EARTH SYSTEM RESEARCH LABORATORY
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Non-CO_2 Climate Gases: *N_2O, CFCs, HCFCs, and other Gases*

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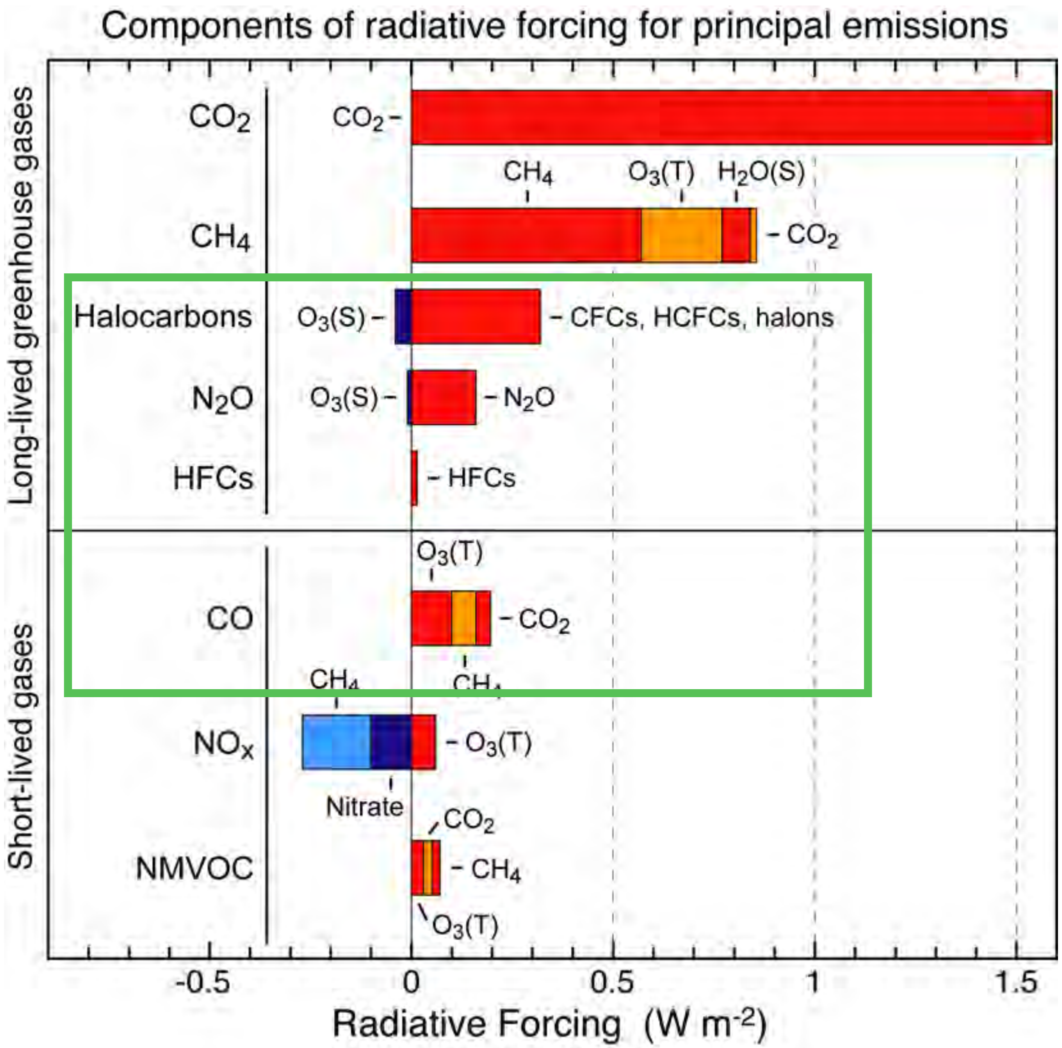
ESRL Atmospheric Chemistry Review
January 29-31, 2008 ~ Boulder, Colorado

1. Motivation

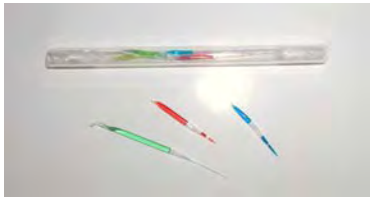


Adopted from IPCC [2007], Fig 2.21

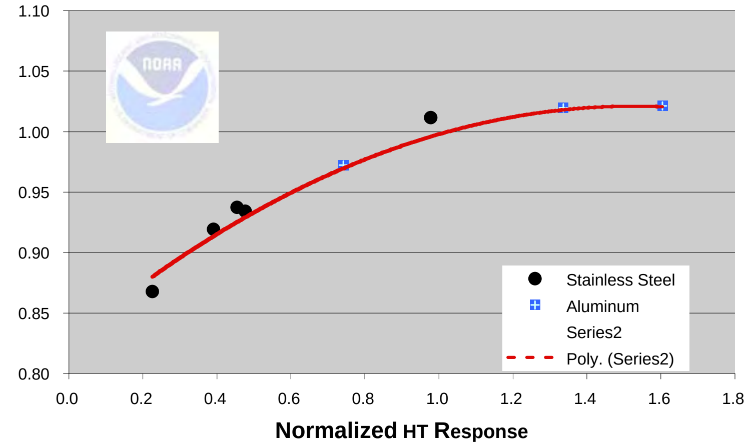
- Talk Will Focus on the GHGs in Green Box.
- Understand the gases that cause stratospheric ozone depletion, directly and indirectly (e.g. CO) affect climate forcing, and air quality.
- Note that small amounts of halocarbons and N_2O have negative forcing by destroying stratospheric O_3.

