EARTH SYSTEM RESEARCH LABORATORY

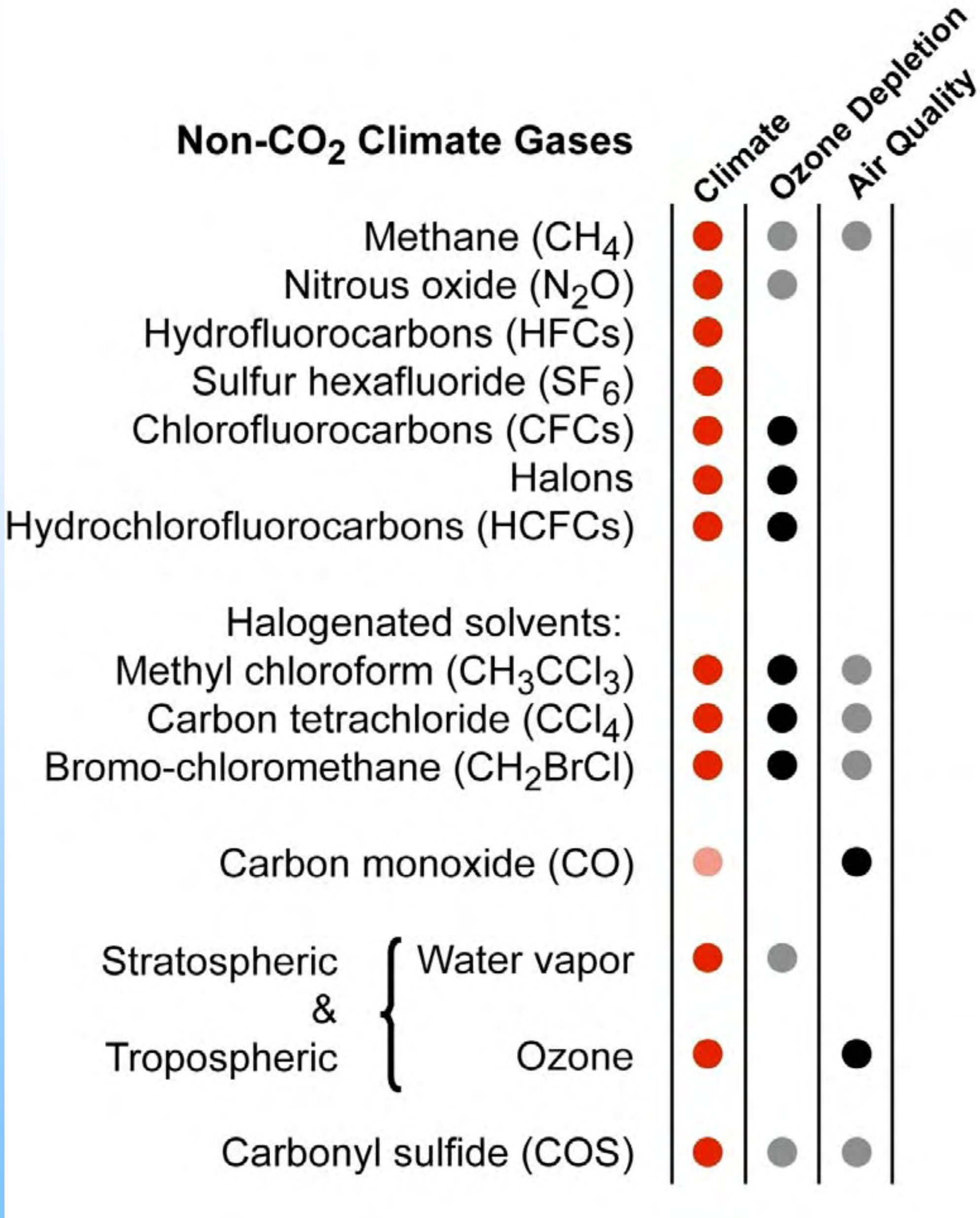
Serving Society through Science

Non-CO_2 Climate Gases: An Overview

David W. Fahey and James W. Elkins

ESRL Atmospheric Chemistry Review

January 29-31, 2008 ~ Boulder, Colorado

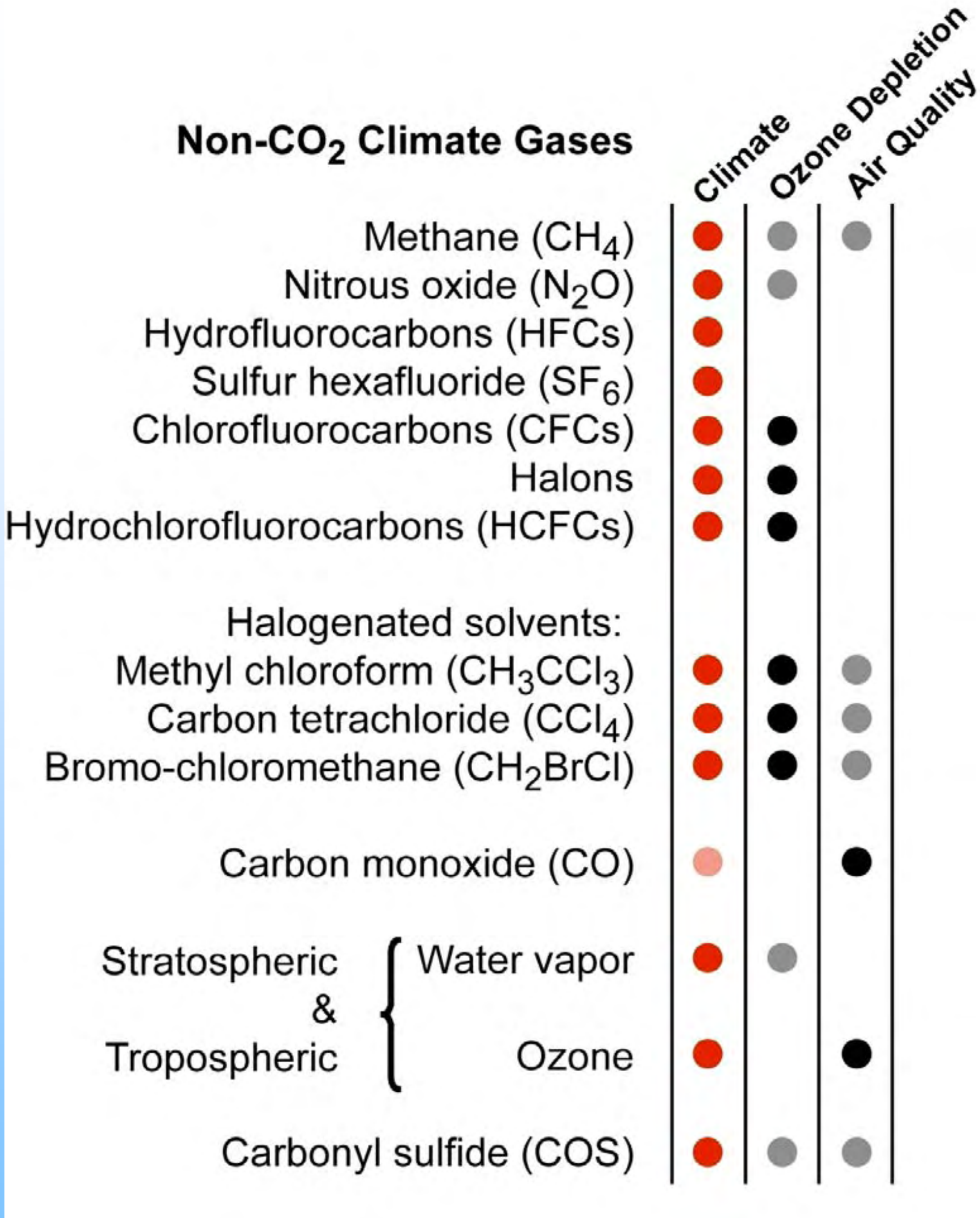


Relevant NOAA ESRL Research Activities

- monitoring these gases at the surface and above
- calculating emissions
- using numerical models for radiative forcing calculations and gas-phase chemistry studies
- conducting laboratory and field studies of atmospheric chemical processes
- contributing to international and national assessments related to climate change and ozone depletion

