



# EARTH SYSTEM RESEARCH LABORATORY

*Serving Society through Science*

## Climate Benefits of the Montreal Protocol

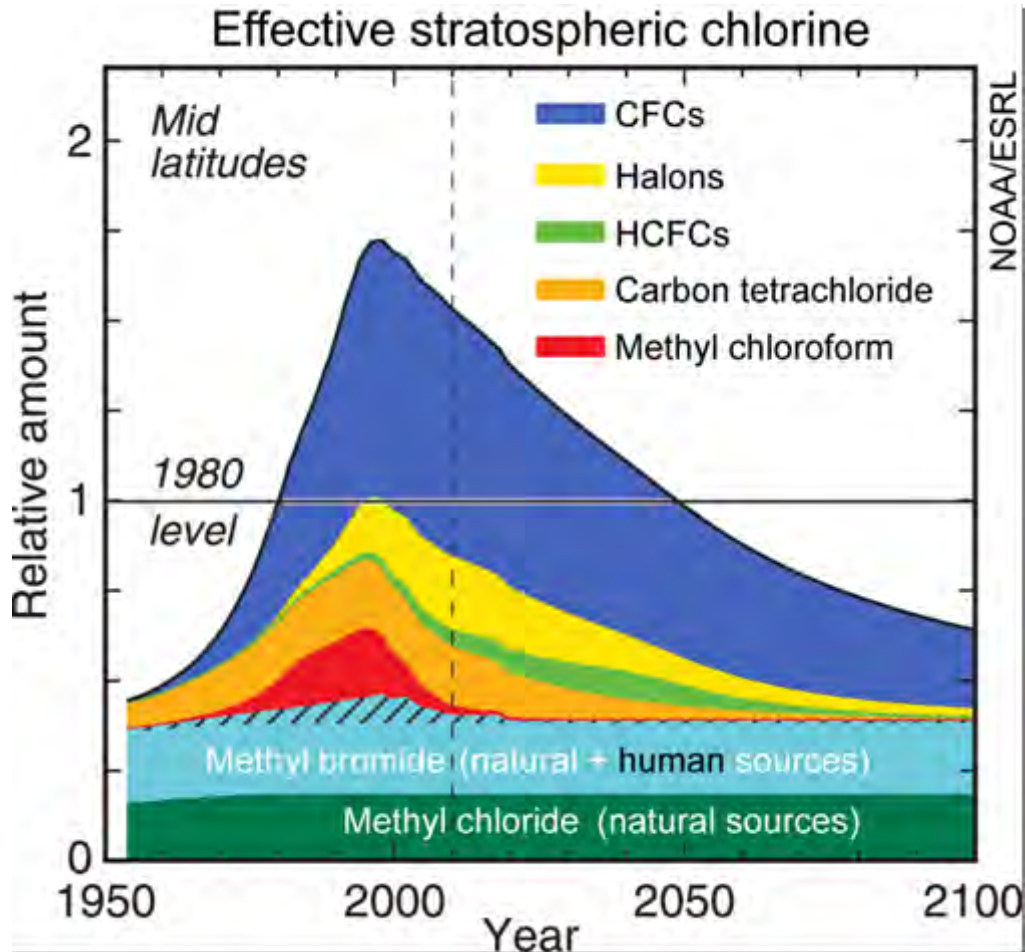
***David W. Fahey and  
John S. Daniel***

- I. The dual benefits of the Montreal Protocol: protecting ozone and climate
- II. Bringing the scientific message to policymakers
- III. The accelerated HCFC phaseout



