

Radiative Forcing of LONG-LIVED Non-CO₂ Greenhouse Gases

*CH₄ (discussed by Ed D.)

*N₂O

*Ozone-depleting gases
and their substitutes:

Chlorofluorocarbons

Other chlorinated and brominated chemicals

Hydrochlorofluorocarbons

Hydrofluorocarbons

*SF₆

*Perfluorinated carbon compounds

Direct and Indirect Influences...

Anthropogenic use is addressed by
the Montreal Protocol or
the Kyoto Protocol



Air sampling
at the South Pole

Current and Past Activities **in NOAA/ESRL** Related to *Radiative Forcing of Non-CO₂ Greenhouse Gases*

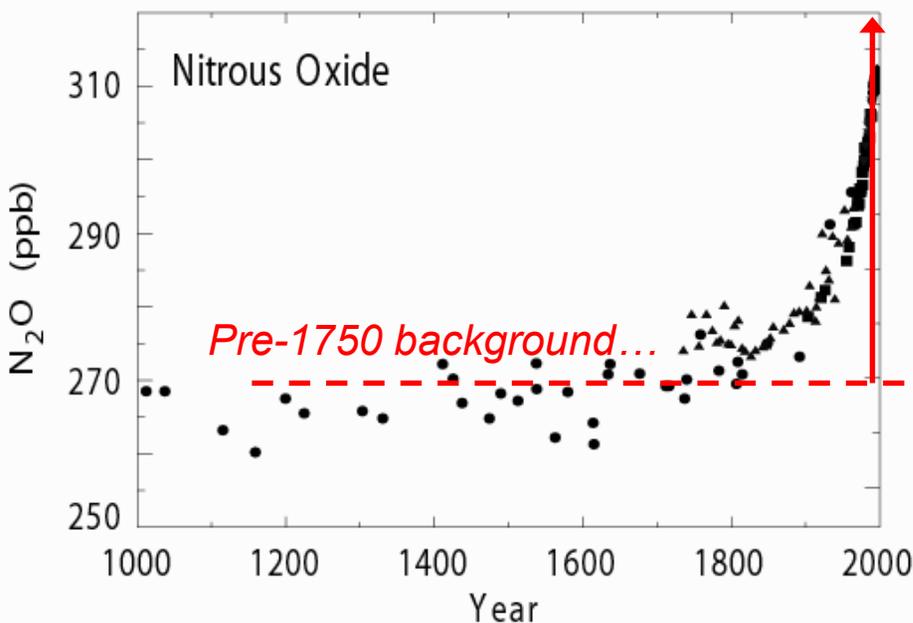
**** Observing global changes for non-CO₂ greenhouse gases:**

Global sampling networks, custom instrumentation, high-accuracy standardization
air trapped in glacial snow...

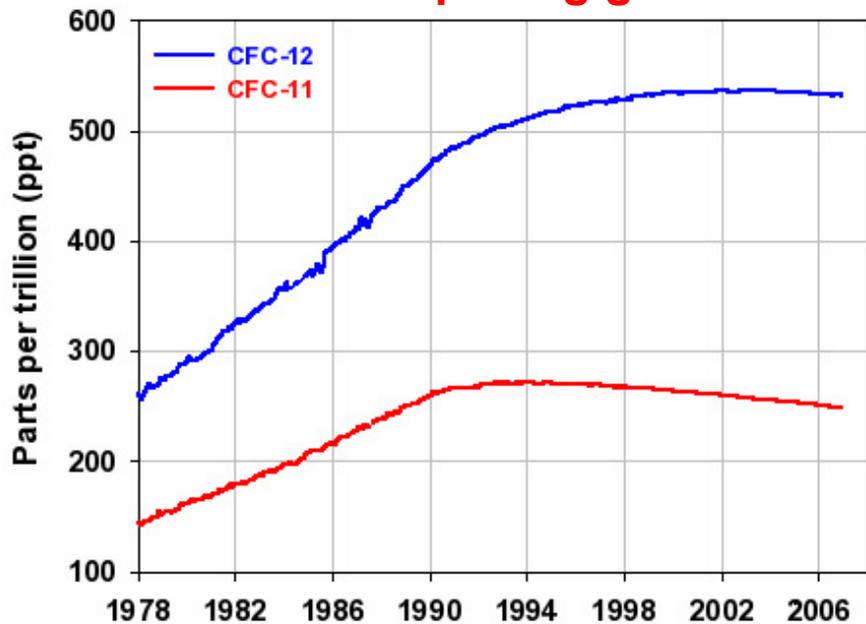
**** Assessing the significance of observed global changes:**