NOAA OAR Strategic Plan: FY2005 - FY2010

- Radiative forcing by non-CO_2 greenhouse gases
- Climate information for policy makers
- Climate model uncertainties
- Climate sensitivity due to water vapor



Observations, Observations, Observations

Investment:

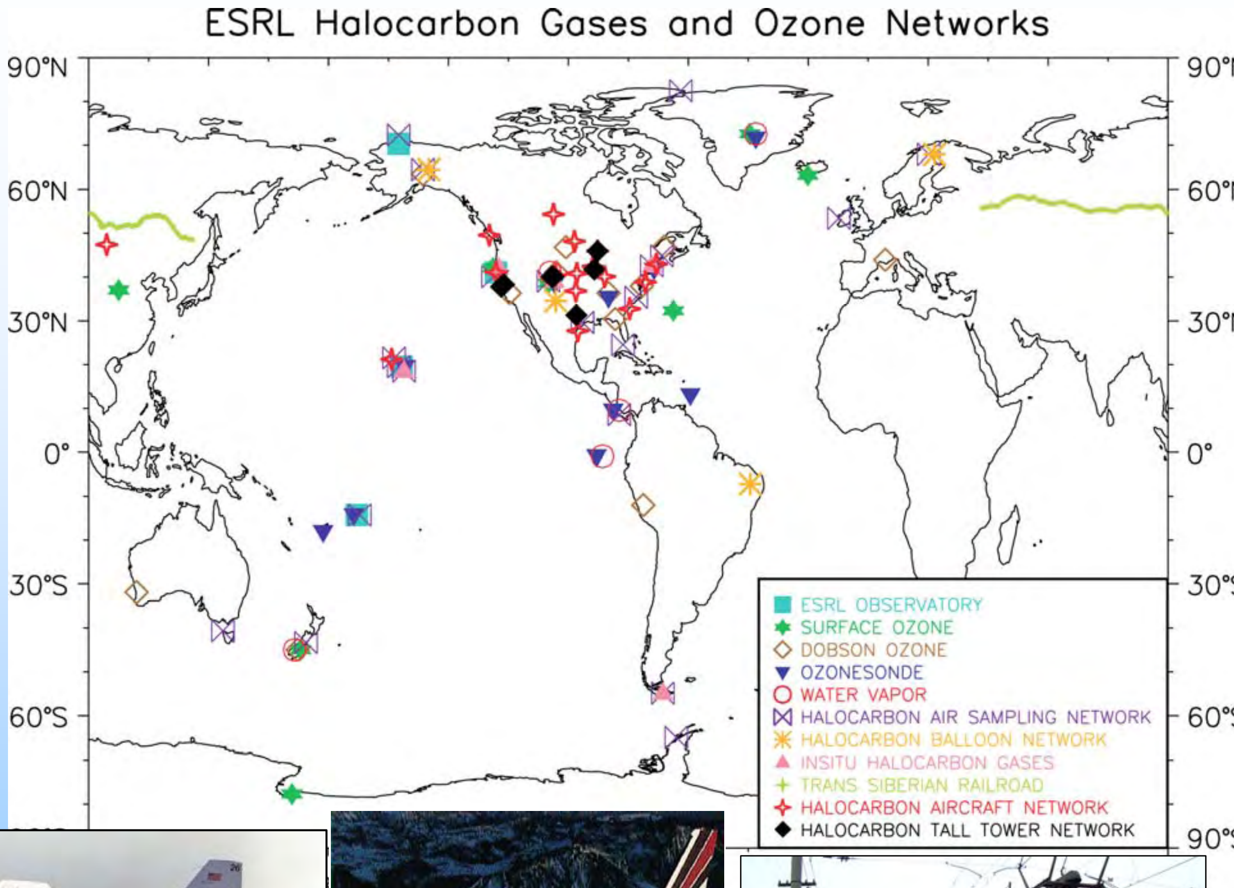
> Diverse sampling, *e.g.*, ground networks, airborne platforms

