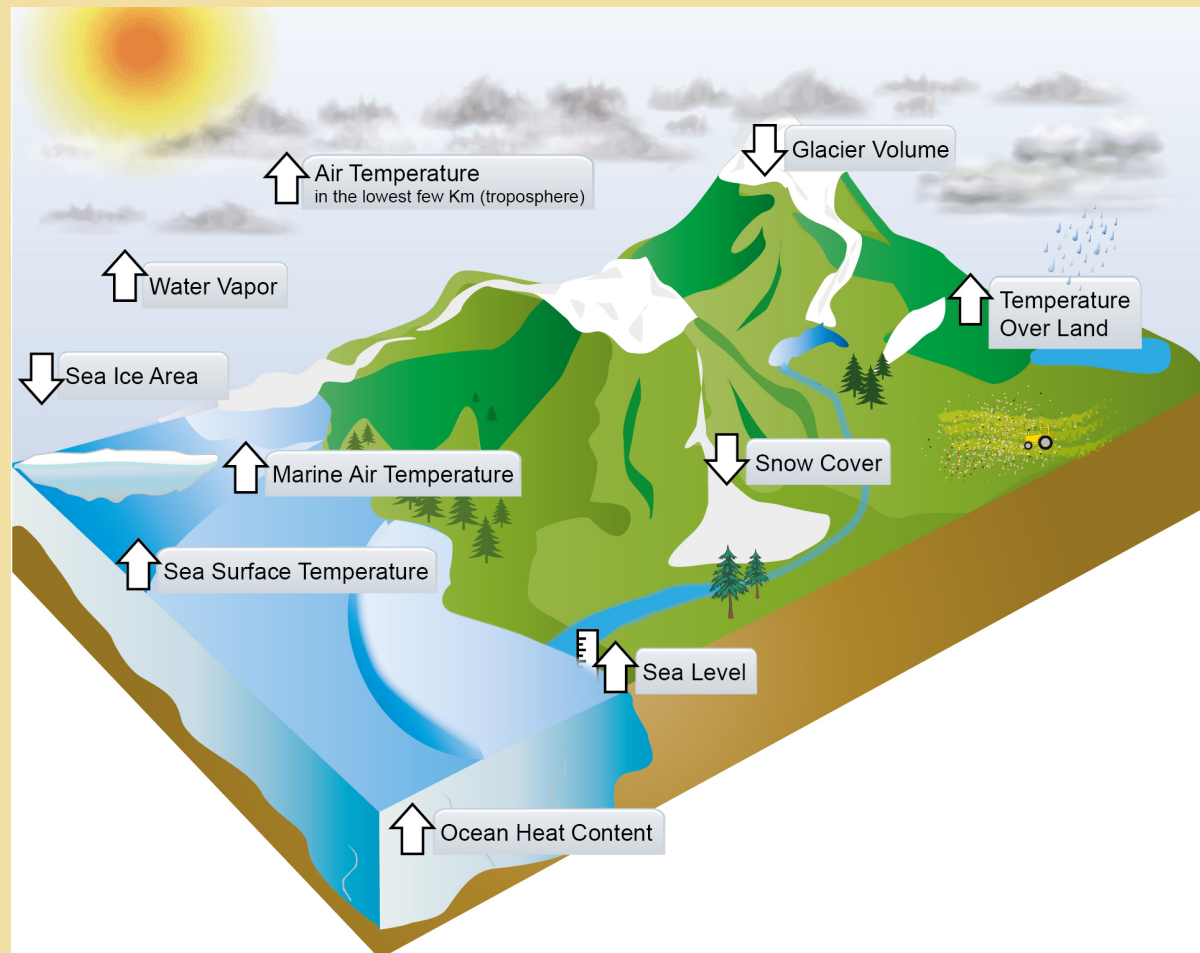


# Climate Change and Society

## GEOL-G490

### Lecture 3: Observations: Atmosphere and Surface



## **Trend:**

is used to designate a long-term movement in a time series that may be regarded, together with the oscillation and random component, as composing the observed values