2a. Quality of Standards: An Essential Part of Quality Measurements

- NOAA is the WMO/Global Atmosphere Watch (GAW) Central Calibration Lab for CO_2, CH_4, CO, and N_2O. Inter-compare with AGAGE and others often.
- We also maintain calibration scales for ~ 40 other trace gases. A total of 784 primary standards were made.
- Many standards are made to address non-linearity of some detection techniques (lower right-hand plot). Secondary standards have to be reanalyzed for potential draft after use.
- Typical uncertainties
  - 0.2% N_2O,   1% HCFC-22
- Scale maintenance, long term
  - 0.06% N_2O,   0.4% CFC-12

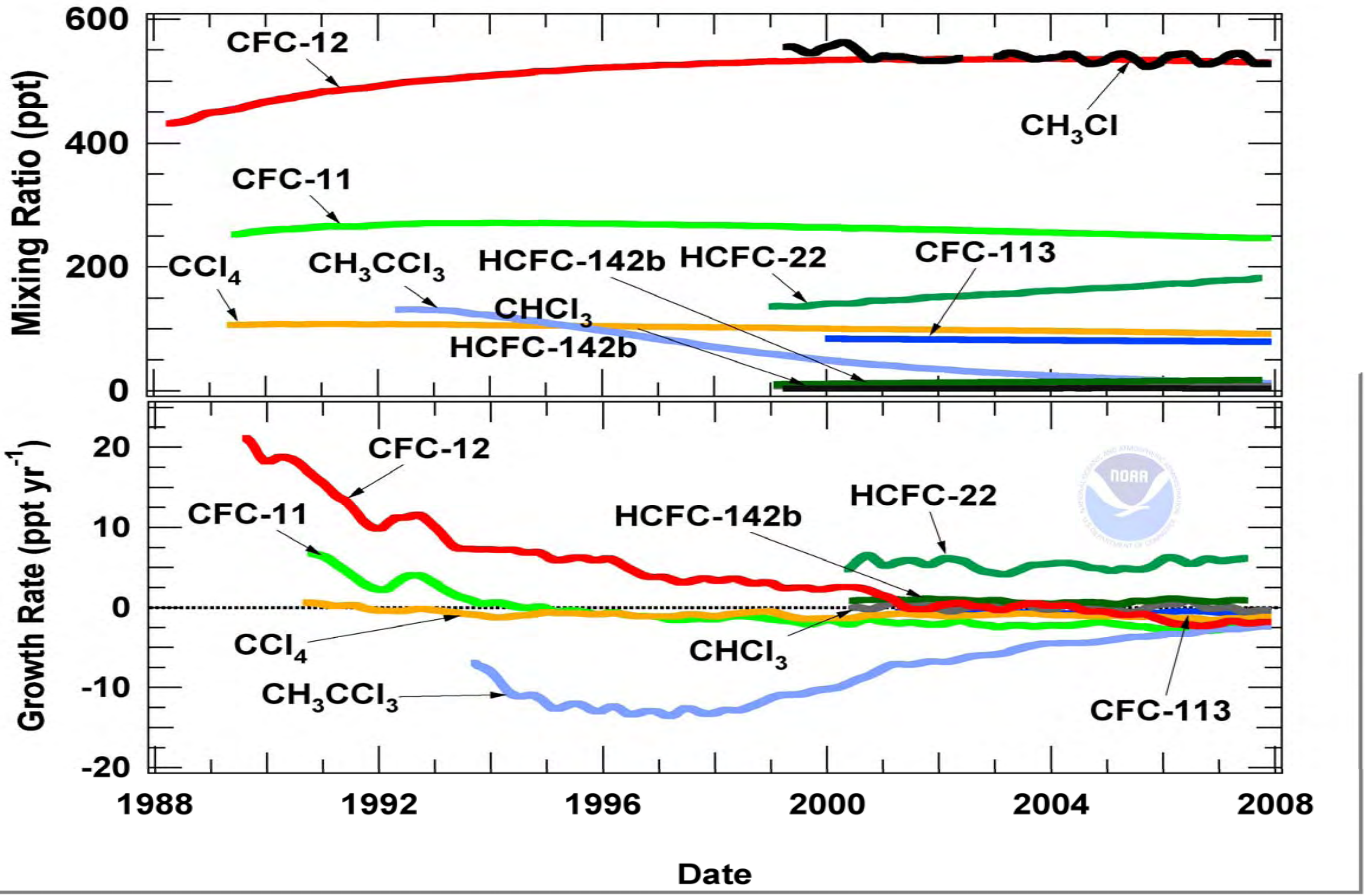


Non-linear response of CCl_4 on ECD



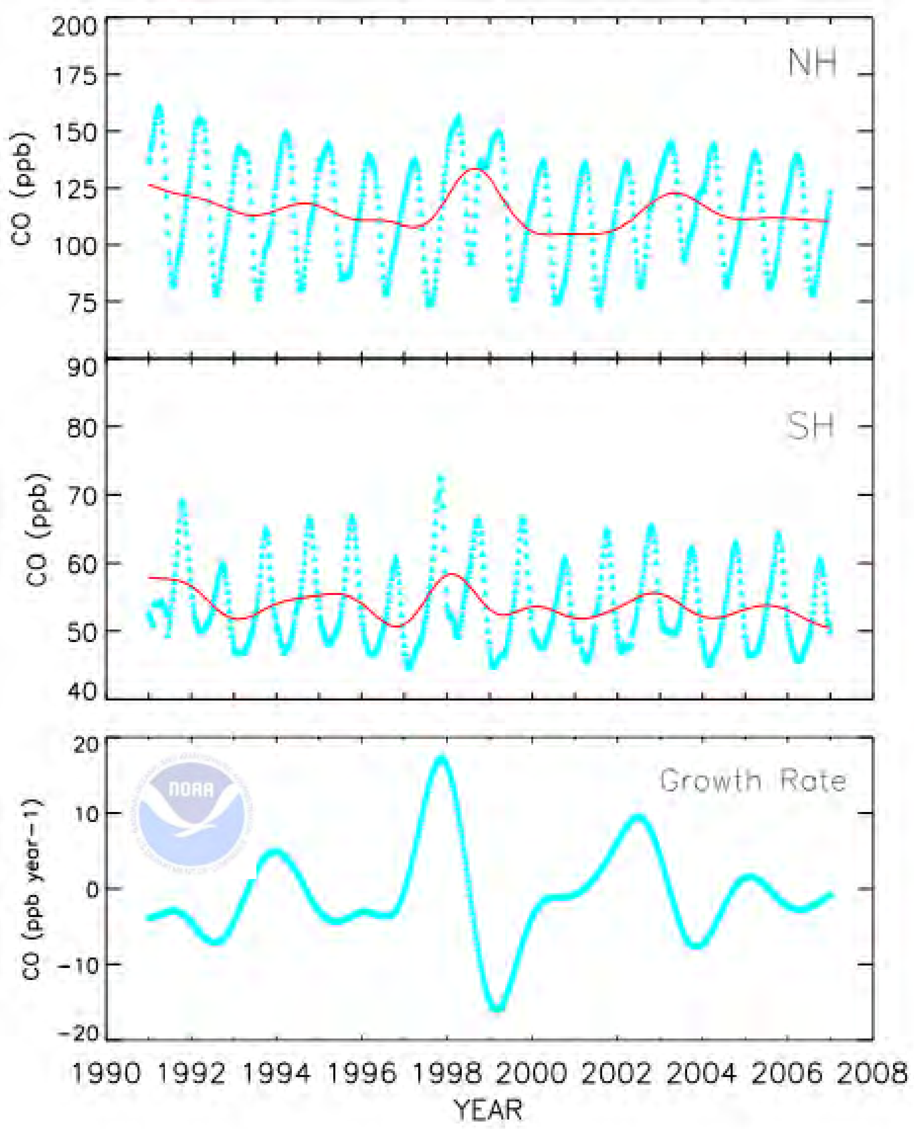
Tuesday lab tour of standards lab.

2b. Quality: Halocarbons (CFCs, halons, solvents)



http://www.esrl.noaa.gov/gmd/hats/insitu/cats/cats_conc.html in situ data from G. Dutton