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

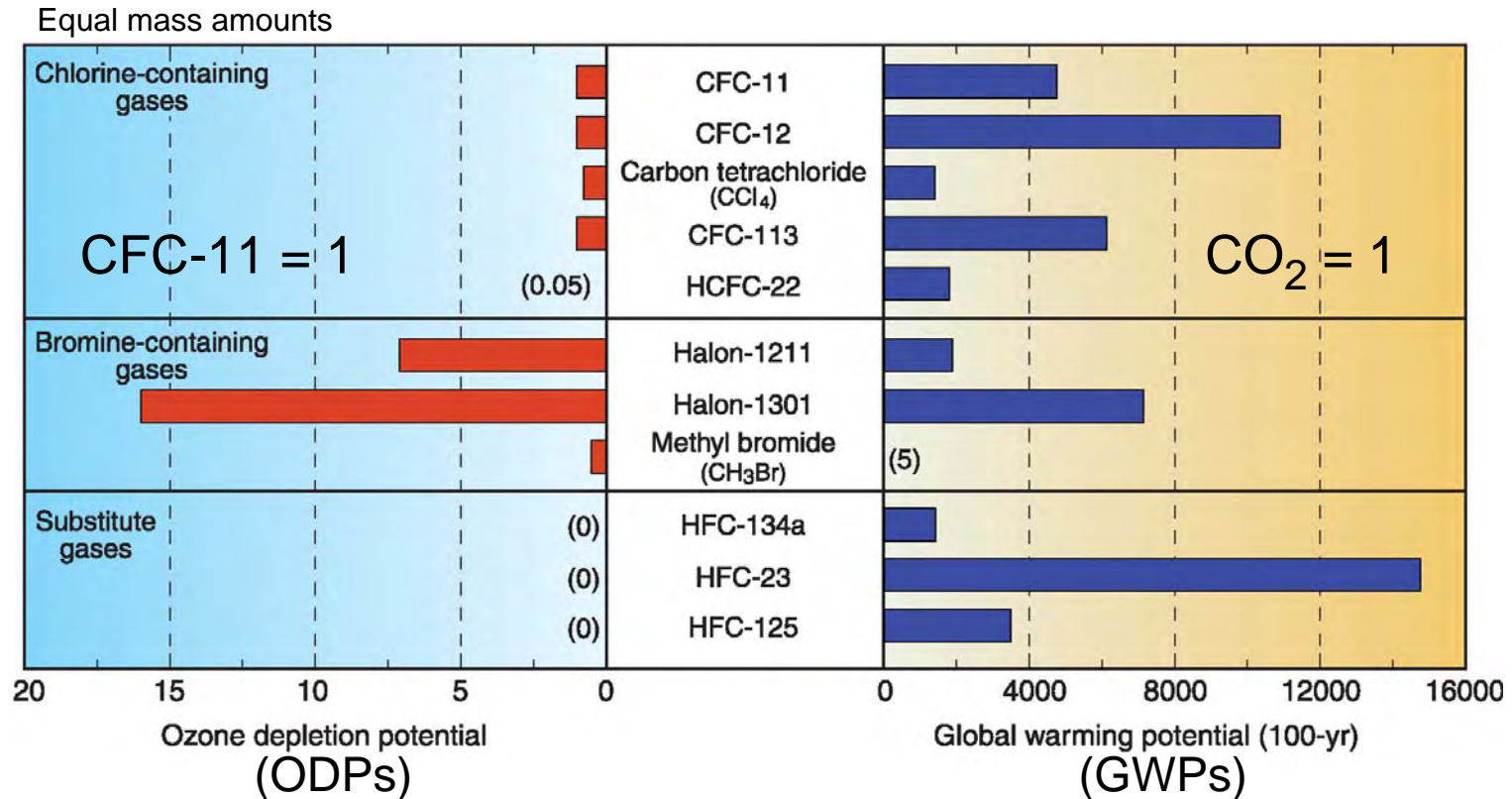
# The success of the Montreal Protocol in protecting ozone



> The Montreal Protocol has **slowed and reversed** the accumulation of ozone depleting substances (ODSs) in the stratosphere.

(Effective stratospheric chlorine is the weighted sum of chlorine and bromine gases in the stratosphere.)