**** Understanding the underlying causes of observed global changes:**

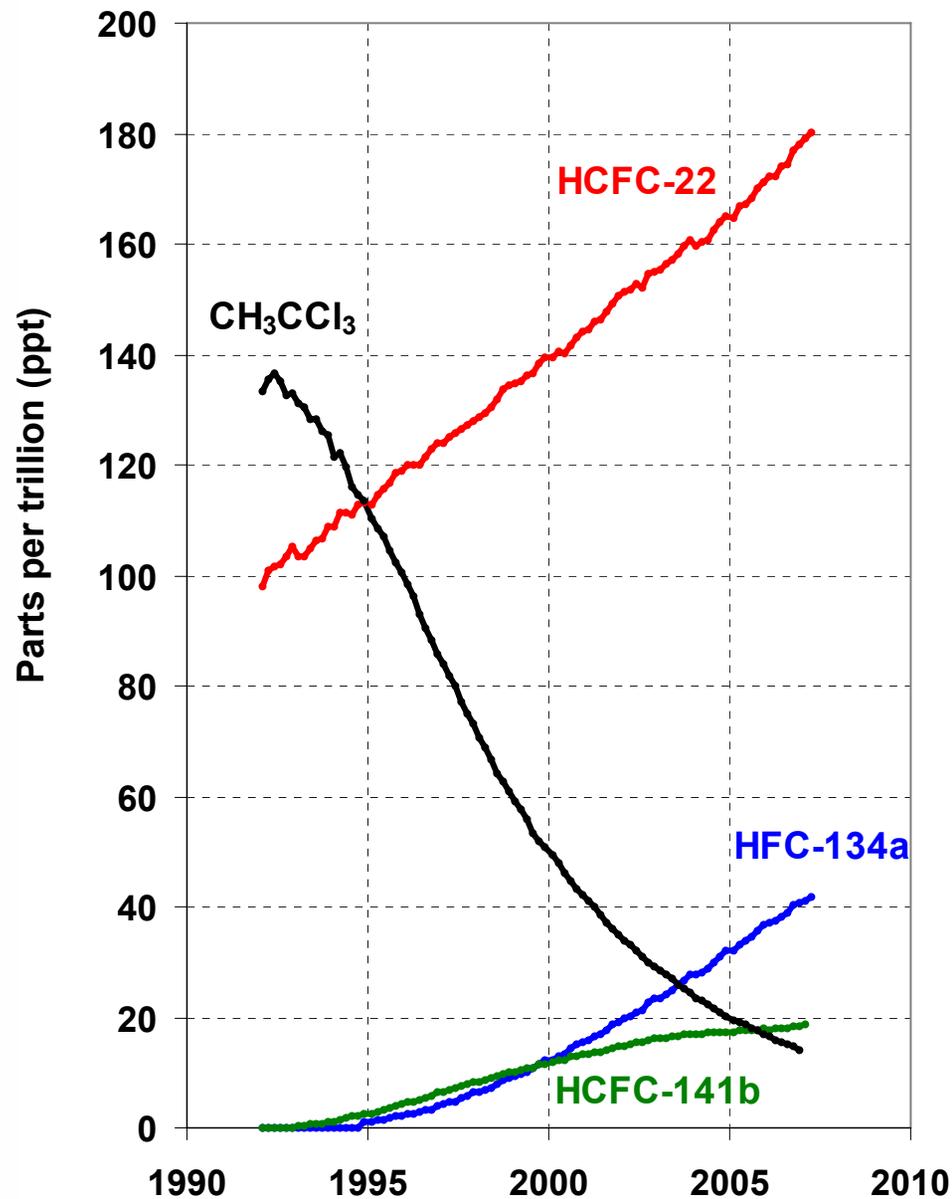
Observing global changes in atmospheric abundance:



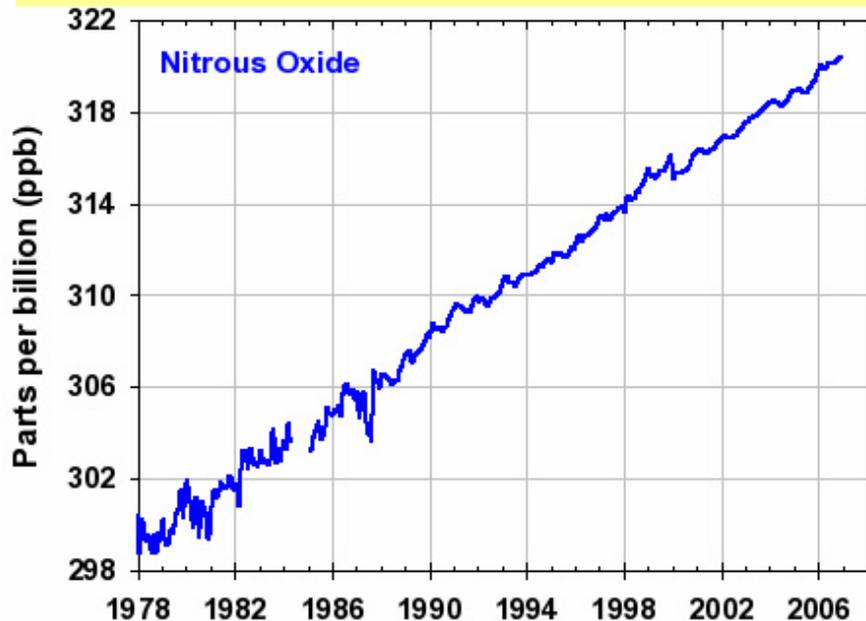
Ozone-depleting gases



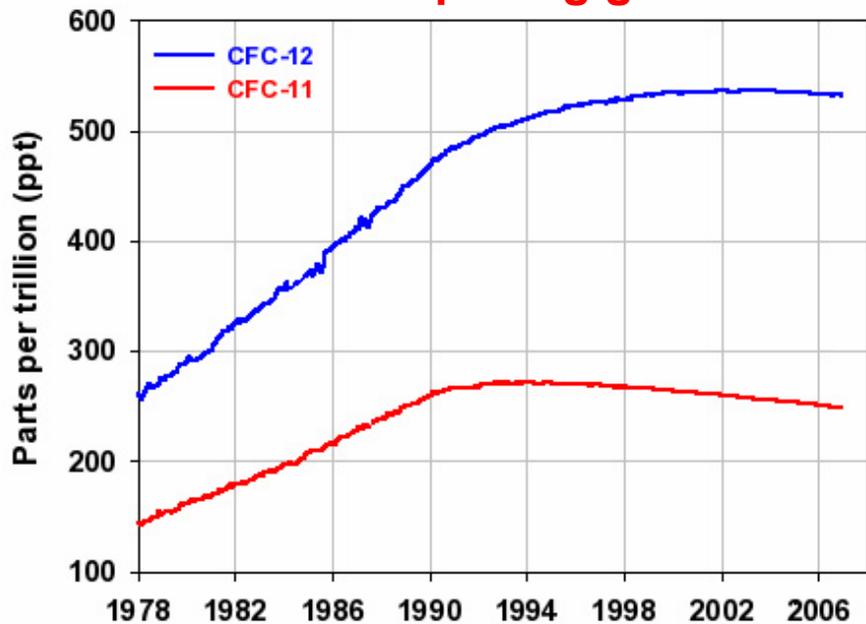
Other ozone-depleting gases and substitute chemicals