2c. Quality of Measurement: CO

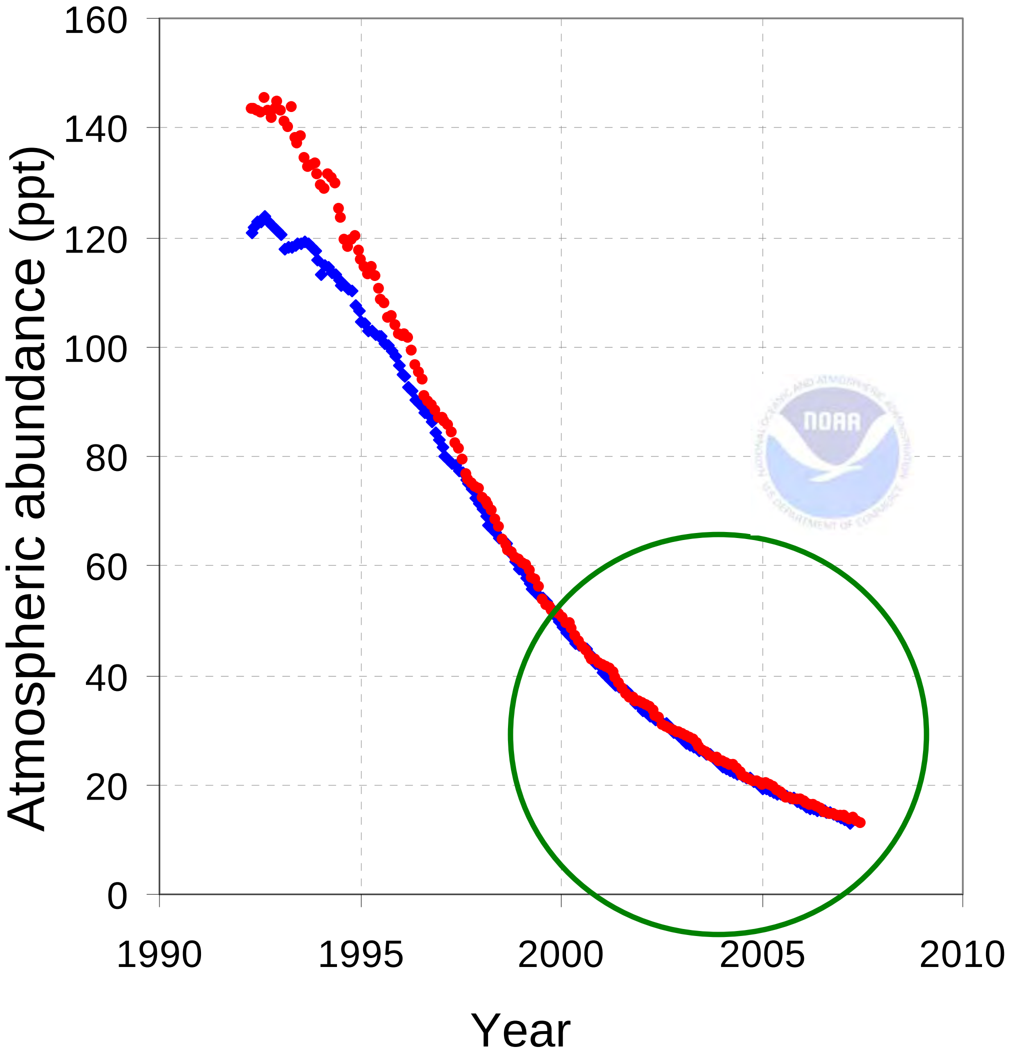


- CO reacts quickly with tropospheric OH.
- CO has a short atmospheric lifetime of ~2 months.
- Source from the burning of fossil fuels and biomass. Use to calculate emissions of other non-CO_2 gases.
- Large interhemispheric gradient.
- No significant trend since 1991.
- El Niño events created droughts in Asia and more forest fires in 1998 and 2004.

Update of *Novelli et al.*, [2003], JGR

2d. Quality of Measurements--Inferring OH abundance

Rate of change in methyl chloroform = Emissions – Loss(OH, k)



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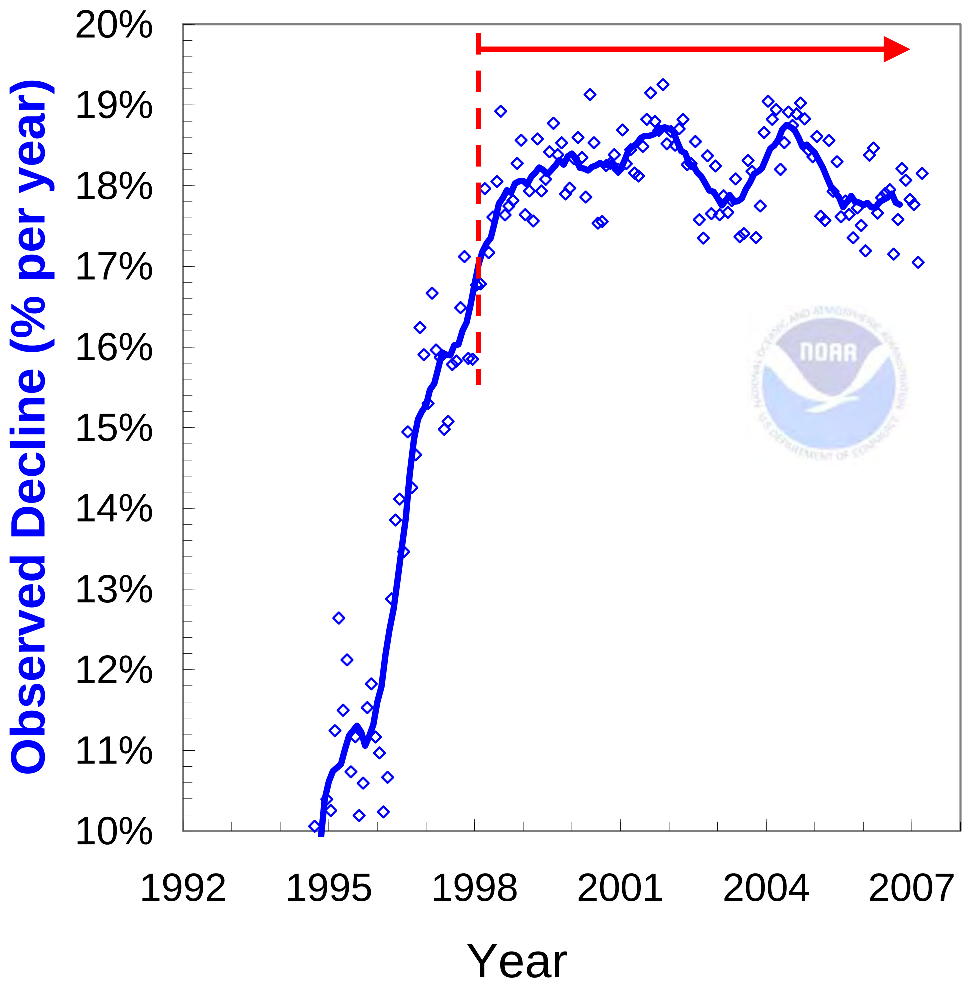