# Dual role of ODSs: ozone depletion and radiative forcing of climate



> The Montreal Protocol has a **dual benefit**: protecting ozone and climate

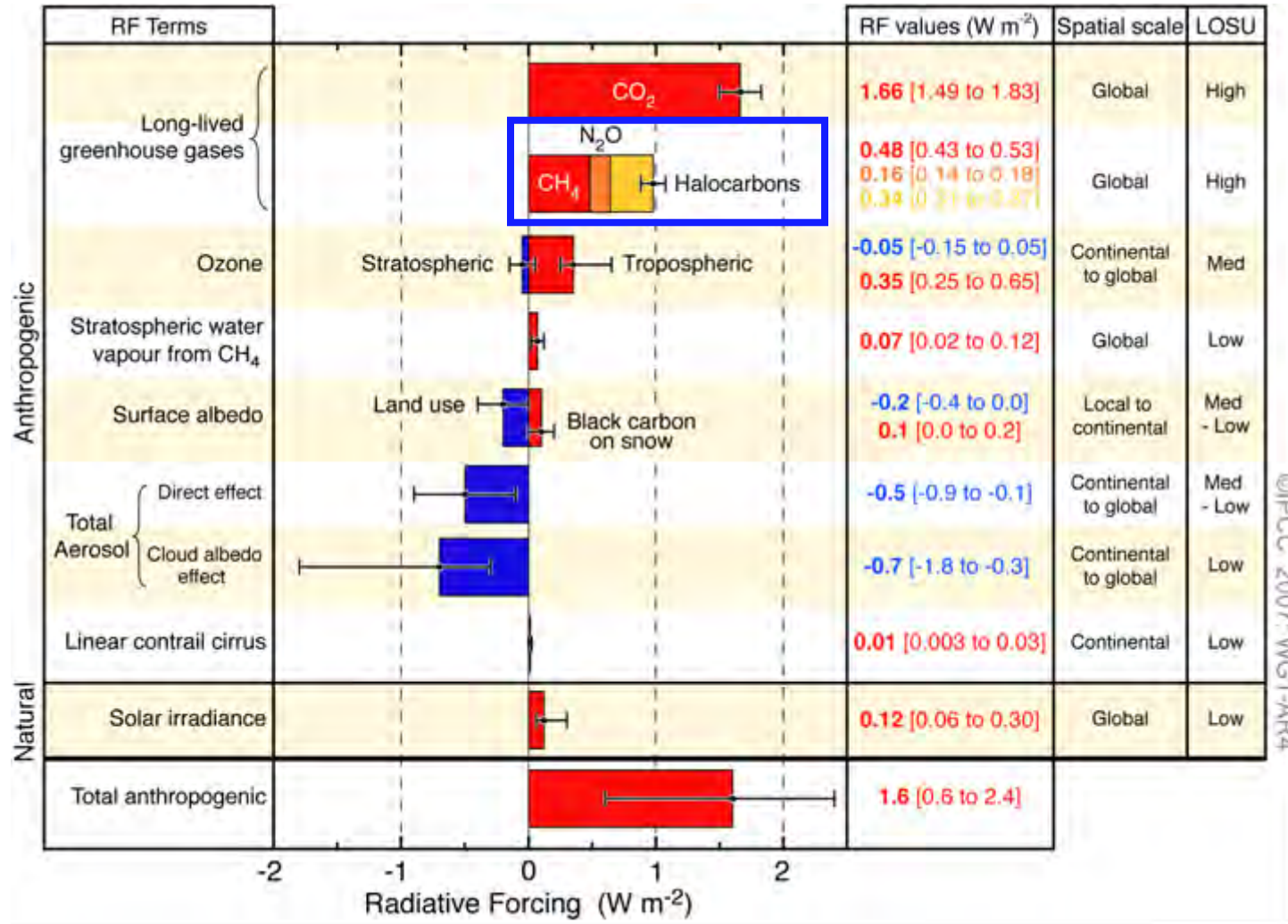
Note: ESRL scientists have played important roles in the quantification of ODPs and GWPs (lab and theory).



More details in Jim Burkholder's presentation

# Radiative Forcing Components in 2005

(since preindustrial times, ca. 1750)



> ODSs contribute significantly to anthropogenic climate forcing



# The Paper

PNAS

## The importance of the Montreal Protocol in protecting climate

Guus J. M. Velders<sup>\* †</sup>, Stephen O. Andersen<sup>‡</sup>, John S. Daniel<sup>§</sup>, David W. Fahey<sup>¶</sup>, and Mack McFarland<sup>¶</sup>

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Edited by William C. Clark, Harvard University, Cambridge, MA, and approved January 11, 2007 (received for review November 21, 2006)

The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer is a landmark agreement that has successfully reduced the global production, consumption, and emissions of ozone-depleting substances (ODSs). ODSs are also greenhouse gases that contribute to the radiative forcing of climate change. Using historical ODSs emissions and scenarios of potential emissions, we show that the ODS contribution to radiative forcing most likely would have been much larger if the ODS link to stratospheric ozone depletion had not been recognized in 1974 and followed by a series of regula-

entered into force in February 2005. The Kyoto Protocol is a global treaty to reduce the emissions of carbon dioxide, CO<sub>2</sub>, the leading greenhouse gas, and five other gases, none of which are ODSs. The absence of ODSs in the Kyoto Protocol and the absence of normal climate considerations in the Montreal Protocol serve as motivation to consider past and future scenarios of ODS emissions and their substitutes, and their relevance to anthropogenic RF.