> Calibration & standards

Scientific return

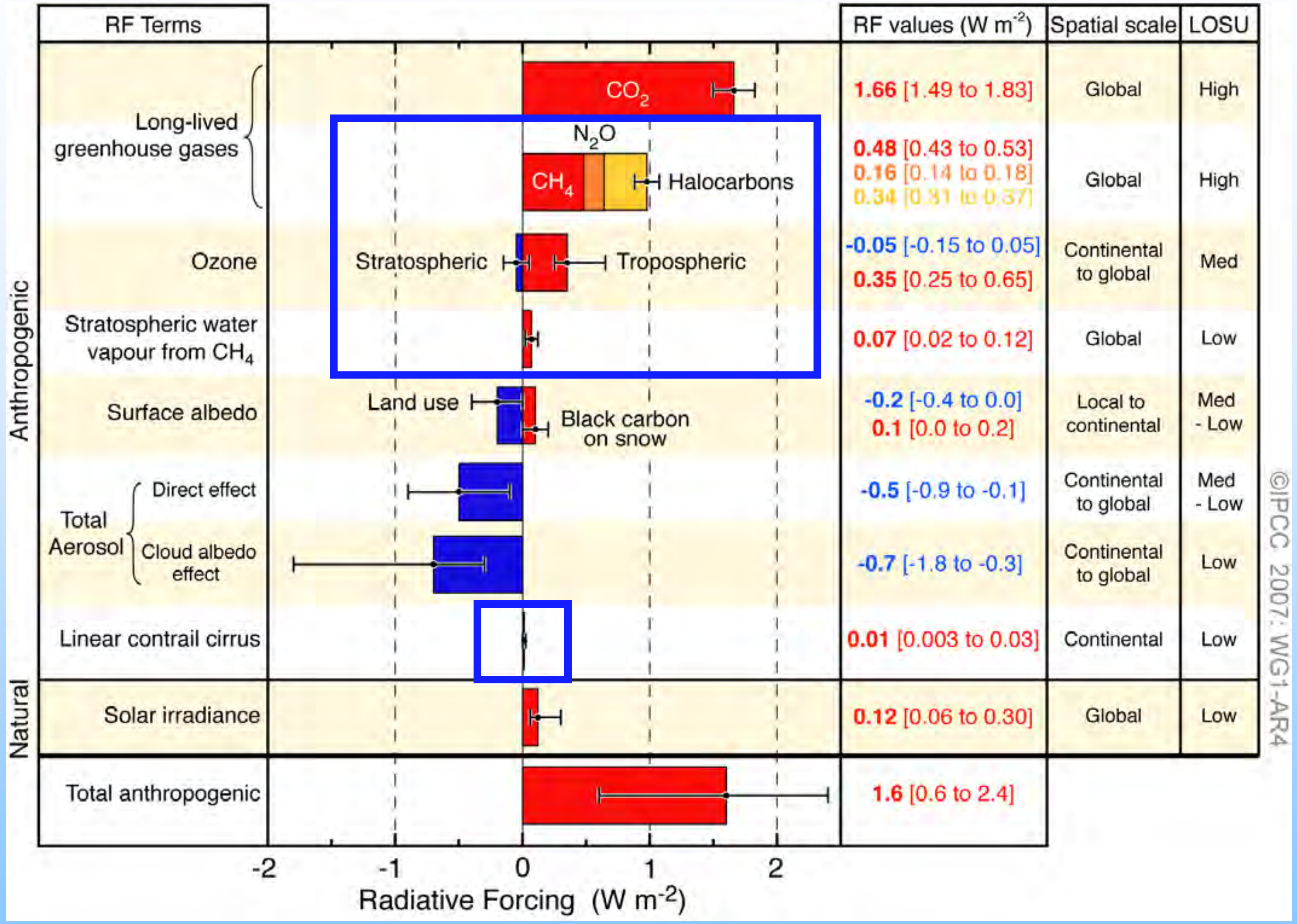
> Concentrations and trends
> Emissions
> Chemical processes: sources and sinks
> Climate feedback processes
> Natural & anthropogenic attribution
> Model projections and uncertainties

