

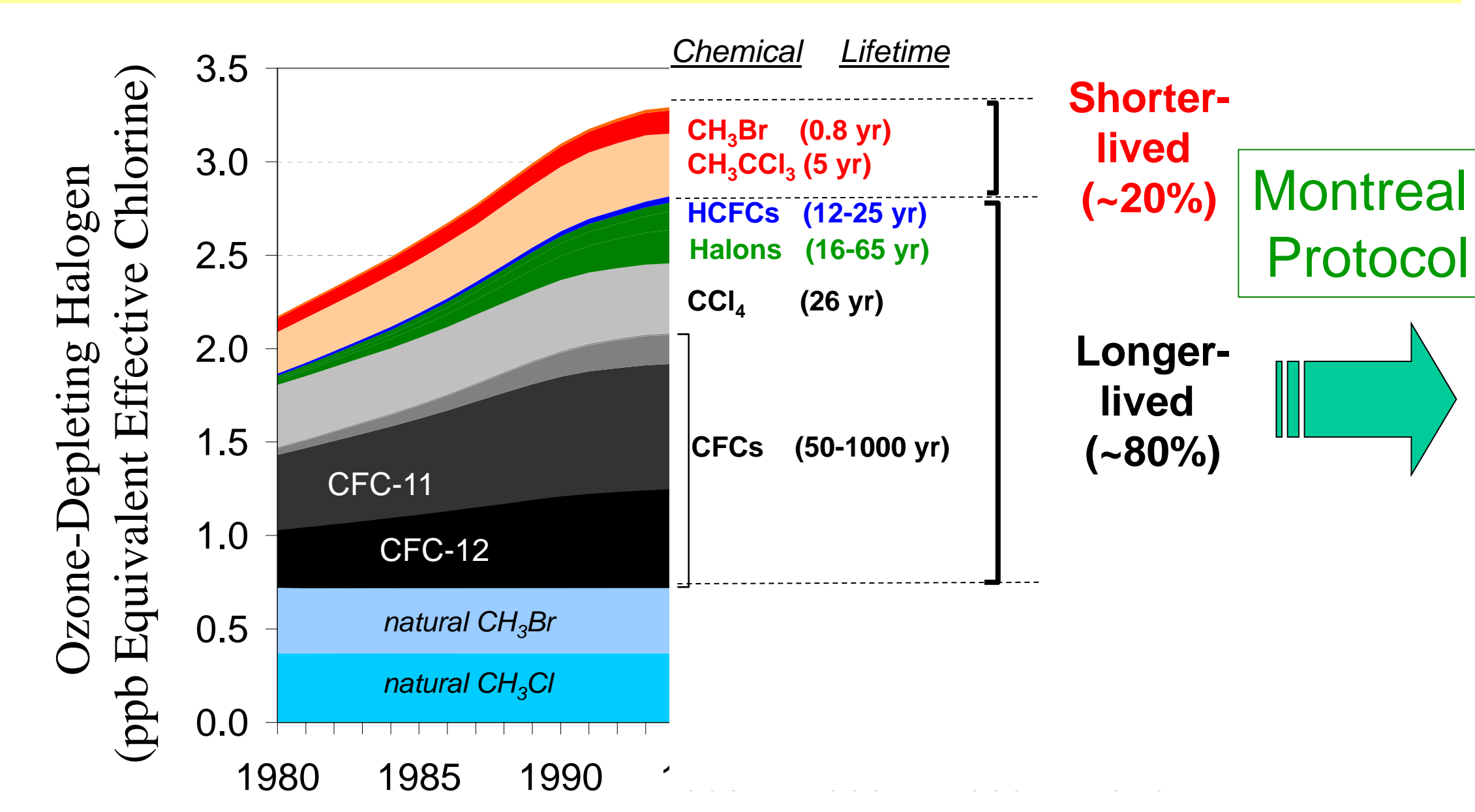
# Shorter-lived trace-gases: opportunities for mitigating ozone depletion and climate change

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## 1) Atmospheric concentrations, pre-control:

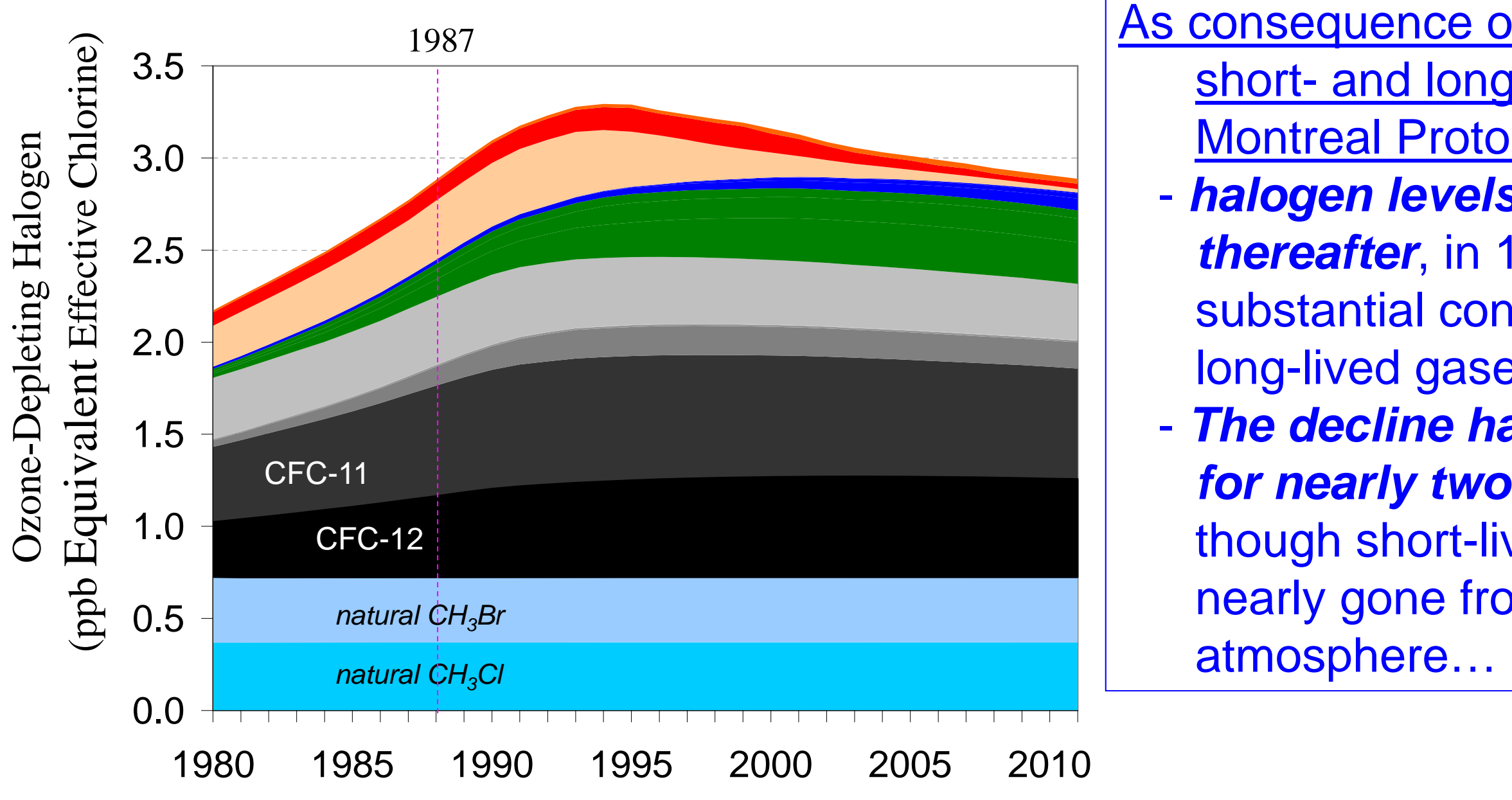
Reactive halogen from ozone-depleting substances\*—**PRE-MONTREAL PROTOCOL (1987)**