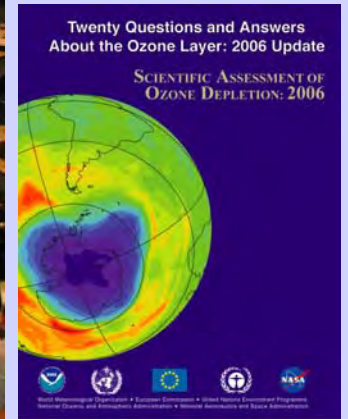
We report here how national regulations, voluntary actions,

Velders *et al.*, *Proc. Nat. Acad. Sci.*, March 2007

Guus Velders	Netherlands Environmental Assessment Agency
Stephen Andersen	US Environmental Protection Agency
John Daniel	NOAA/ESRL
David Fahey	NOAA/ESRL
Mack McFarland	DuPont Fluoroproducts

# The Paper

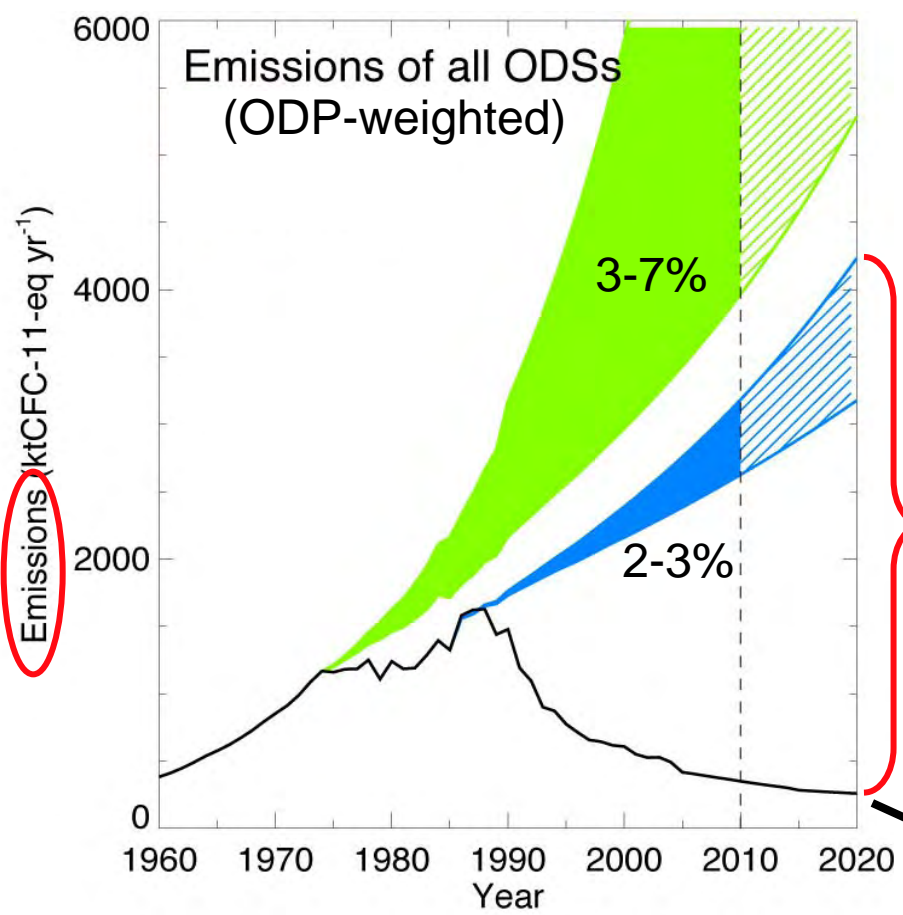
Plenary meeting in  
Les Diablerets,  
Switzerland,  
June 2006



**Need:** Update the message of the Montreal Protocol's protection of climate for policymakers and scientists

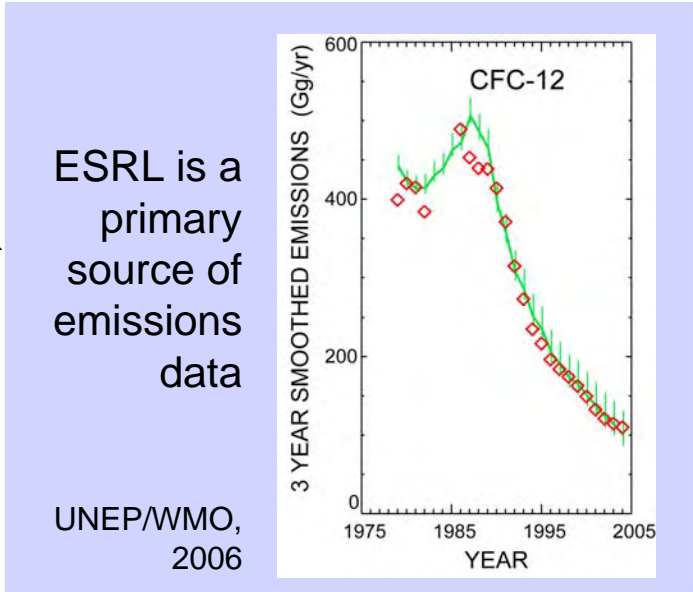
**Response:** Form an author group to write a paper for a peer-reviewed journal

