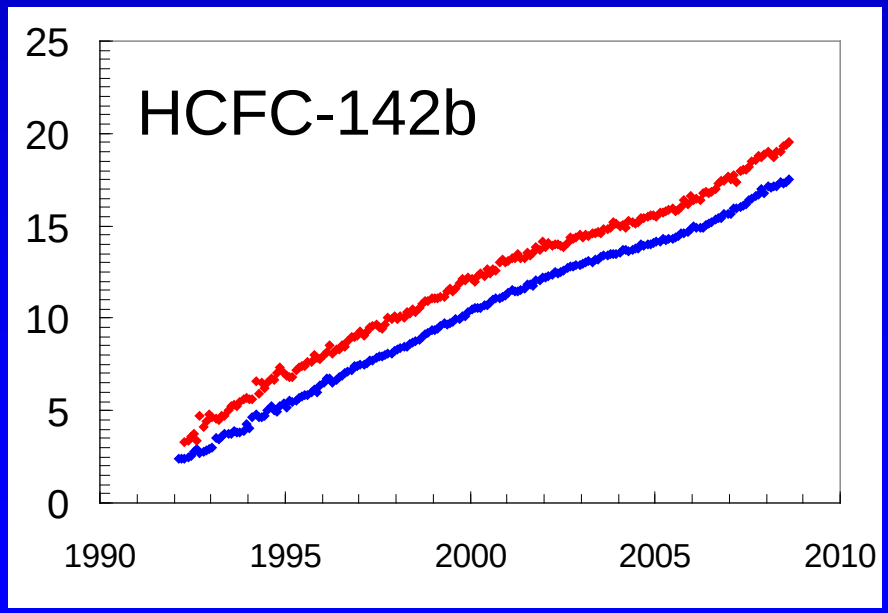
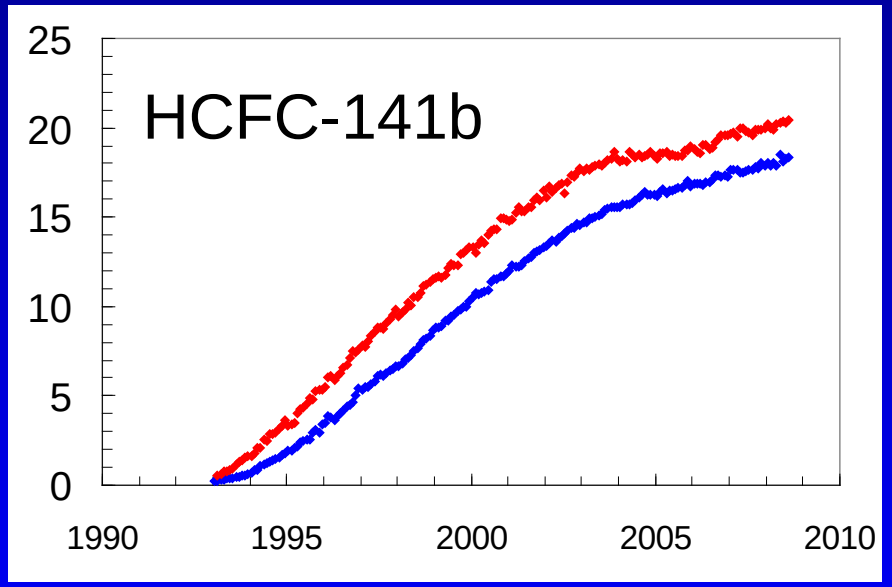