Shorter-lived (~20%)  
Longer-lived (~80%)  
Montreal Protocol

## 2) Atmospheric changes, post control:

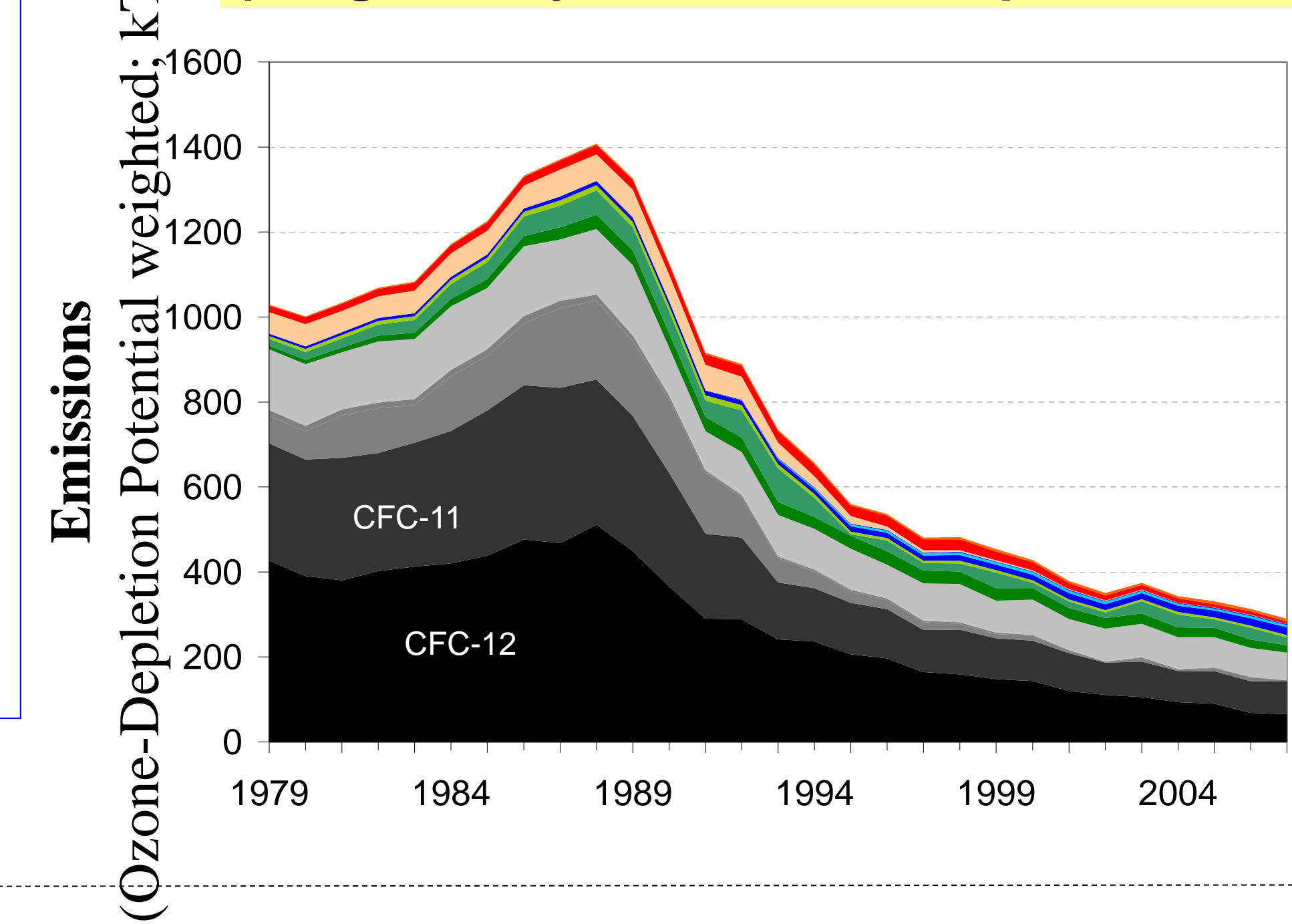
Reactive halogen from ozone-depleting substances\*—**PRESENT DAY**



As consequence of controls on both short- and long-lived gases in the Montreal Protocol:  
- halogen levels peaked shortly thereafter, in 1994, despite substantial contributions from long-lived gases  
- The decline has been sustained for nearly two decades even though short-lived gases are nearly gone from the atmosphere...

## 3) Current Emission Trends

Emissions of ozone-depleting substances (weighted by their Ozone Depletion Potentials)