# ODS emissions: The baseline and worlds avoided

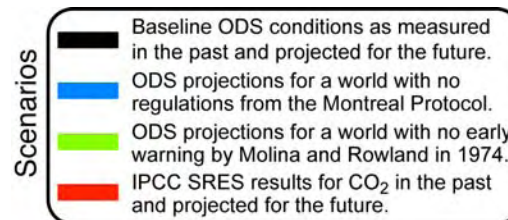
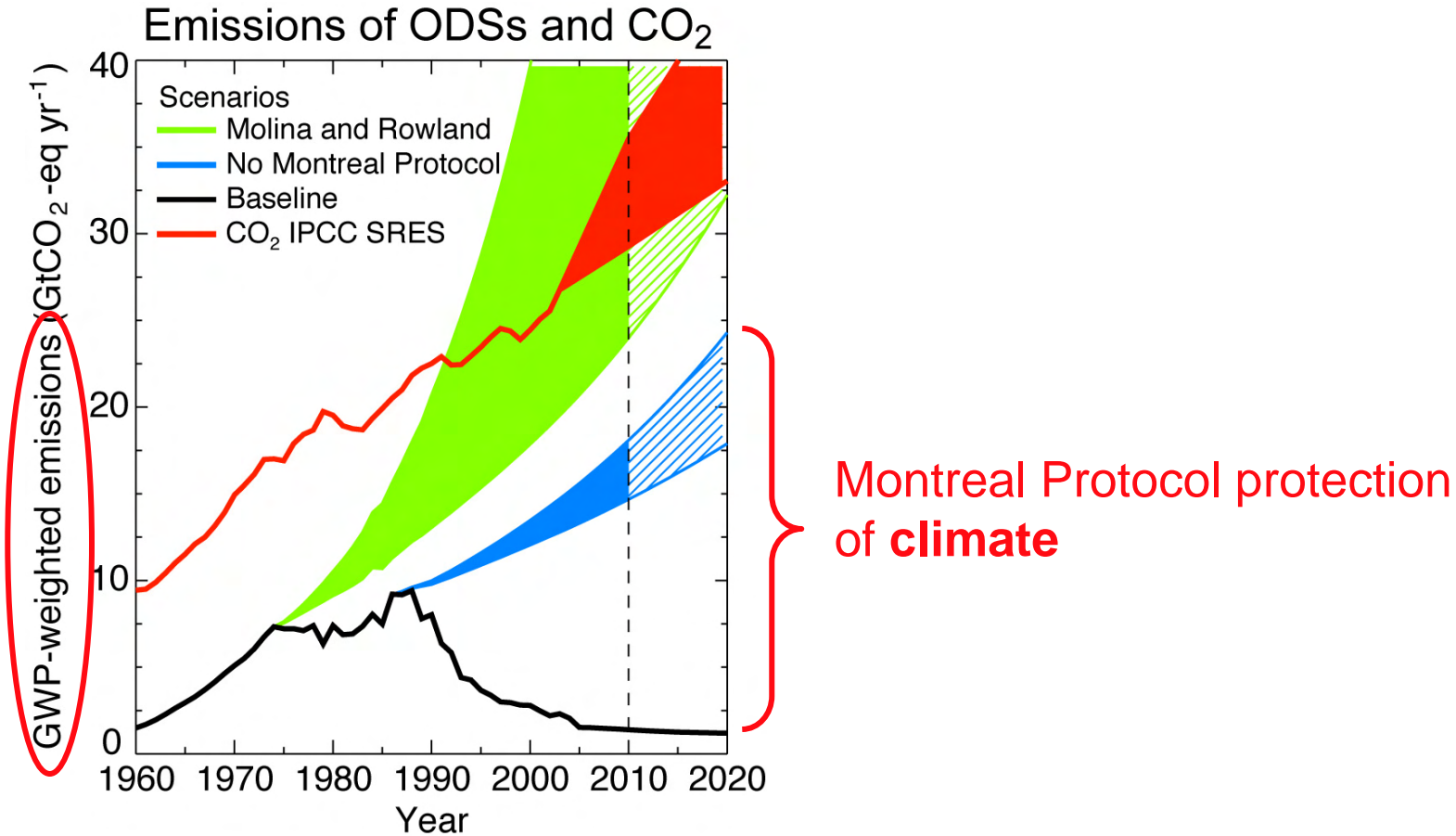


- Baseline ODS conditions as measured in the past and projected for the future.
- ODS projections for a world with no regulations from the Montreal Protocol.
- ODS projections for a world with no early warning by Molina and Rowland in 1974.