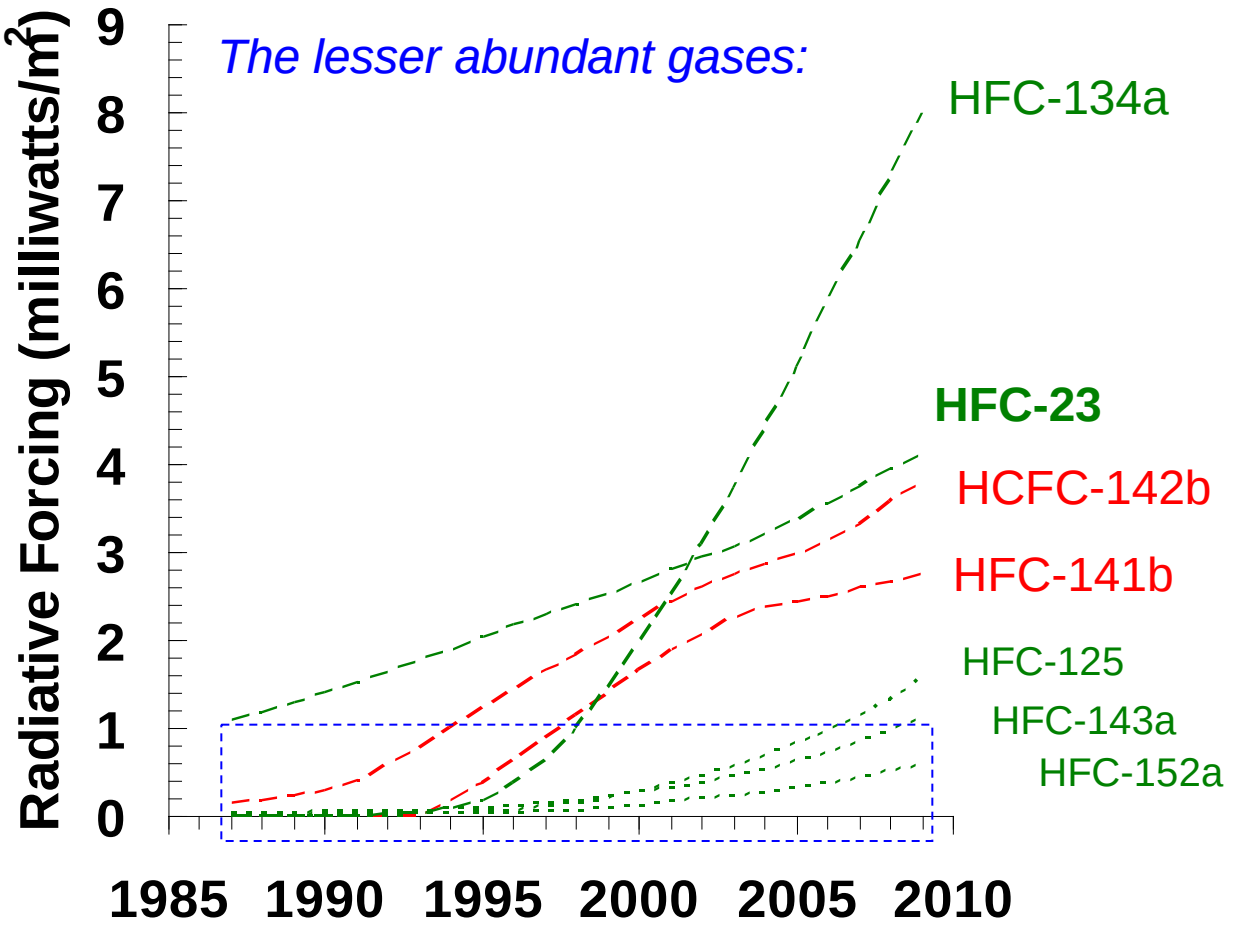