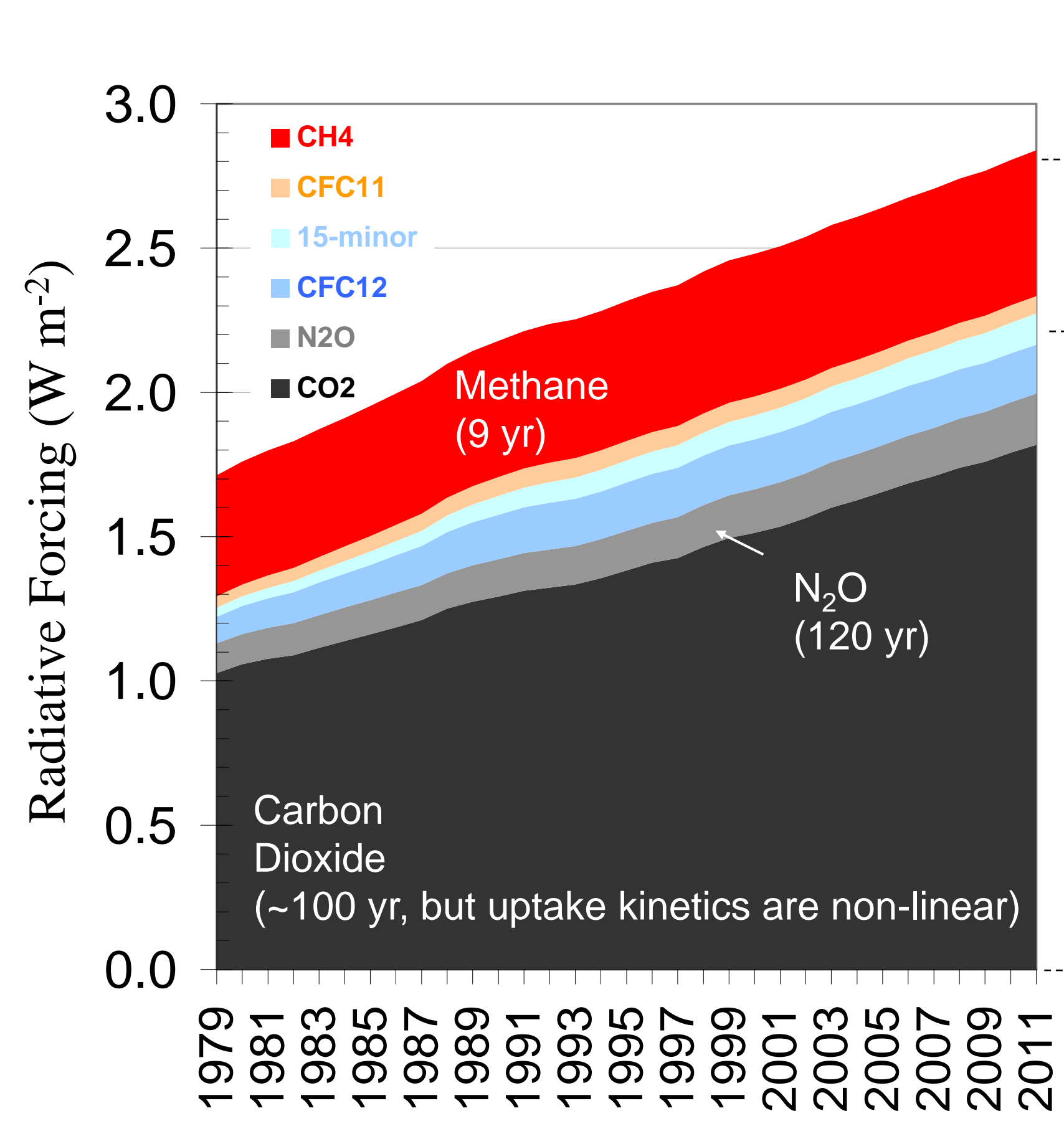
Atmospheric decreases in long-lived chemicals are only achievable with large cuts in emissions.

**The problem:** Radiative forcing from long-lived greenhouse gases continues to increase. Are there lessons to be learned from the success of the Montreal Protocol on Substances that Deplete the Ozone Layer that could be applied to Greenhouse gases to slow down and reverse their continued increase?

**Consider ozone-depleting substances (ODSs) in 1987:** Though most ODSs have lifetimes of decades to centuries, *only a few years after the Montreal Protocol was ratified, the summed concentration of ozone-depleting halogen began decreasing.*

**A parallel situation exists currently for greenhouse gases.** The relative contribution of long- and shorter-lived greenhouse gases to radiative forcing today is fairly similar to the relative contributions of long- and shorter-lived ozone-depleting substances to atmospheric halogen in the 1980s (before controls were agreed to in the Montreal Protocol)