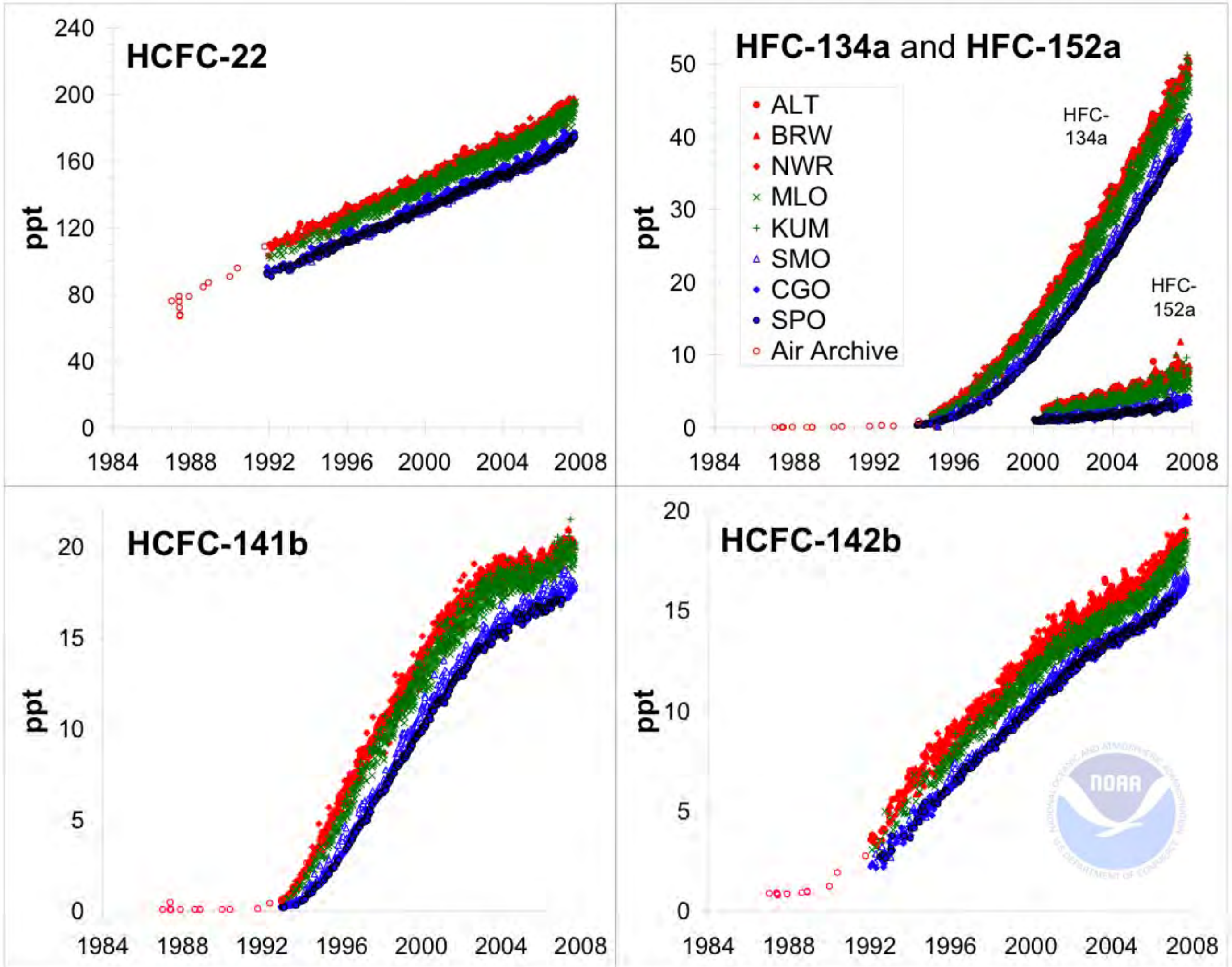
Rapid declines in MC emissions allow more direct insights into OH abundance and variability!

* **Global OH abundance**
  ~1.1 × 10^6 radicals/cm^3

* **Interannual OH variability of ± 2%** (related to CO/burning?)
  → Suggests OH is buffered against large changes