Observational Network and Platforms



Radiative Forcing Components in 2005

(since preindustrial times, ca. 1750)

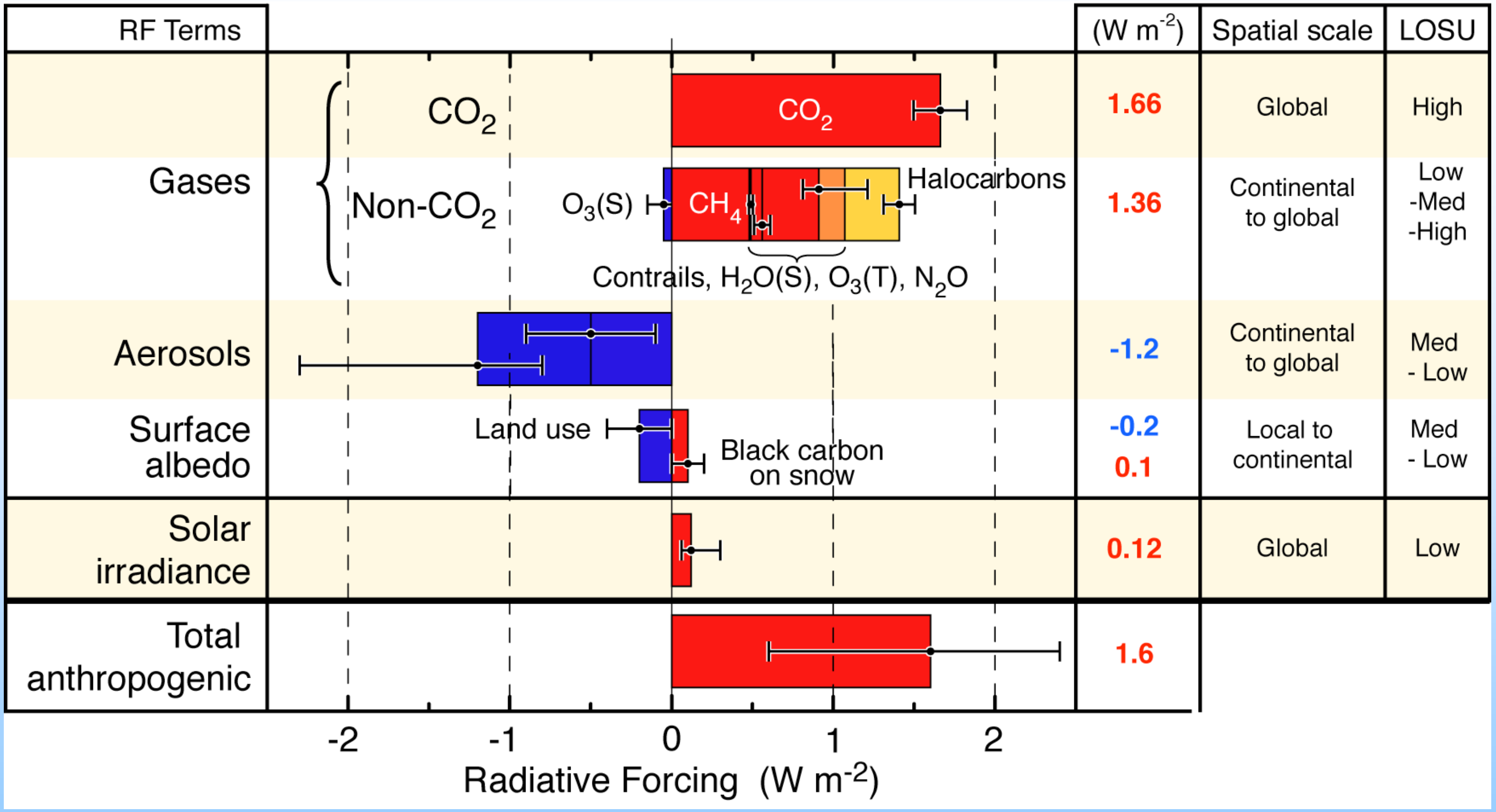


- Long-lived non-CO_2 climate gases and ozone represent a