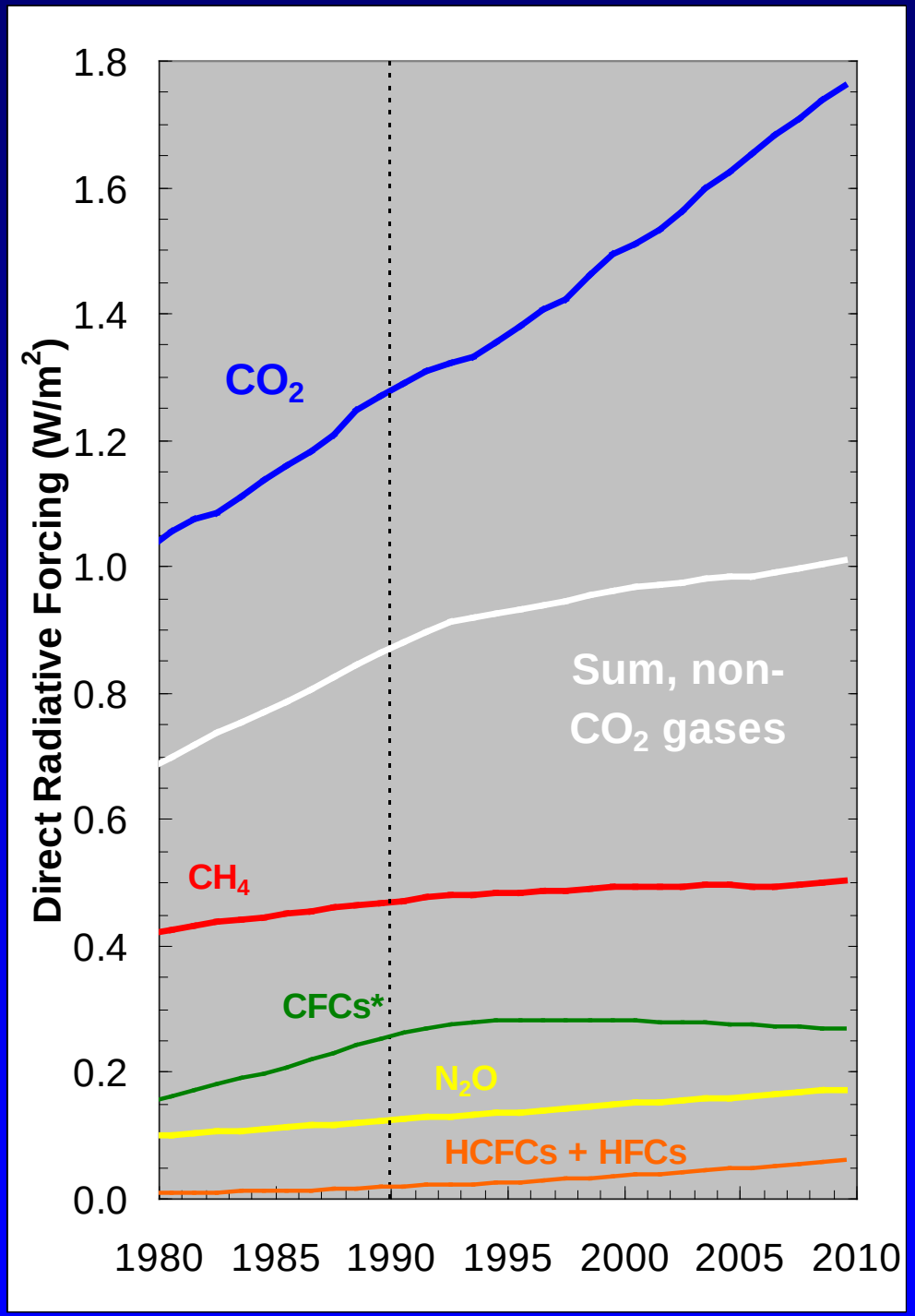
Radiative forcing from HCFCs and HFCs



The direct climate impact from these chemical is still dominated by the HCFCs (HCFC-22)

The increase in radiative forcing from HCFCs is still larger than from HFCs (over the past 5 years)