Montreal Protocol protection of ozone

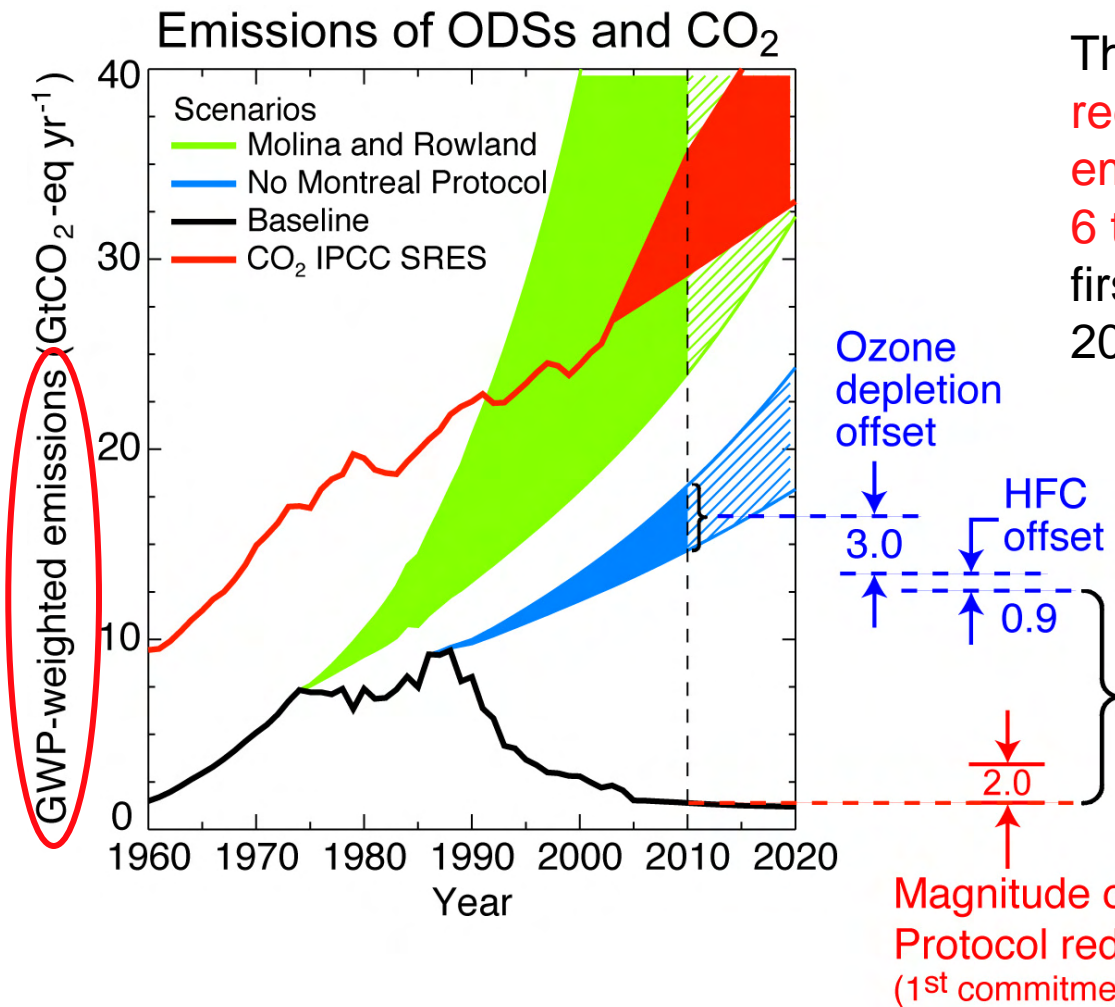


# Global Warming Potential of ODS Emissions



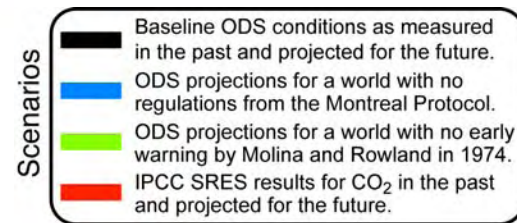


# Global Warming Potential of ODS Emissions

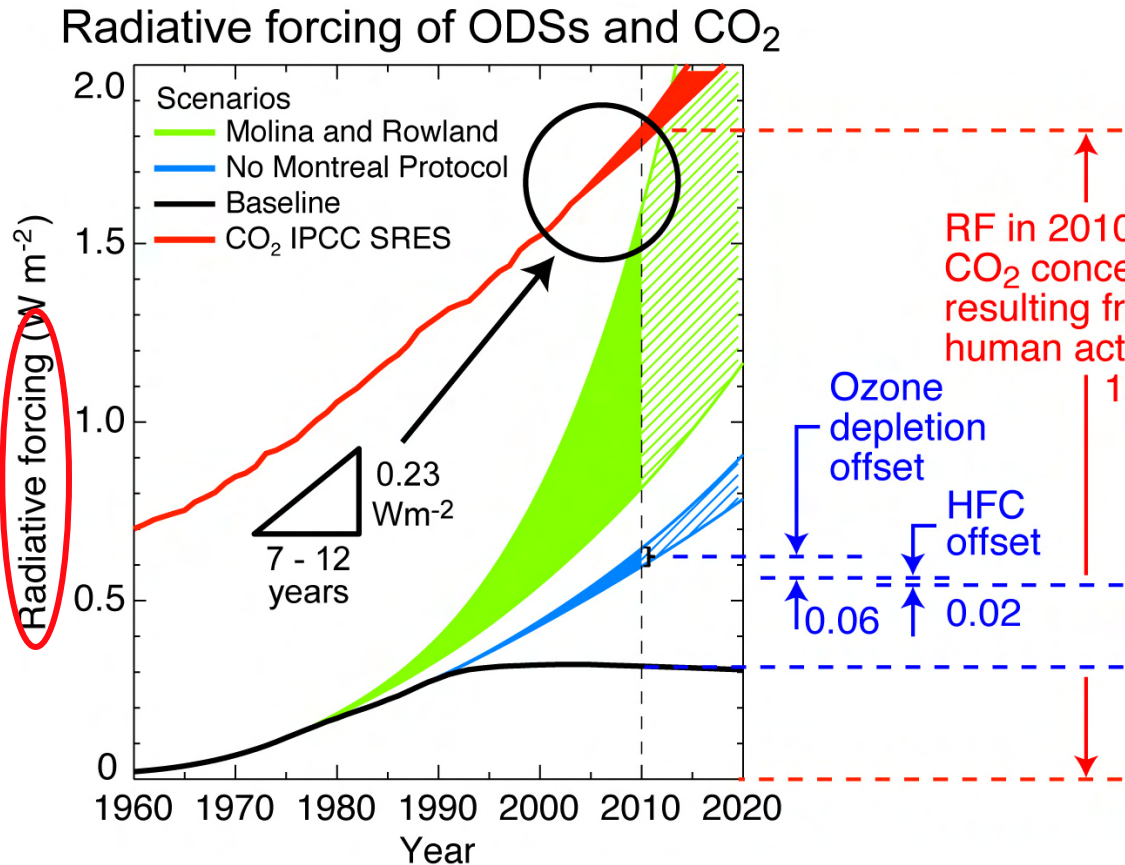


The Montreal Protocol will have **reduced net GWP-weighted emissions from ODSs** in 2010 by **5-6 times** the reduction target of the first commitment period (2008-2012) of the Kyoto Protocol.

The Montreal Protocol will have **reduced net GWP-weighted emissions** from ODSs in 2010 by about 11 Gt CO<sub>2</sub>-eq yr<sup>-1</sup>.

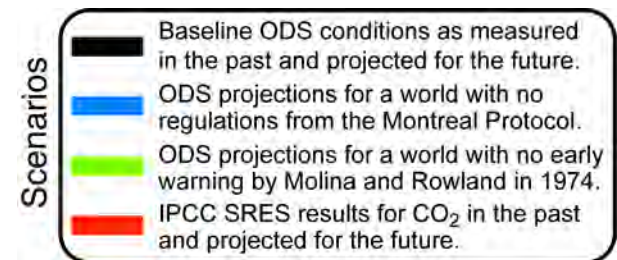


# Radiative forcing of ODS Emissions



The Montreal Protocol **net reduction in ODS radiative forcing** in 2010 will be equivalent to about **7-12** years of growth in radiative forcing of CO<sub>2</sub> from human activities.

The Montreal Protocol will have **reduced net radiative forcing from ODSs** in 2010 by about 0.23 Wm<sup>-2</sup>, which is about **13%** of that due to the accumulated emissions of CO<sub>2</sub> from human activities.