significant fraction of anthropogenic RF in 2005
- Ozone forcings have large uncertainties

IPCC, AR4, 2007

Radiative Forcing Components in 2005

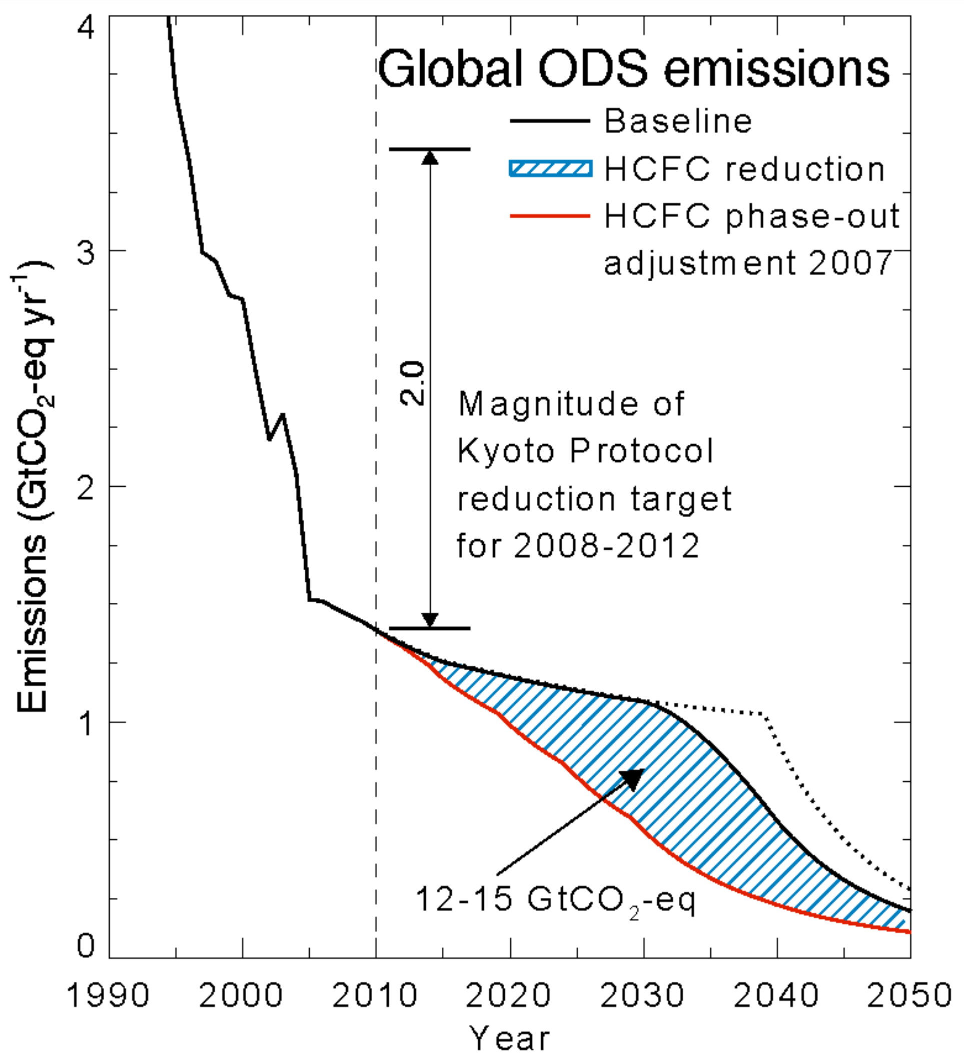
(since preindustrial times, ca. 1750)