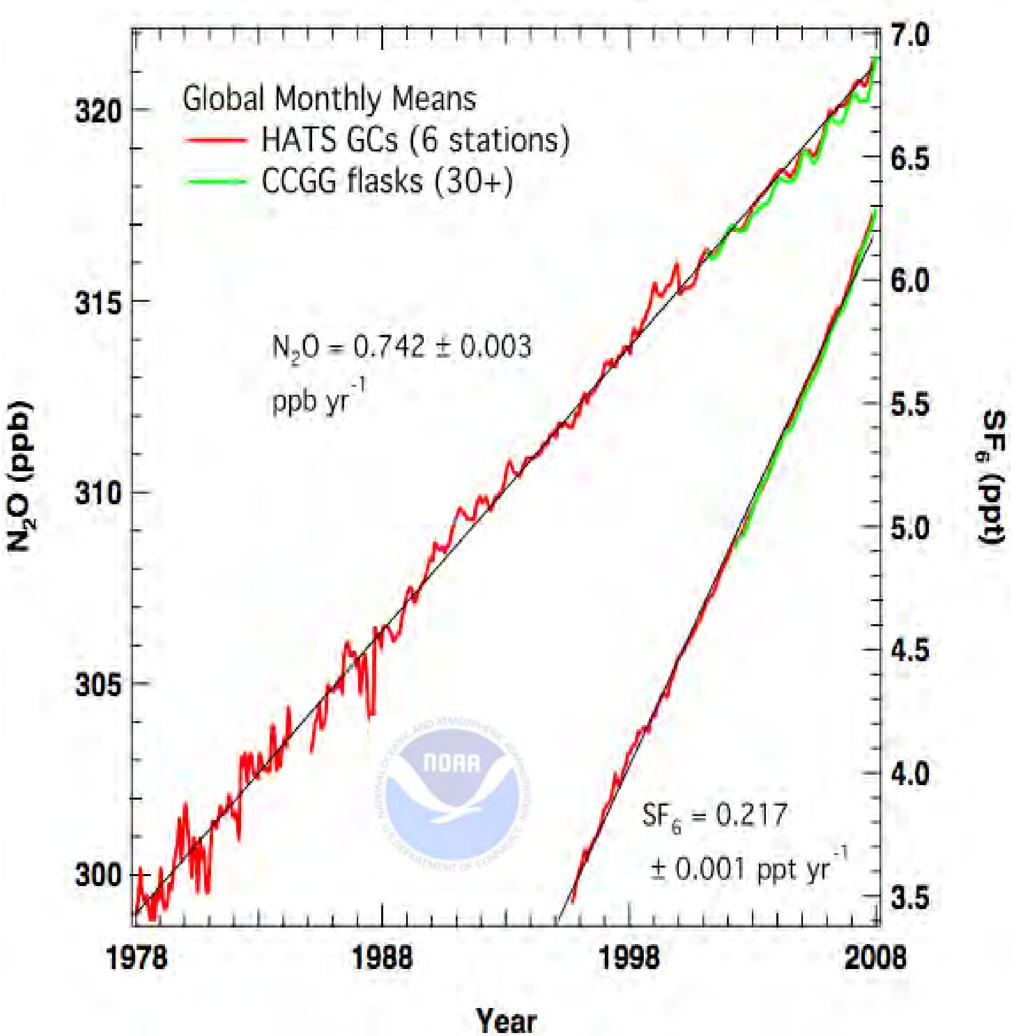
More Details later on Thursday…

3. CFC Substitutes (HCFCs & HFCs)



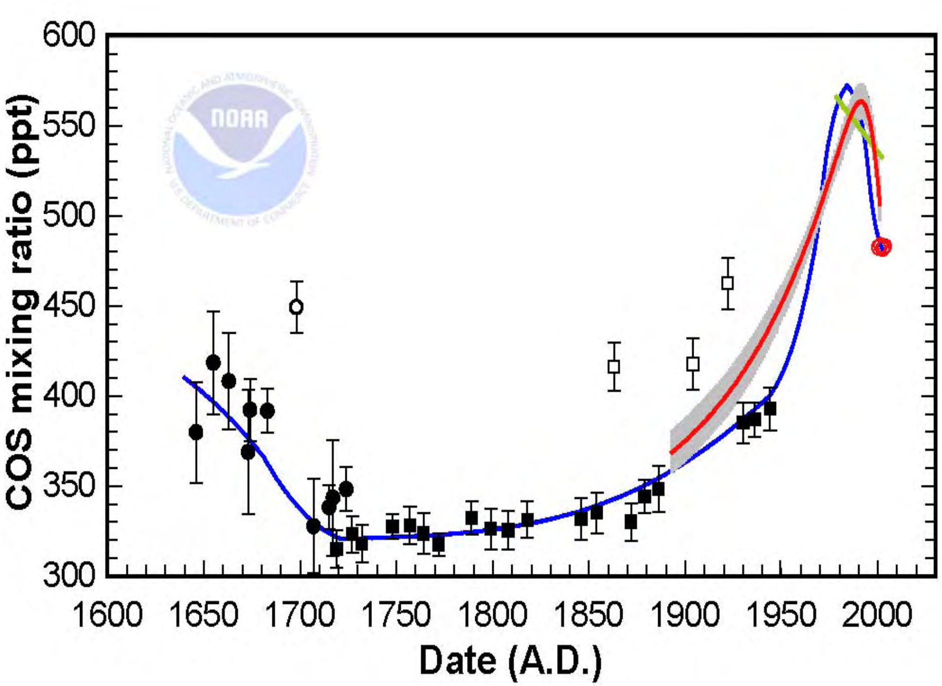
Data from S. Montzka

4. The Importance of N_2O and SF_6



- N_2O and SF_6, on average linear growth rate, like CO_2.
- N_2O budget is 30% out of balance. N_2O is used as a proxy for altitude.
- Production of N_2O after the use of fertilizers for crops is the major man-made source.
- N_2O source may reduce gains in use of biofuels (*Crutzen et al.,* [2007]).
- SF_6 is directly tied to the distribution of electricity.
- There is no substitute for SF_6 that is more climate friendly.
- SF_6 used in transport studies (e.g.mean age)