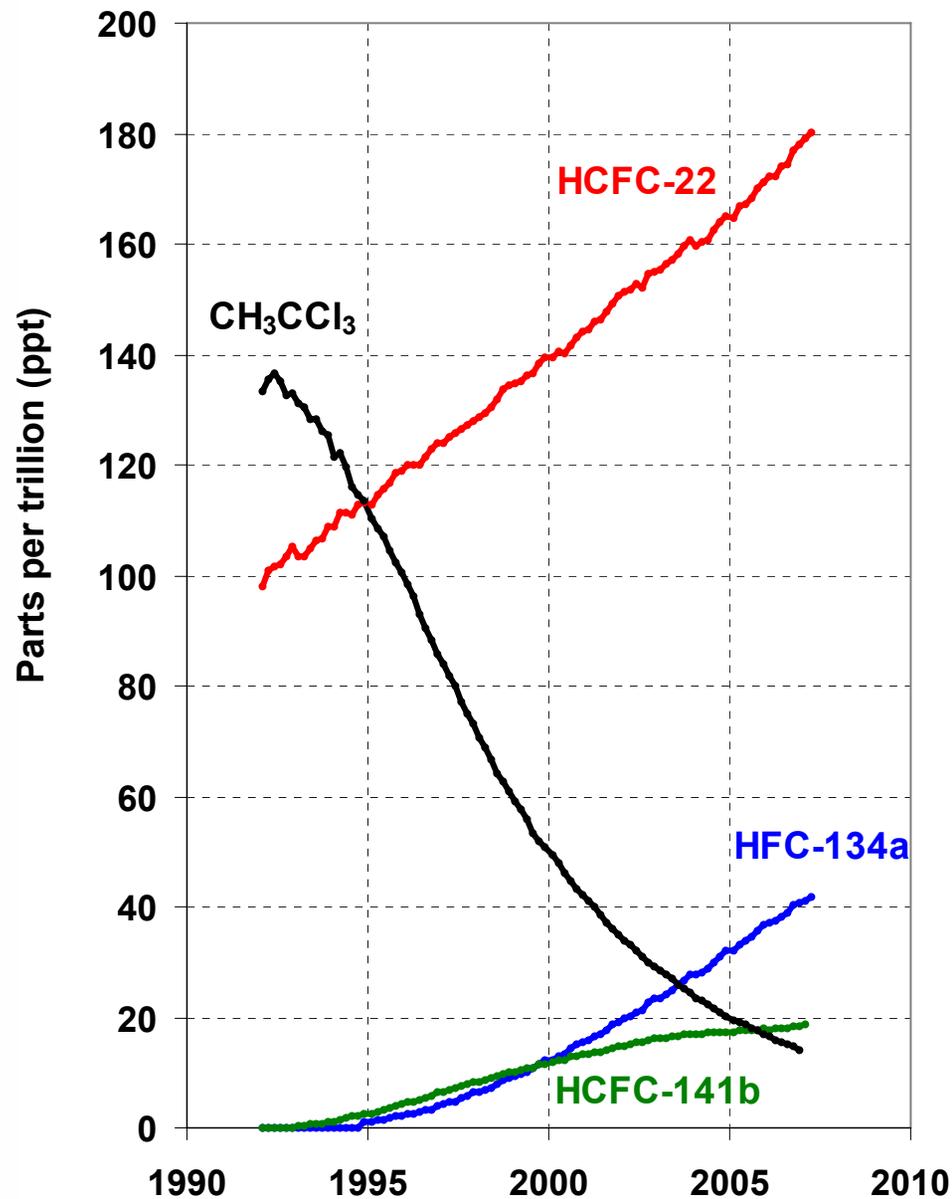
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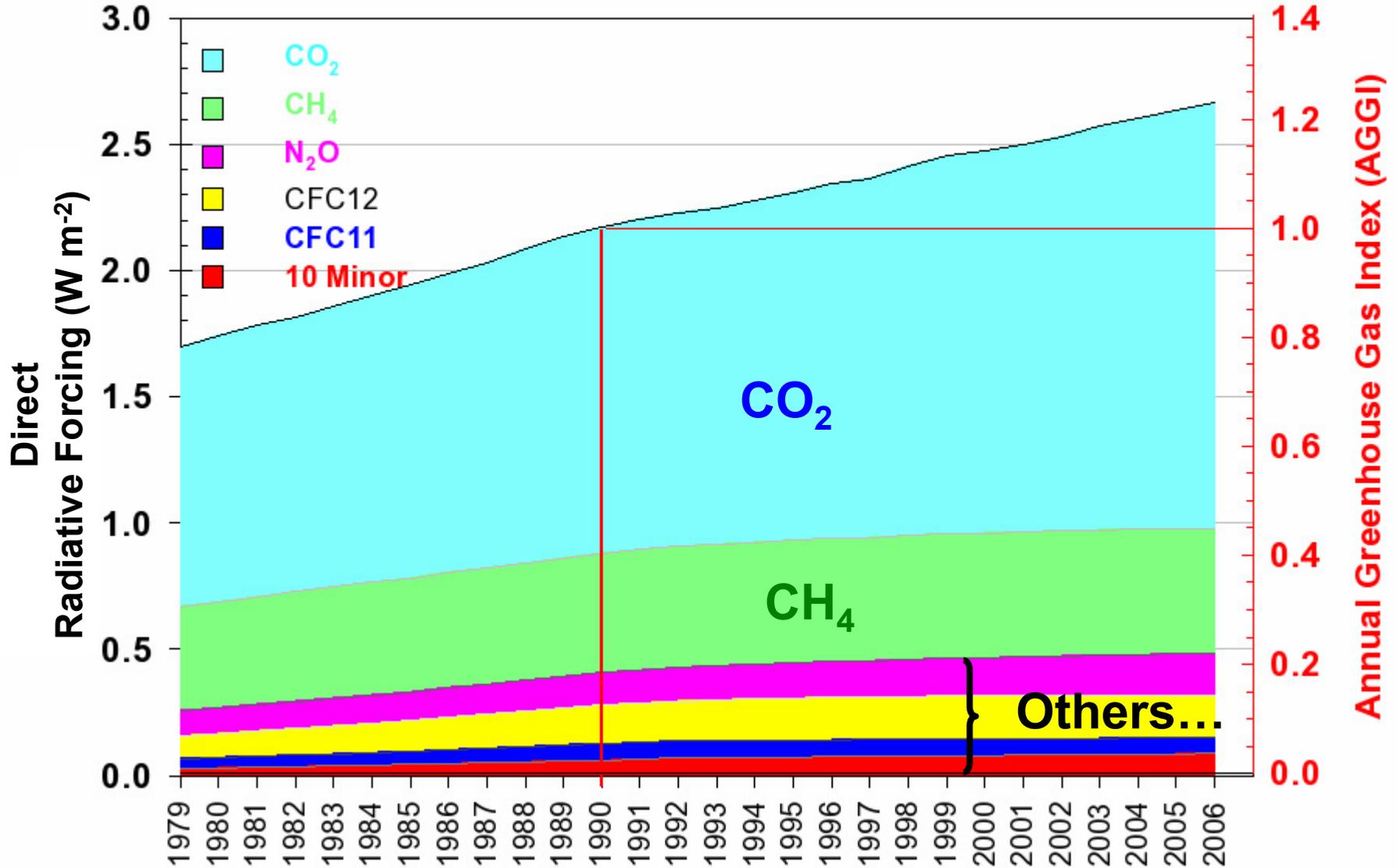
Considering measured abundances and laboratory studies of chemical properties:

→ Quantifying radiative forcing changes over time (e.g., as the AGGI)

** Understanding the underlying causes of observed global changes:

Assessing the Significance of the Observed Changes:

NOAA Annual Greenhouse Gas Index $\sim \sum(\text{Abundance} * \text{Radiative Efficiency})$



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Considering global emissions inferred from observations:

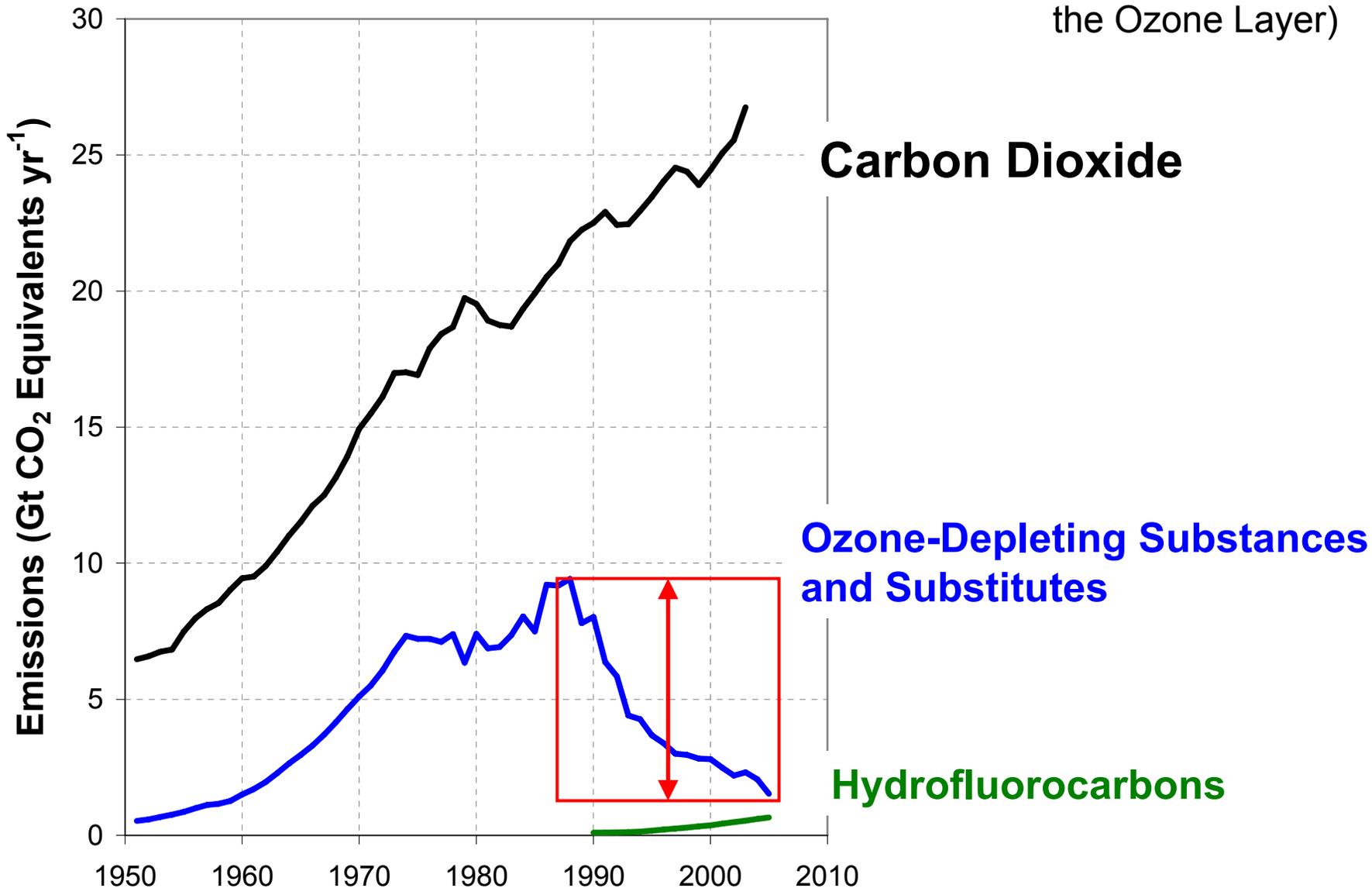
→ **Inferring global-scale, CO₂-equivalent emissions**