- Long-lived non-CO_2 climate gases and ozone represent a significant fraction of anthropogenic RF in 2005
- Ozone forcings have large uncertainties

IPCC, AR4, 2007

Montreal Protocol Accelerated Phaseout of HCFC-22



- HCFC phaseout accelerated in September 2007.
- Policy decisions of this magnitude ultimately must rely on scientific results of high quality and relevance.
- ESRL has been and will continue to be a leader in measuring HCFC and CFC abundances.

Velders *et al.*, PNAS, 2007

Ozone profiles and surface ozone at Trinidad Head, California

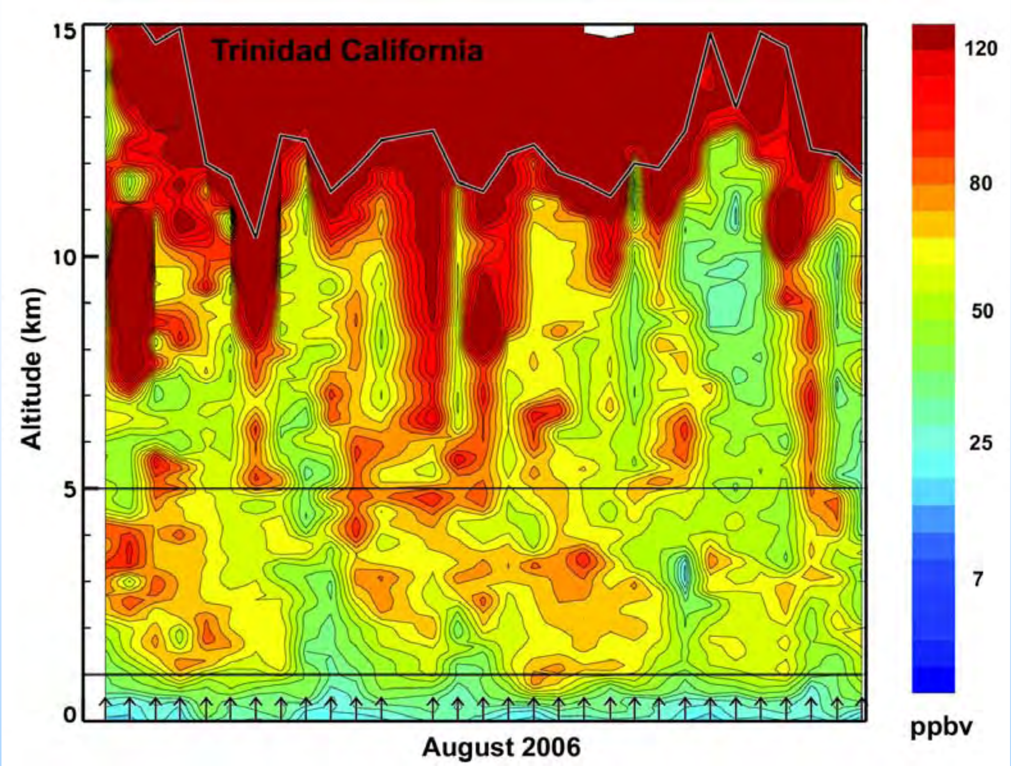
Strat-trop exchange (S)

Long-range transport (T)

Lightning (L)

Photochemical production/loss (P/L)

Emissions (E)



• Tropospheric ozone displays significant variability as result of many controlling processes ⟶ limiting our understanding

"*The picture of long-term tropospheric ozone changes is a varied one in terms of both the sign and magnitude of trends and in the possible causes of the changes*."
S. Oltmans, *Atmos. Environ*., 2006.