5a. COS-Stratospheric Aerosol Source, Forcing, & CO_2

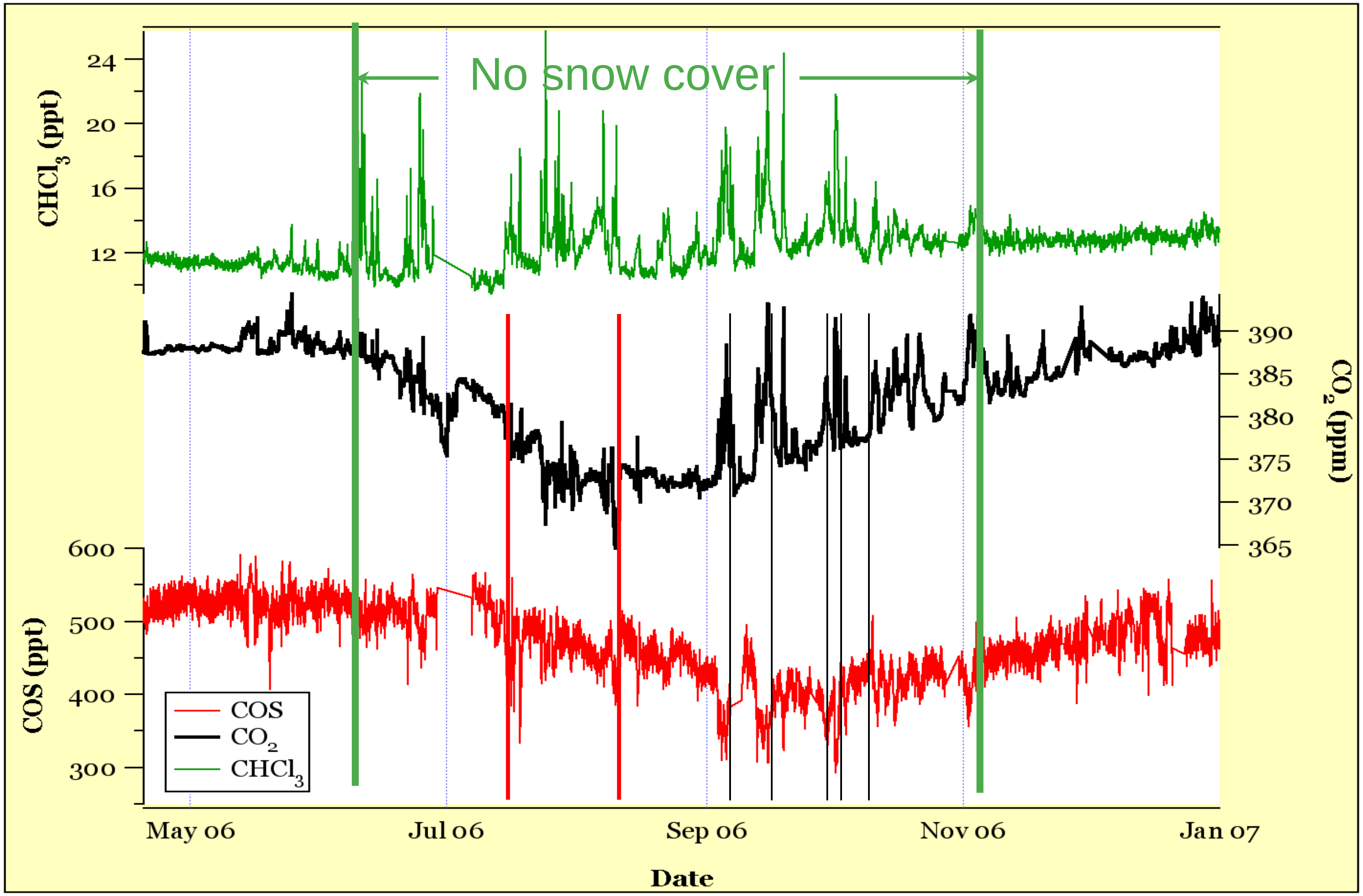


Montzka et al. [2004] and Ice Core results from Saltzman & Aydin et al.

- COS, longest lifetime (~3 yr) and most abundant sulfur background gas (~480 ppt).
- Responsible for 20-50% of the stratospheric sulfate aerosol layer.
- Pre-Industrial levels of 320-410 ppt
- COS is related to trends in sulfur emissions from fossil fuels
- COS forcing= (0.12 ppb) x 0.1 W m^{-2} ppb^{-1} = 0.12 W m^{-2}=[SF_6] + [HFC-134a] = Largest minor gas. Not included in IPCC or AGGI.