HFC-227ea and HFC-365mfc to be added



Direct Radiative Forcing

*** CO_2 contributes more** than all other gases combined

*** Changes** over the past 5 years (in W/m^2):

0.134	CO_2
0.015	HFC + HCFC
0.013	N_2O
0.006	CH_4
-0.008	CFCs*

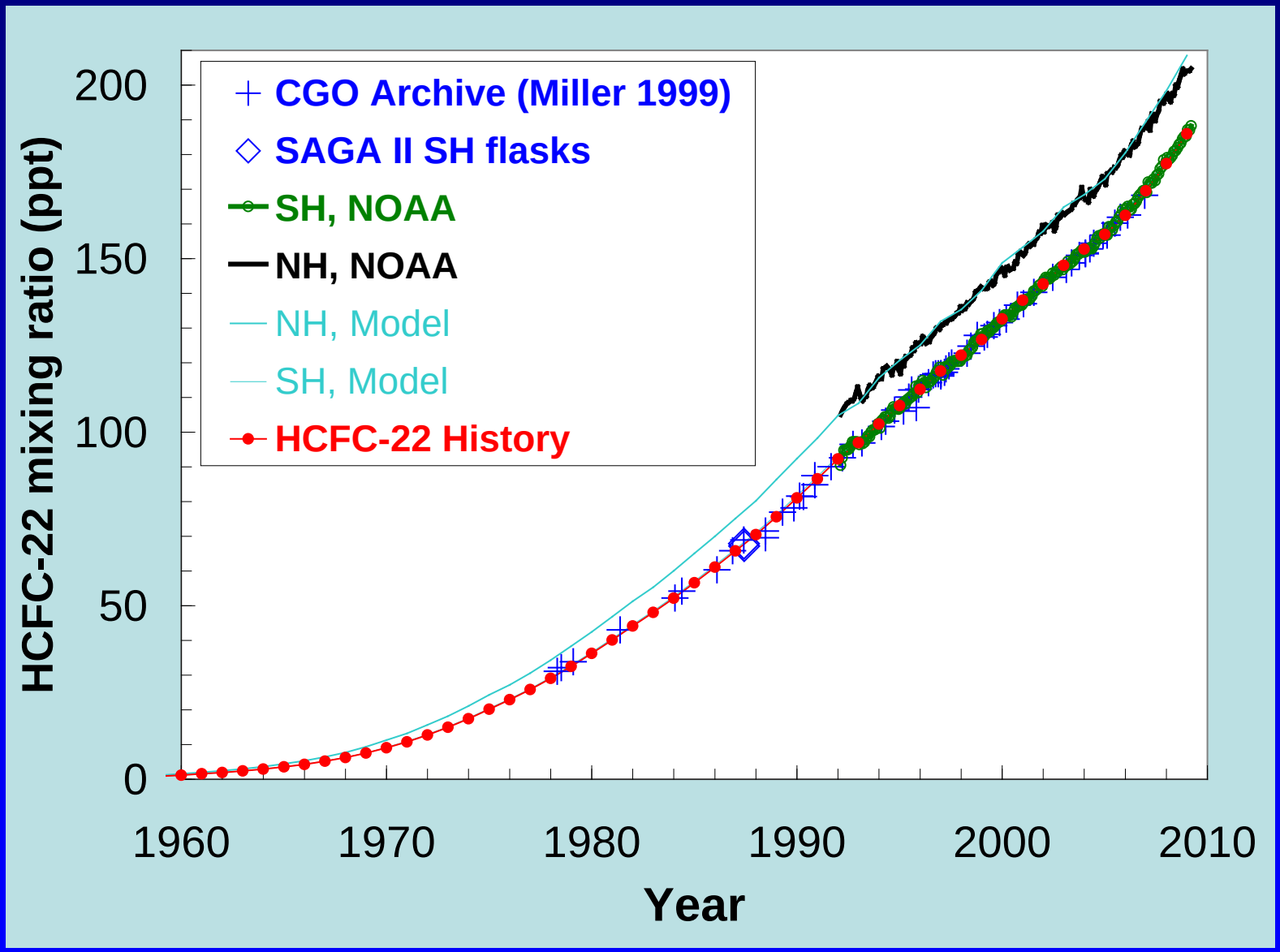
NOAA global data from HATS and CCGG groups

Conclusions:

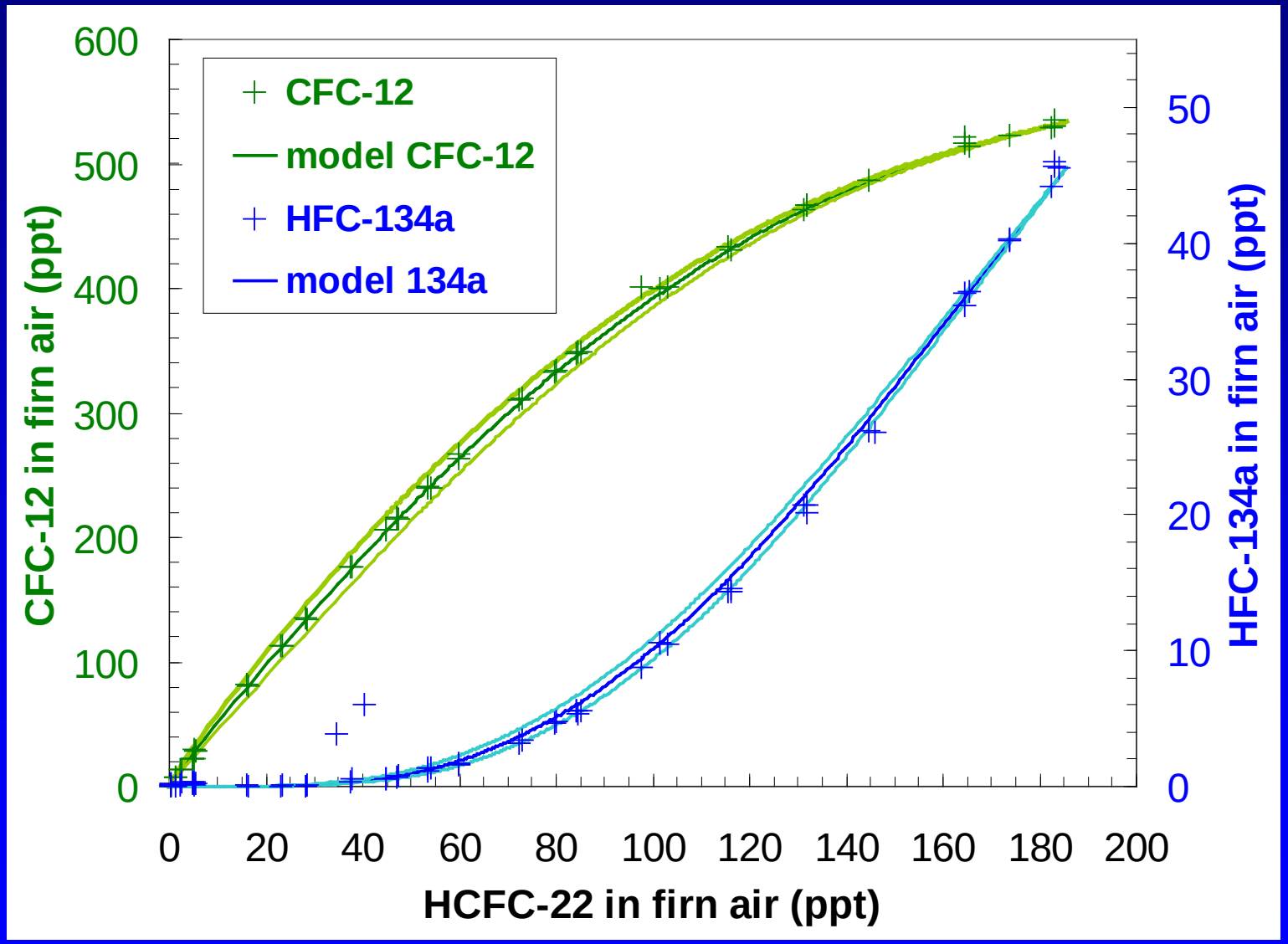
- *Our observations indicate a 50% increase in global HFC-23 emissions since the early 2000s—likely related to developing country production of HCFC-22*
- *CDM projects covered less than 50% of HFC-23 emissions from HCFC-22 production in developing countries in 2007*
- *Global HFC-23 emissions augmented the climate influence of HCFC-22 during 2006-2008 by about 33%*
- *Direct radiative forcing from HCFCs and HFCs is relatively small, but increasing*
- *The 5-yr increase in radiative forcing from substitutes for CFCs, is second only to CO_2 in magnitude.*