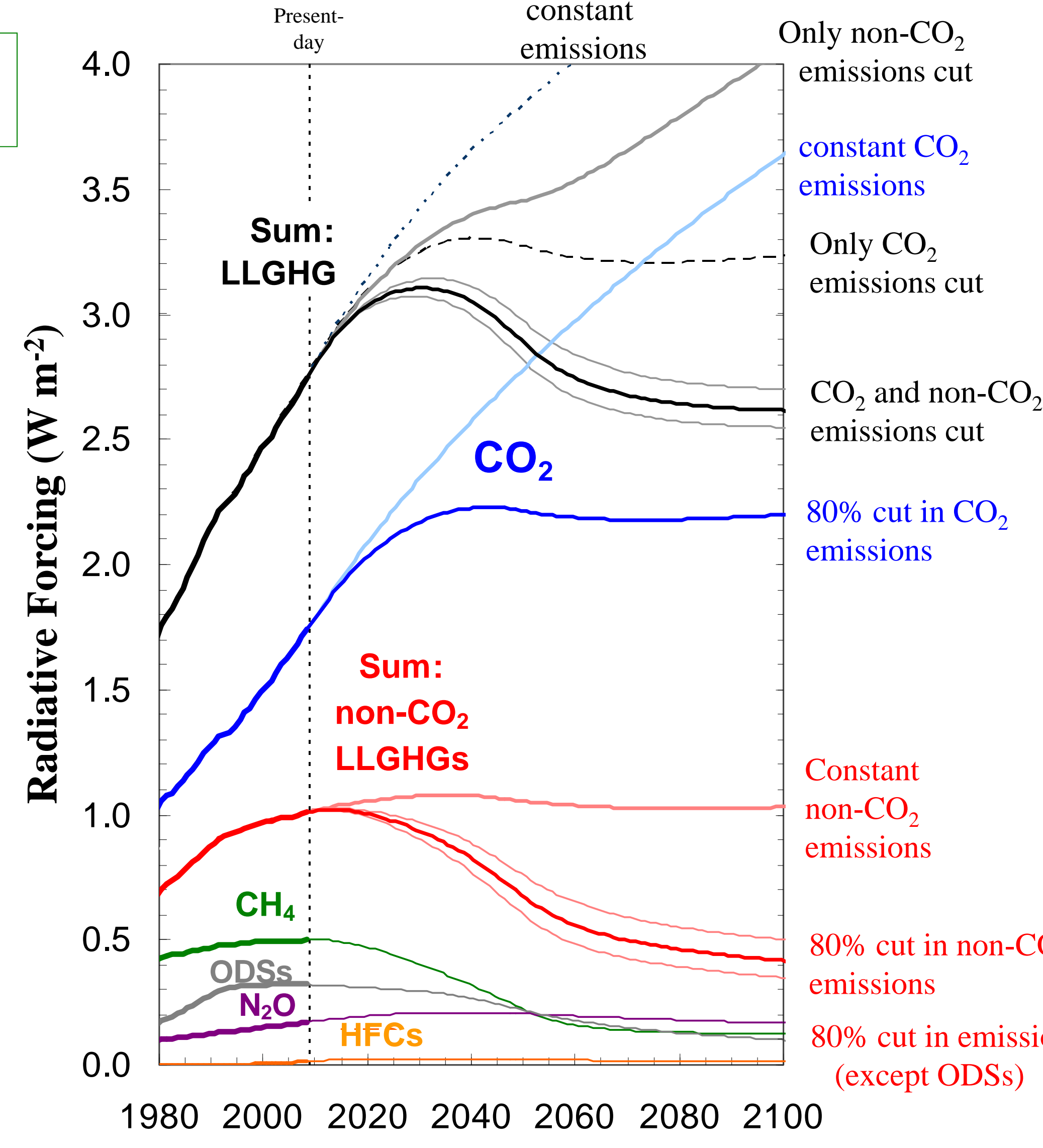
The heating influence from >99% of all long-lived greenhouse gases\*



International Agreement?