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Assessing the Significance of the Observations:

Deriving Global Emissions from observations (as CO₂-equivalent emissions)

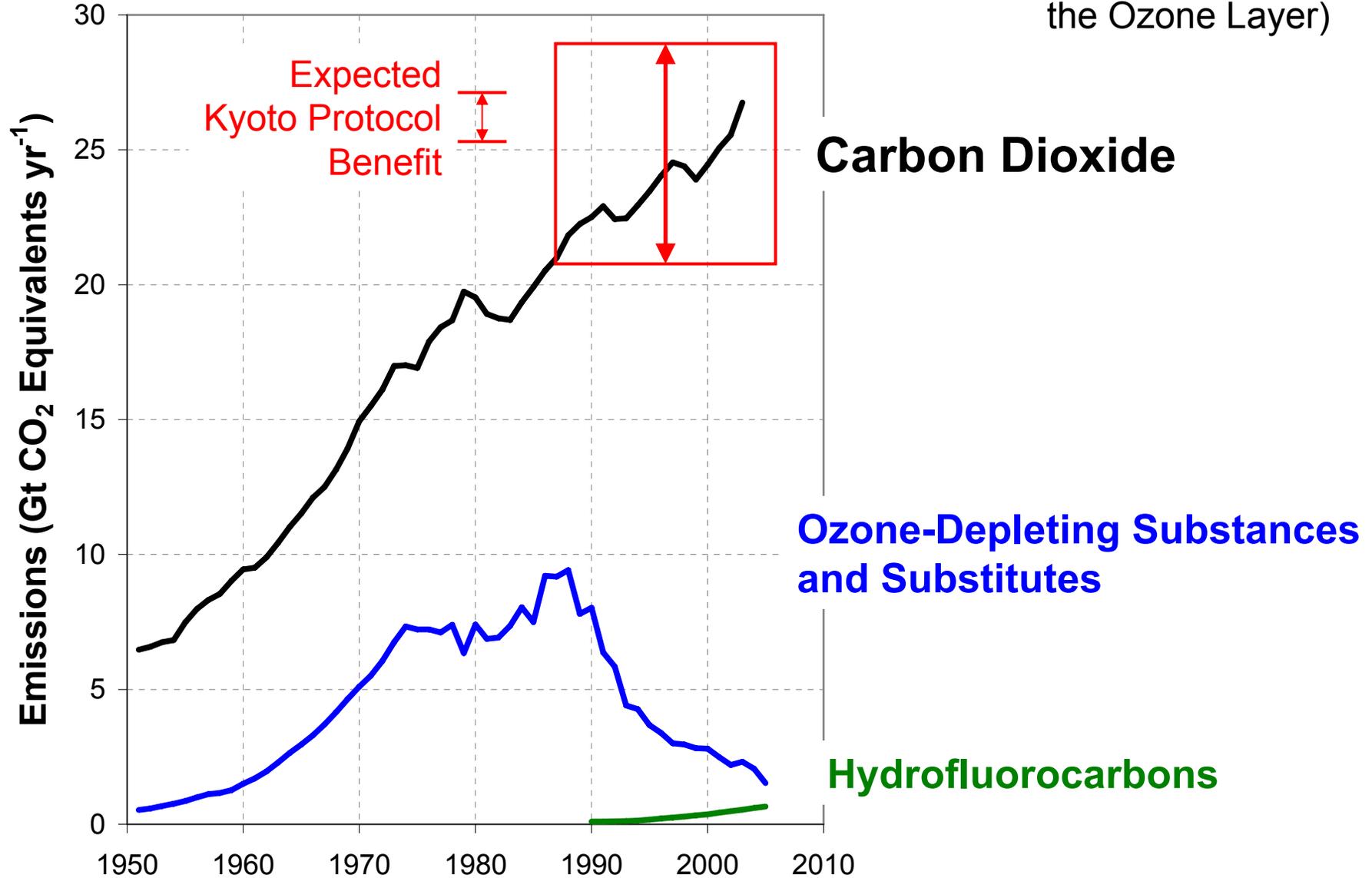
(On the climate benefits of the Montreal Protocol on Substances that Deplete the Ozone Layer)