End

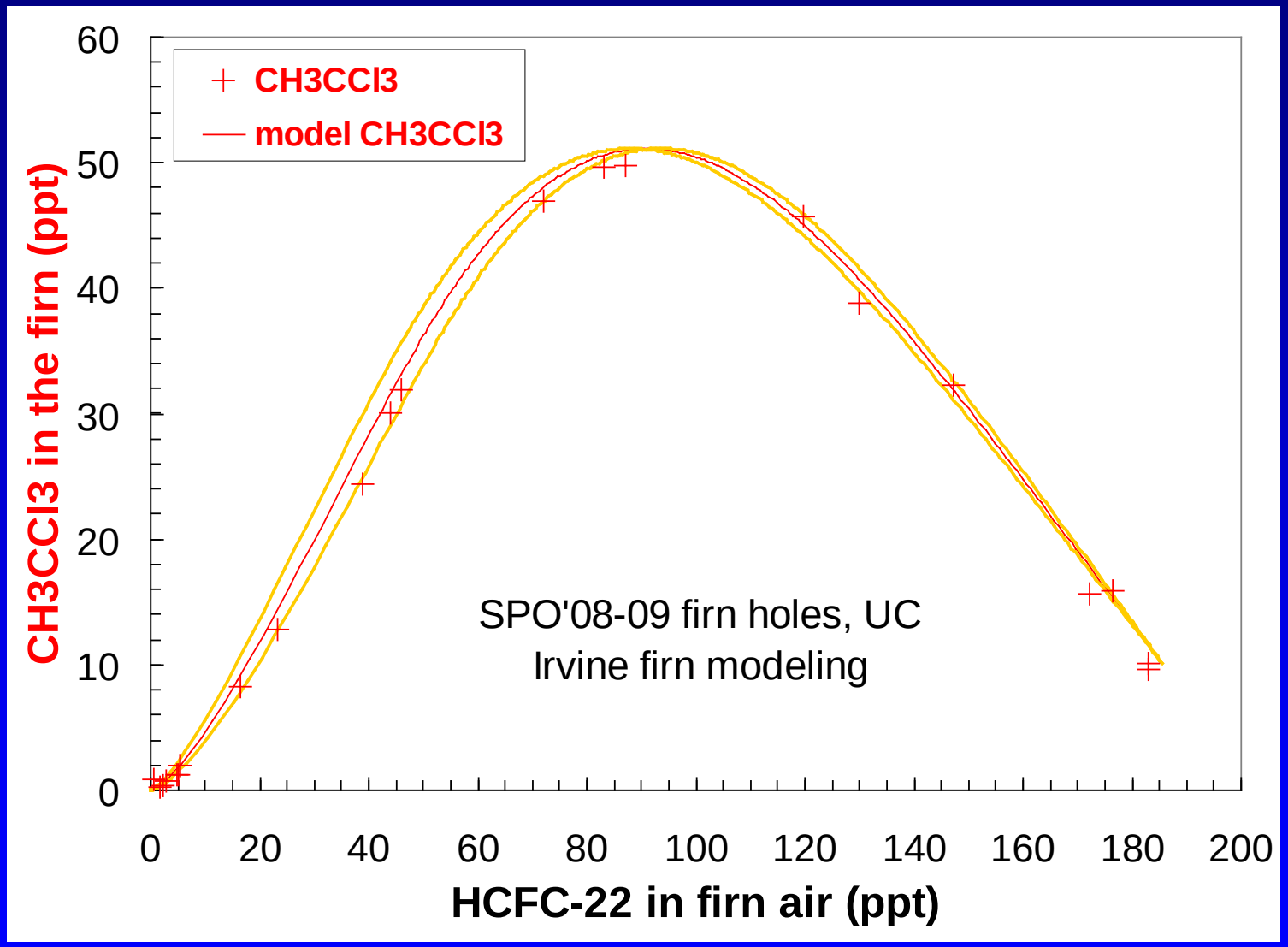
The SH history of HCFC-22 derived from archived air (Miller, 1999) and regular atmospheric sampling (Montzka et al., 1993; 2010)