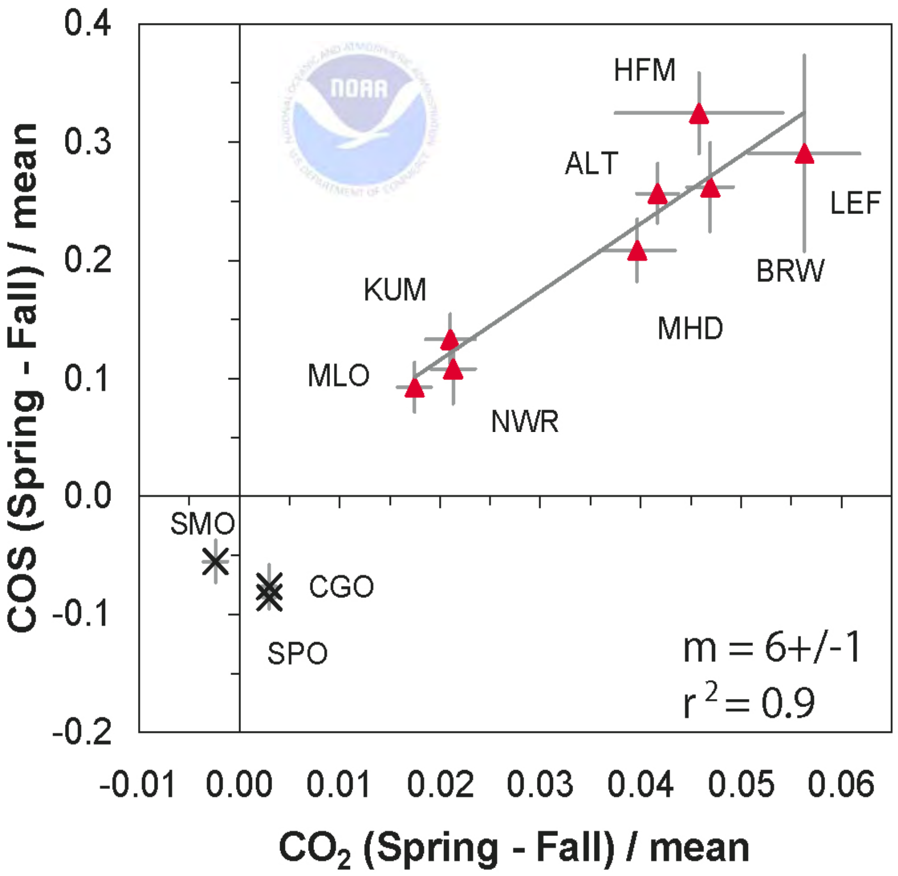
In red: J. Burkholder, private comm., [2005]

5b. COS-Stratospheric Aerosol Source, Forcing, & CO_2



In situ CATS GC & NDIR (CO_2) at Pt. Barrow, G. Dutton snow melt on June 10, 18 gases, 5 stations, 750,000 obs./yr.

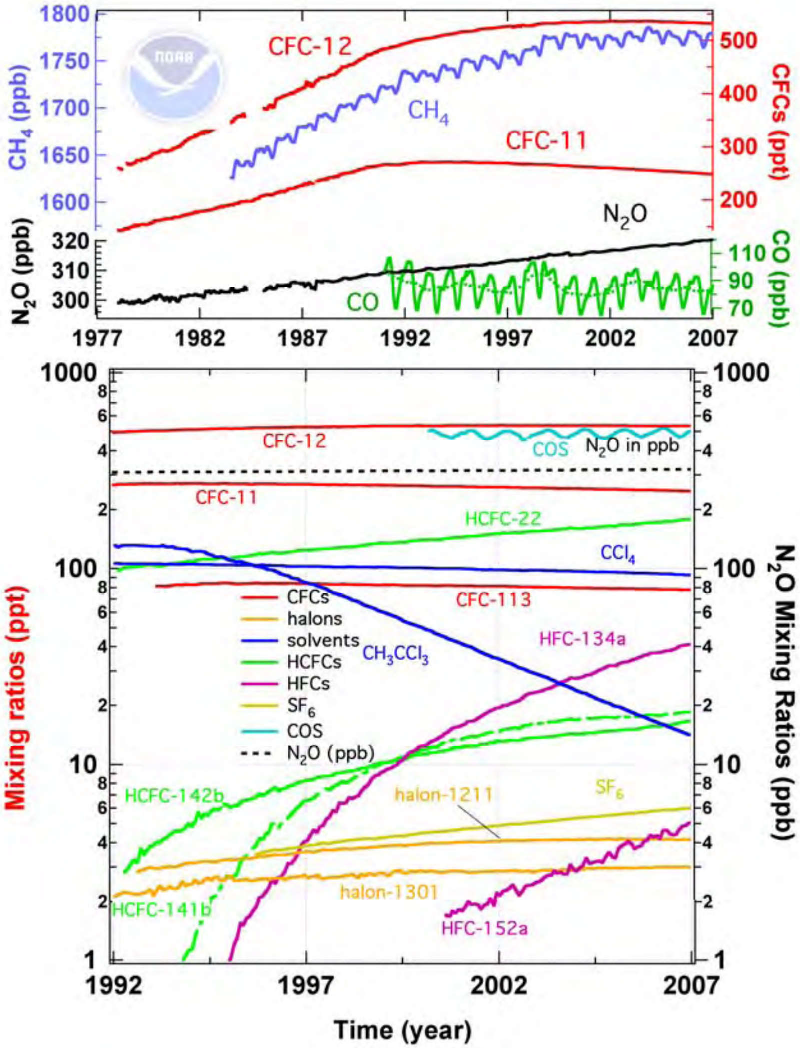
5c. COS-Stratospheric Aerosol Source, Forcing, & CO_2



Montzka et al., [2007]

- The relative N.H. amplitude of COS seasonality ((Spring-Fall)/mean) is ~6 times that of CO_2.
- COS is assimilated by the same enzymes as CO_2 during photosynthesis.
- COS may provide a useful tool to quantify terrestrial, gross primary production of CO_2 independent of respiration.

6. Summary of Talk



- Quality measurements require reliable high quality standards.
- Every CFC, halon, and solvent (Annex A and B) has leveled off or is decreasing except halon-1301. All will continue to influence radiatively forcing because of long lifetimes.
- N_2O & SF_6, similar to CO_2, are increasing at linear rates.
- HCFCs have shown a decline in growth rates prior to 2004, however, they are increasing again.
- COS is a unique gas, with broad interest in atmospheric chemistry.
- Trends of CO have been relatively flat over the past 18 years.