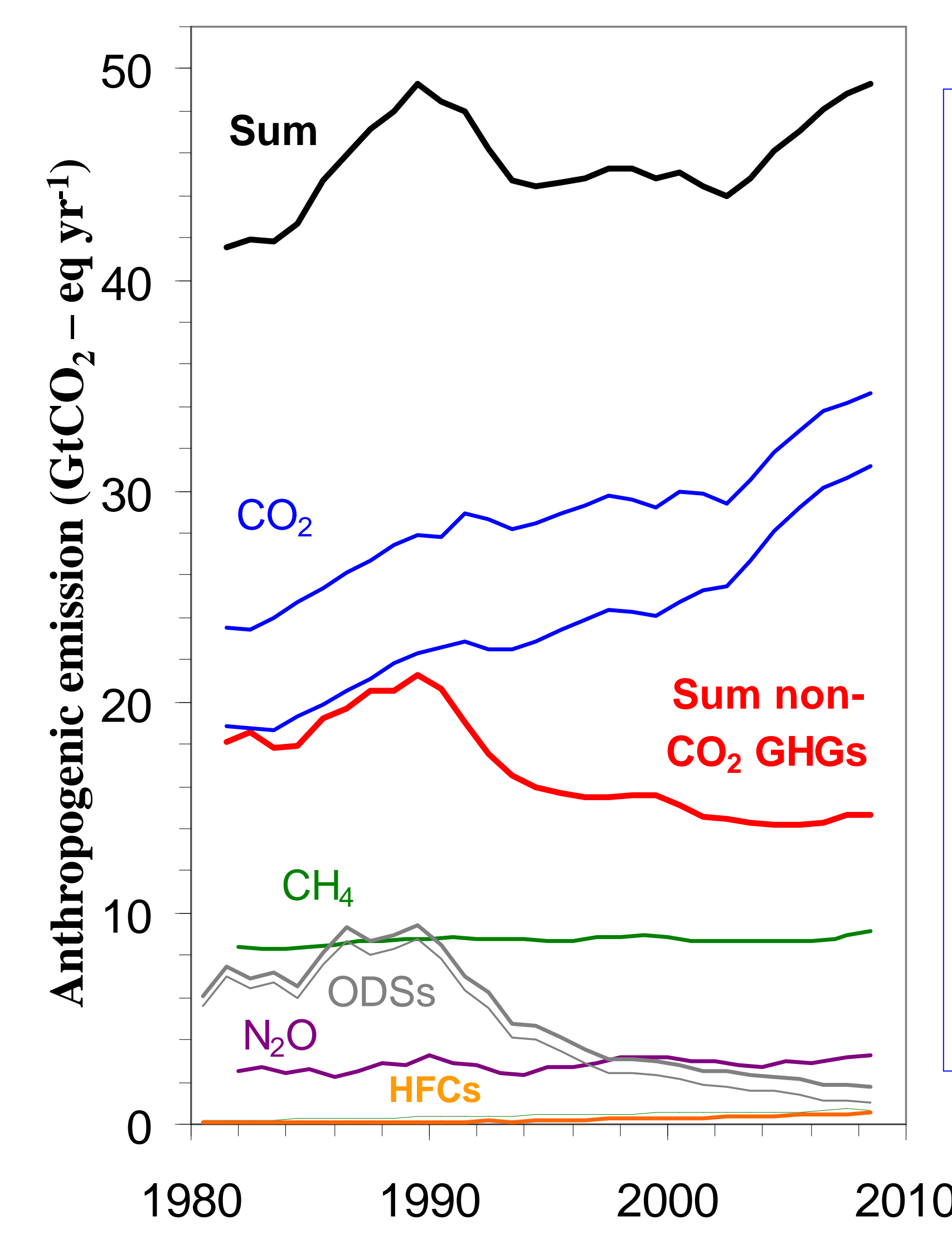
Shorter-lived, <=50 yr (~25%)  
Long-lived "lifetimes" >=100 yr (~75%)