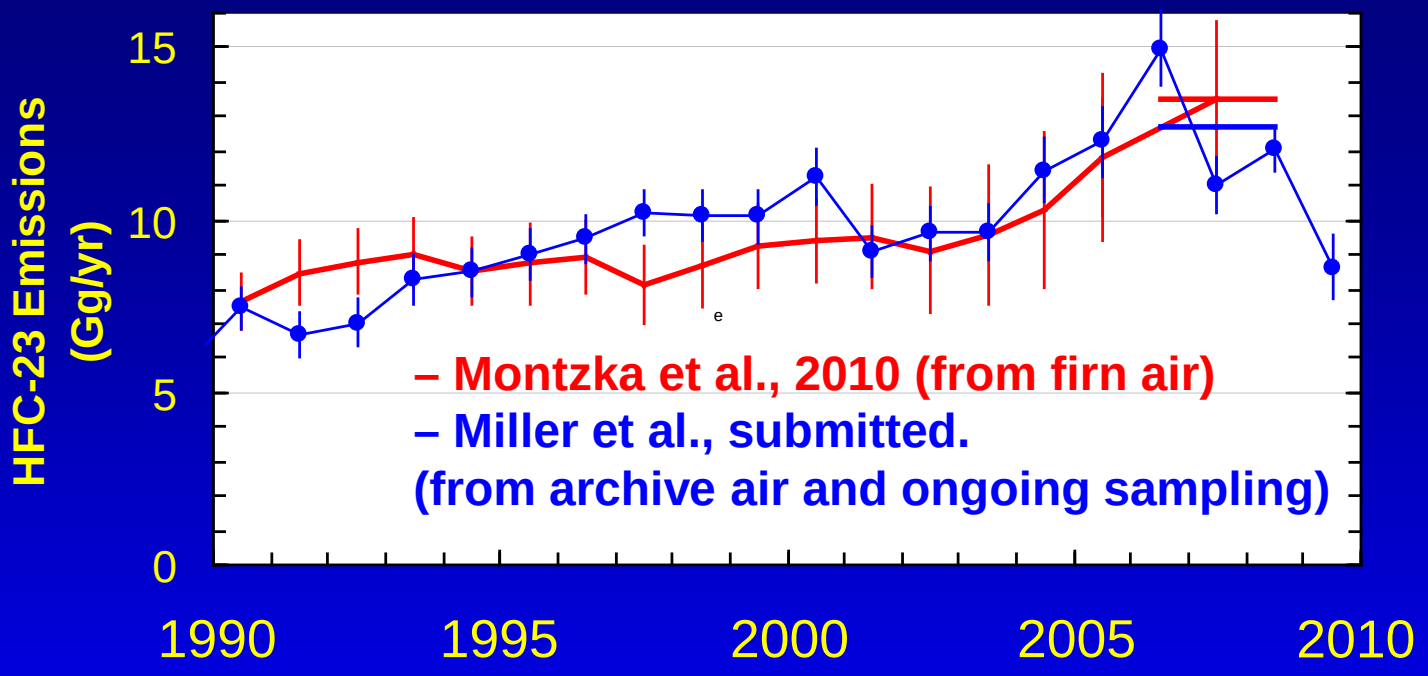


Testing the firn model diffusivity parameterization with known histories: of CFC-12 and HFC-134a:



Testing the firn model diffusivity parameterization with known histories: of CH_3CCl_3:




HFC-23 Emissions
(Gg/yr)
15
10
5
0
1990
1995
2000
2005
2010
– Montzka et al., 2010 (from firn air)
– Miller et al., submitted.
(from archive air and ongoing sampling)