• Trend measurements and analysis guides and constrains ozone process studies
Trends = fcn (S + T + L + P/L + E + ….)

Water vapor observations and analysis

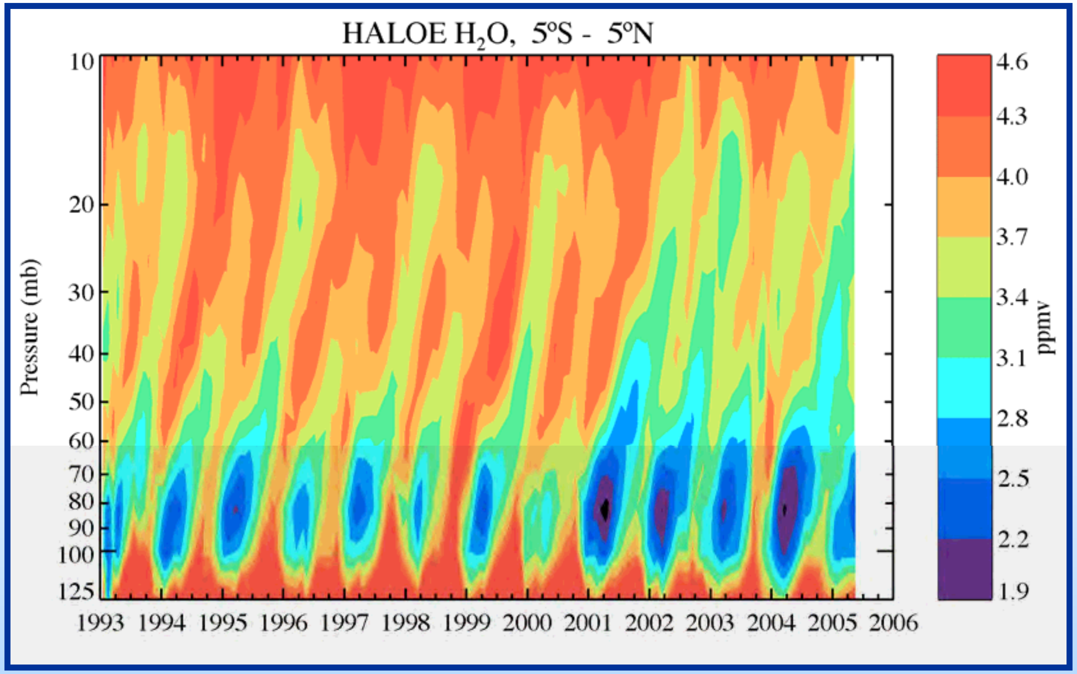
Strat-trop exchange (S)

Long-range transport (T)

Convection (C)

Microphysics (M)

Dehydration (D)



- Atmospheric water vapor, as key feedback, strongly affects climate sensitivity to radiative forcing
- Modeling studies necessary to define mechanisms and their importance
- Trend measurements and analysis guides and constrains ozone process studies

  Trends = fcn (S + T + C + M + D + ….)
- Water vapor instrumentation is currently a limiting factor, esp. < 10 ppm

Presentations

N_2O, CFCs, HCFCs, and Other Gases
James Elkins

Airborne and Emissions Studies of Non-CO_2 Climate Gases
Dale Hurst

Assessing and Understanding Tropospheric Ozone Changes
Samuel Oltmans

Water Vapor in the Upper Troposphere and Lower Stratosphere
Karen Rosenlof