FUTURES derived with potential emission scenarios



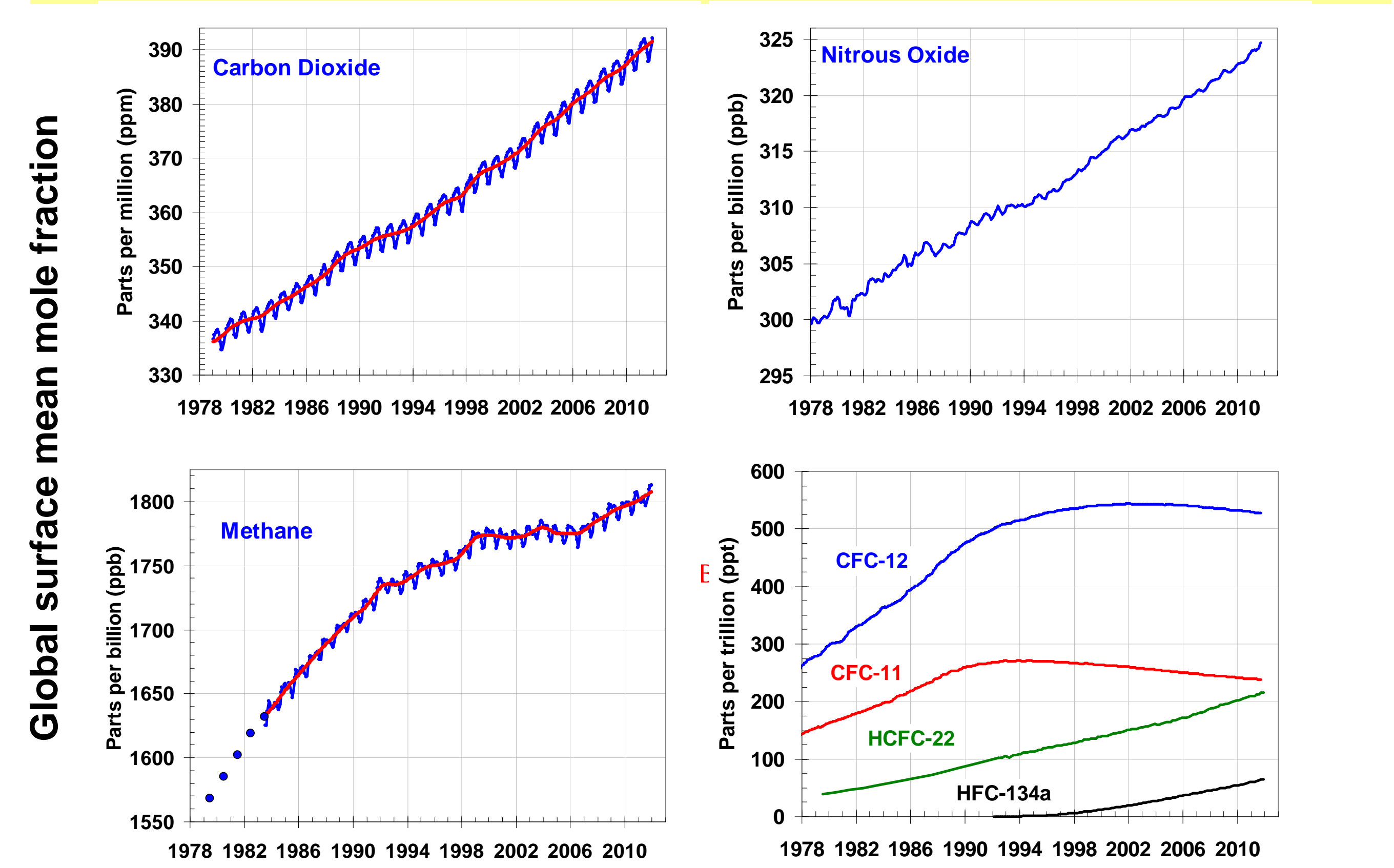
Only large cuts in emissions of CO<sub>2</sub> and non-CO<sub>2</sub> greenhouse gases would allow radiative forcing to peak and begin decreasing rapidly and sustainably over the next century.  
NOTE:  
\* Feedbacks between climate and fluxes not considered...  
\* Lifetimes are held constant in the future