# The Paper

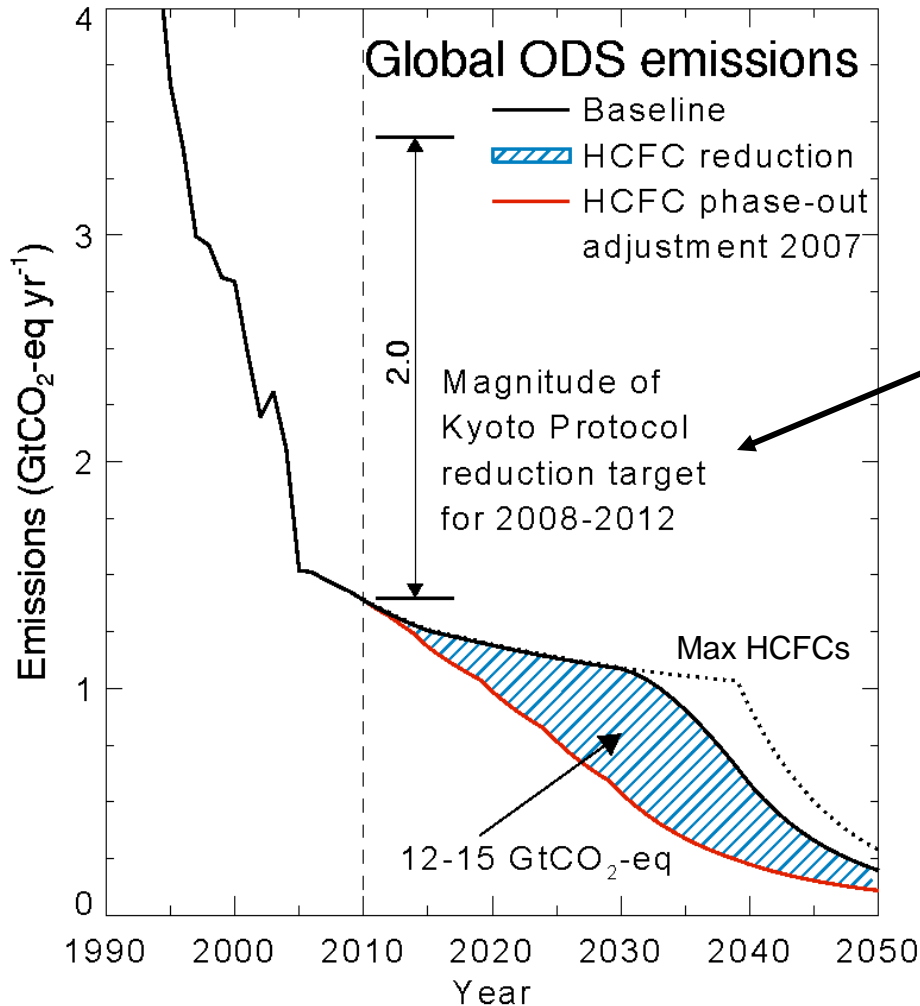
## Impact/significance:

- Provided ozone-depletion policymakers with important information about the climate consequences of the Montreal Protocol.
- Created heightened awareness of the potential of the Montreal Protocol to further protect climate
- Facilitated the successful agreement of the Montreal Protocol parties to accelerate the HCFC-22 phaseout in **developed and developing** countries in September, 2007.

## Notable evidence:

Nine parties that submitted **formal proposals** to adjust the Montreal Protocol's regulations on HCFCs were from small island states (Micronesia, **Mauritius**, Iceland) and countries with low lying coastal areas (Mauritania, **Argentina**, Brazil, Norway, and the **USA**). **Several** cited the Velders *et al.*, study.

# Climate protection from the accelerated HCFC phaseout



- Climate protection from HCFC phaseout (**12-15 GtCO<sub>2</sub>-eq**) is significant wrt to Kyoto Protocol targets

**Kyoto = 2 GtCO<sub>2</sub>-eq x 5 yrs + future years**

- Gain = **eliminating** the climate emissions from 50% of US cars for the next 30 yrs (*EPA*)
- Ultimately, climate benefit depends on **choice** of substitutes, *i.e.*, low ODP, low-GWP options



More details in Jim Burkholder's presentation



# Summary Points

- Ozone-depleting substances (ODSs) are also **climate gases** that contribute to anthropogenic radiative forcing
- The Montreal Protocol has provided a **dual benefit**: protection of ozone and climate
- The Velders *et al.* paper provided **policymakers** with important, timely information about the climate consequences of the Montreal Protocol.
  - > **Highly influential** in the negotiations and deliberations that led to an **accelerated HCFC phaseout** agreement by developing and developed nations

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Success of this initiative = Combination of skilled people, up-to-date scientific knowledge, awareness of policymakers' needs, and the freedom to act.



Thank you for your attention.