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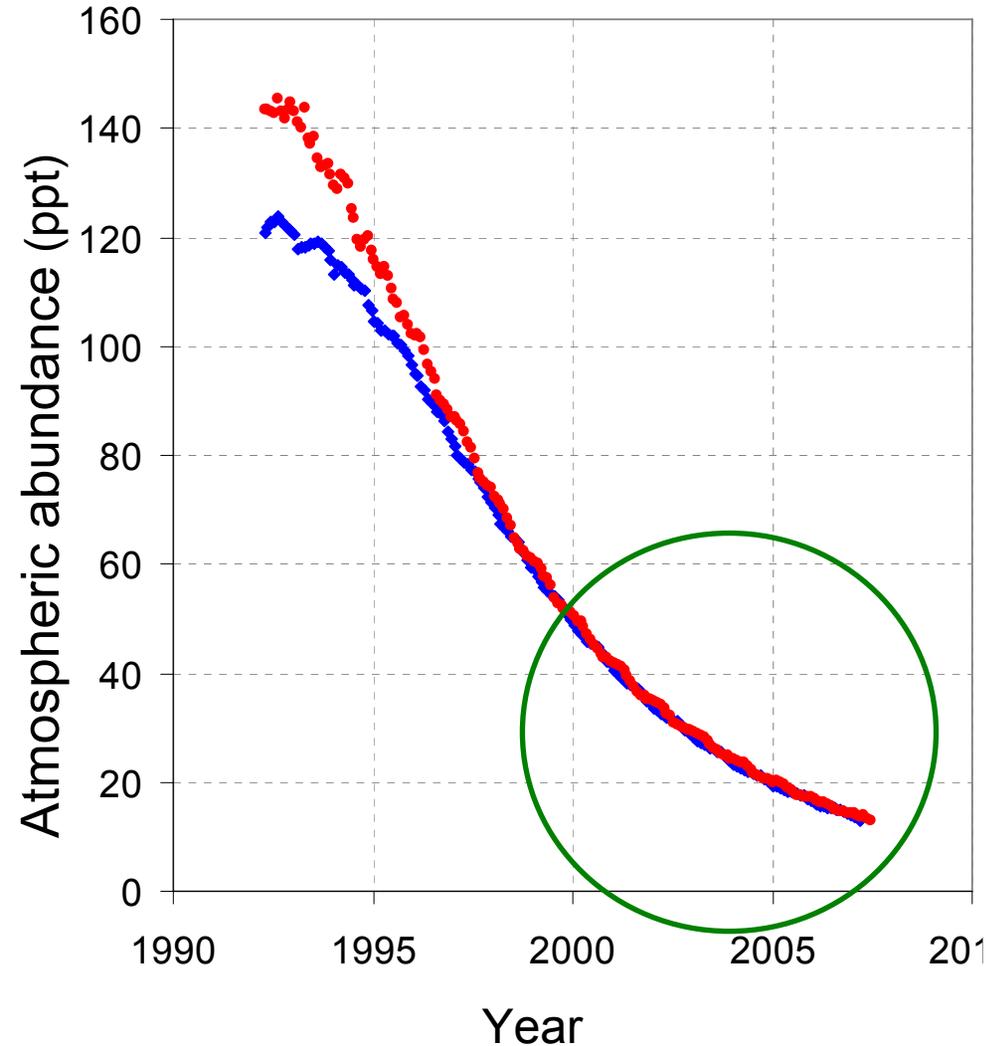
Related to sinks:

Abundance and variability in the atmospheric hydroxyl radical (OH)

(OH ties together many issues related to non-CO₂ GHGs)

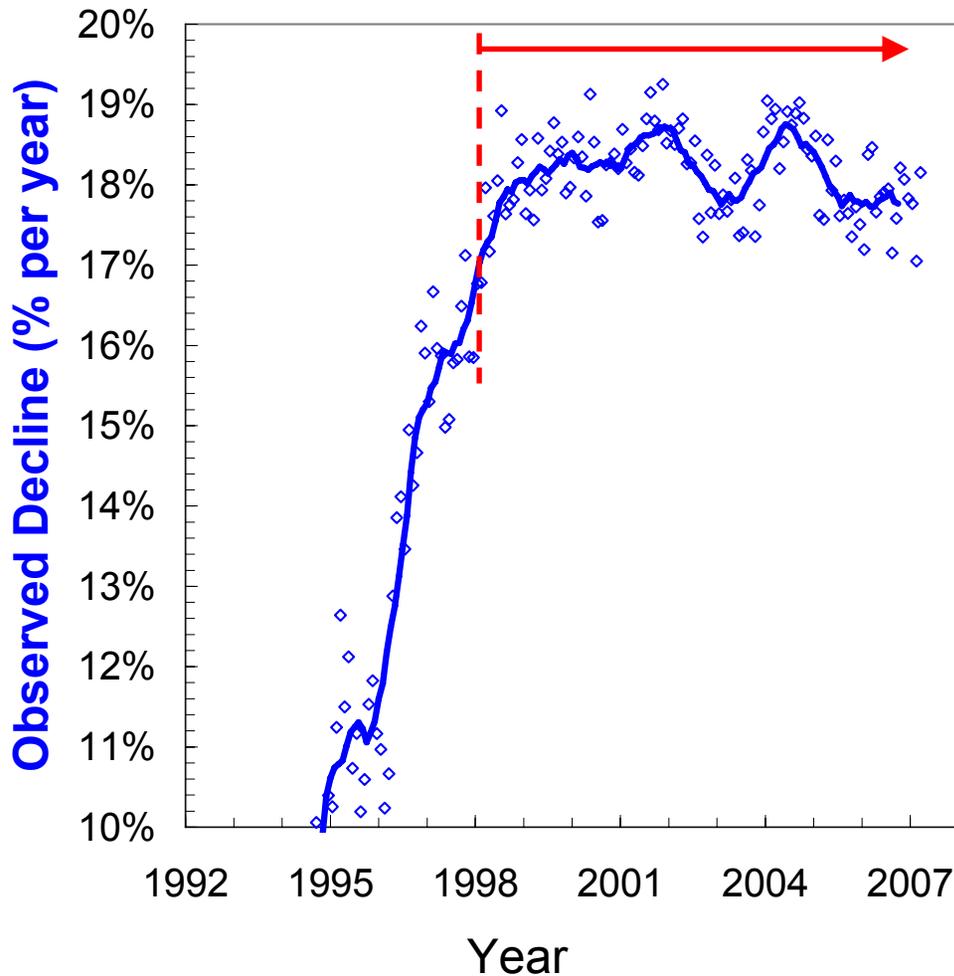
Inferring OH abundance and variability from trace gas observations:

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



Inferring OH abundance and variability from trace gas observations:

$$\text{Rate of change in methyl chloroform} = \text{Emissions} - \text{Loss(OH, k)}$$



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

- * **Global OH abundance**
 $\sim 1.1 \times 10^6$ radicals/cm³
- * **Interannual OH variability**
of $\pm 2\%$ (related to CO/burning?)
→ **Suggests OH is buffered against large changes**

See poster later on...

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Related to ecosystem processes and regional sources:

Quantifying the role of other processes (ocean, land, biosphere, regions)

Working on for the future:

Quantifying Regional/National emissions—applying **Carbon Tracker** to other gases and for verification of Kyoto Protocol targets...

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