Greenhouse Gas emissions weighted by their 100-yr Global Warming Potentials

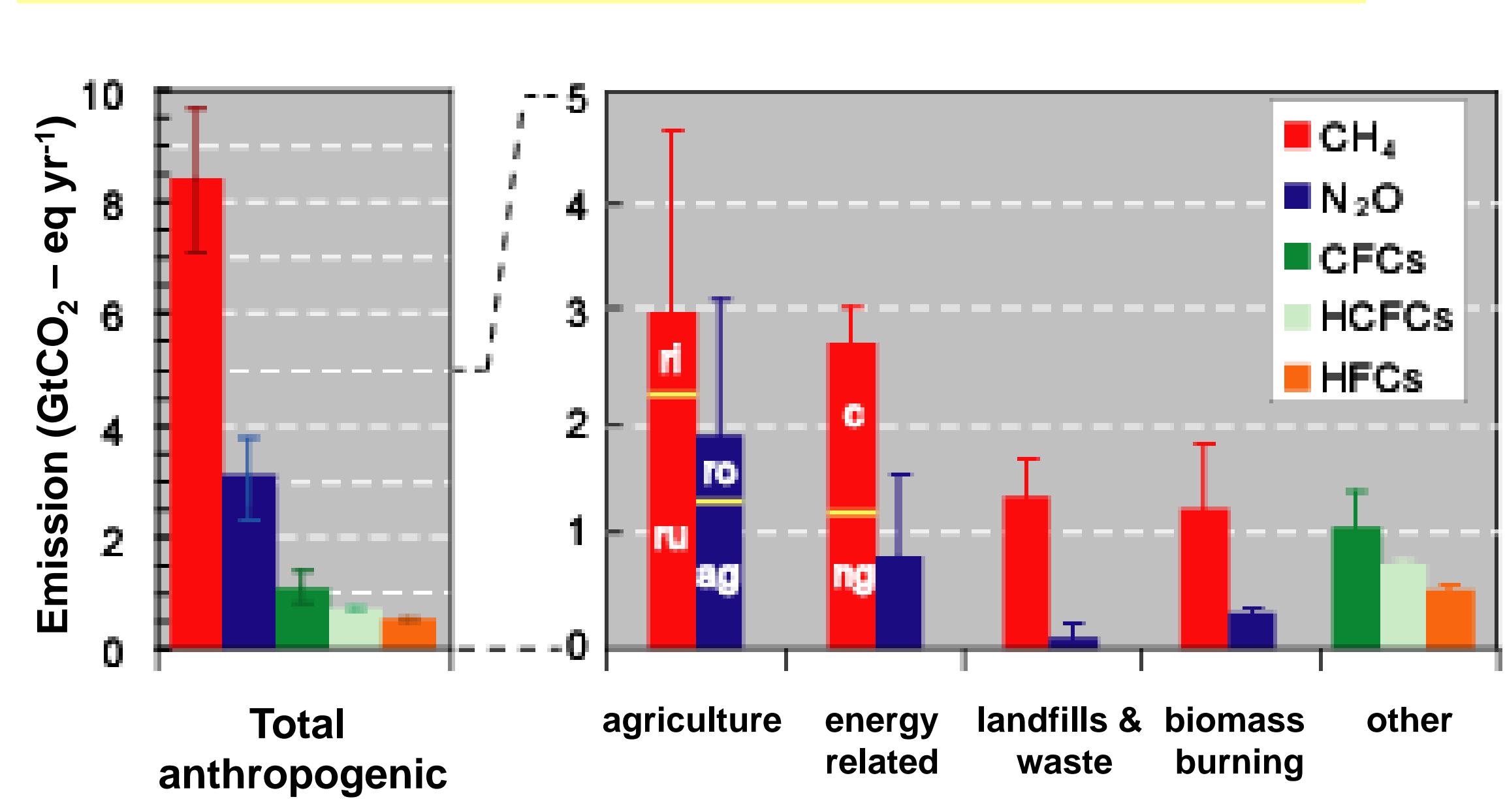


Emissions of the main greenhouse gases have not decreased in recent years. Past declines in emissions of Ozone-Depleting Substances (ODSs) because of the Montreal Protocol had a significant effect on overall GHG emission magnitudes and trends.

Measured atmospheric changes in long-lived greenhouse gases (NOAA/ESRL/GMD and CIRES)



What are the main activities that contribute emissions of non-CO<sub>2</sub> greenhouse gases to the atmosphere?



Key: for CH<sub>4</sub>: ri = rice agriculture, ru = ruminants, c = coal, ng = natural gas.  
for N<sub>2</sub>O, ag = from agriculture directly, ro = from agriculture run-off to aquatic systems.

## Take-home messages:

GMD's long-term observations provide scientific insights related to global environmental issues showing that:  
**\*\*the Montreal Protocol was successful** at reducing the atmospheric concentration of ozone-depleting halogen fairly *rapidly* and *sustainably* owing to cuts in production of both short- and long-lived chemicals.  
**\*\*greenhouse gases with a range of lifetimes contribute significantly to radiative forcing of climate.** *Only very substantial cuts* in emissions of long-lived gases (CO<sub>2</sub>, N<sub>2</sub>O) will cause future declines in radiative forcing. Cuts in emissions of short-lived non-CO<sub>2</sub> gases (CH<sub>4</sub> especially) cause responses on relatively short timescales, but benefits to such cuts have limits.  
**\*\*as was true for ozone-depleting gases, cuts in emissions of both short- and long-lived GHGs would provide a means to rapidly stabilize radiative forcing** and allow a decline in radiative forcing to proceed in a sustainable fashion.