## **Long term trend vs short term trend:**

1880 vs. 1979

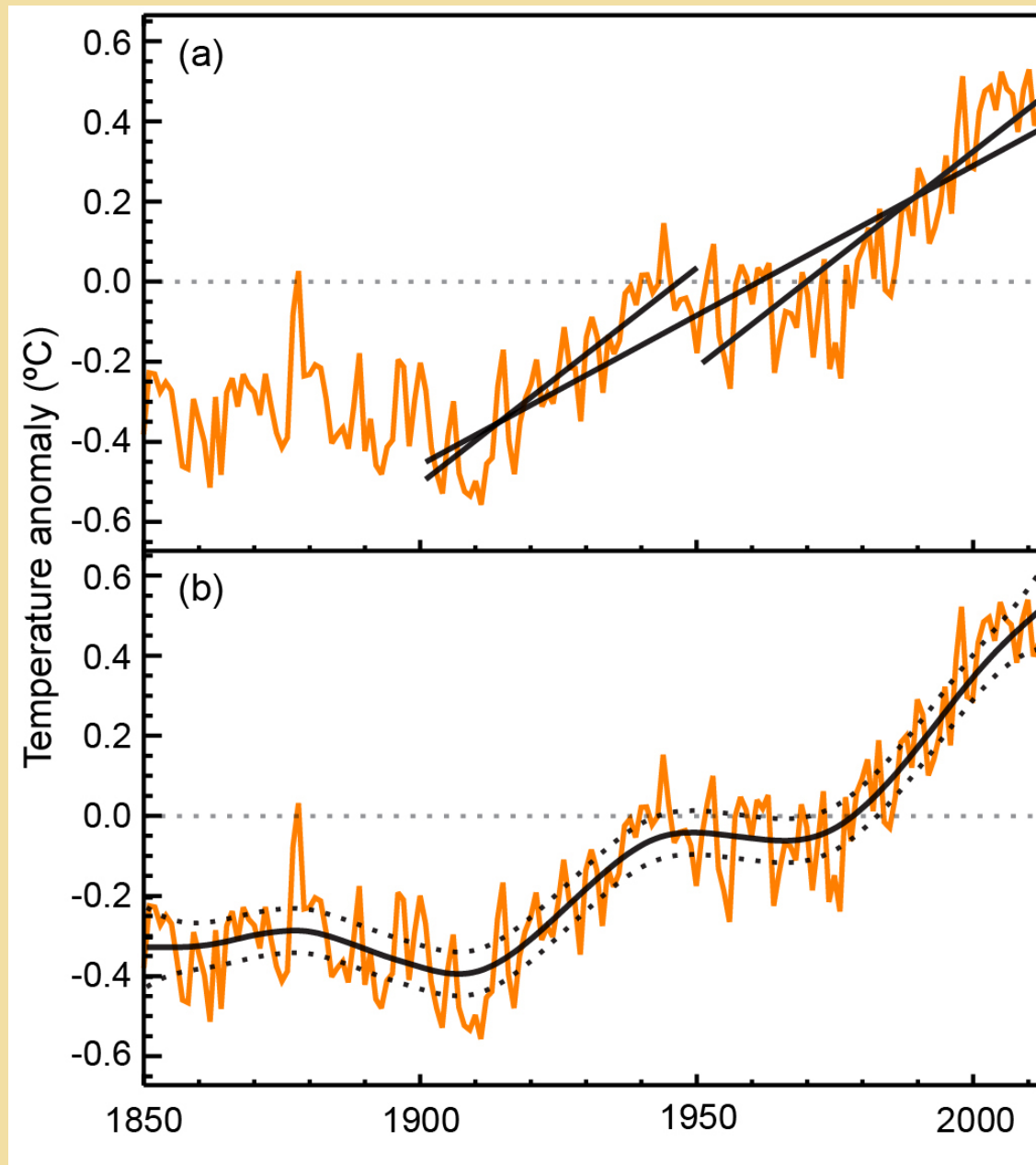
## **Short term trend exception:**

Greenhouse gas

## **Reference period:**

1961-1990

## Trend analyses:



**1. Changes in Atmospheric Composition**

**2. Changes in Radiation Budgets**

**3. Changes in Temperature**

**4. Changes in Hydrological Cycle**

**5. Changes in Extreme Events**

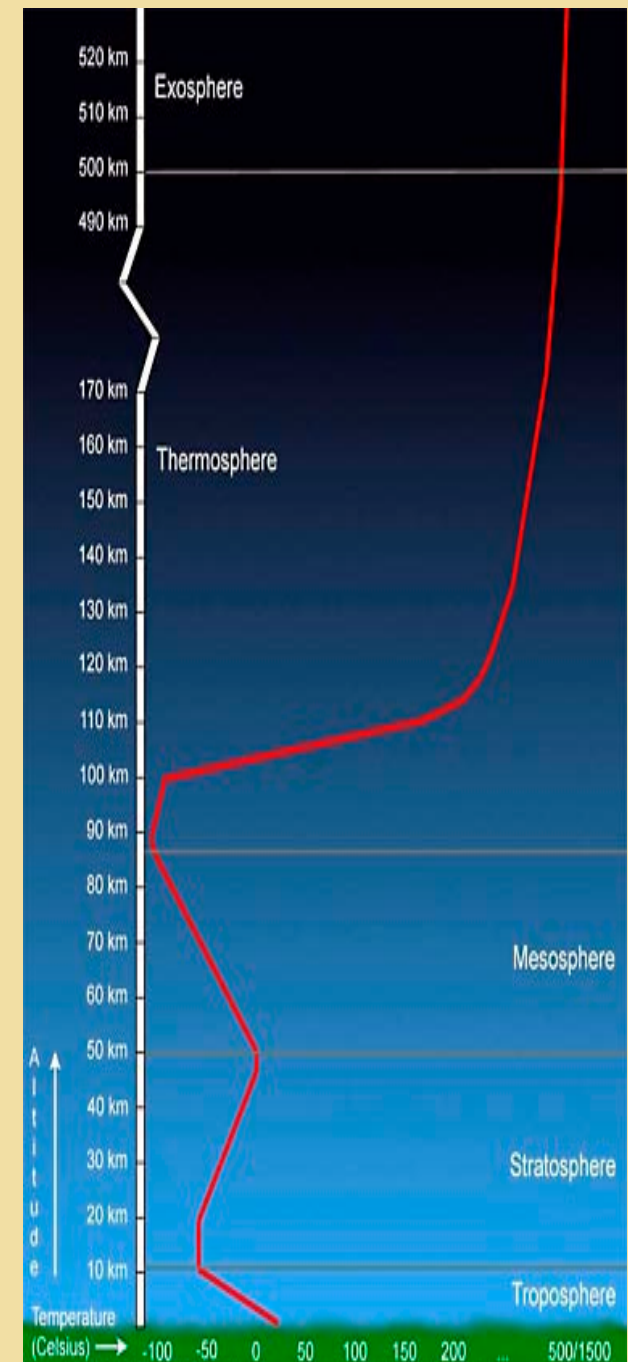
**6. Changes in Atmospheric Circulation**



# 1. Changes in Atmospheric Composition



- Troposphere (< 10 km)
- Stratosphere (10-50 km)
- Mesosphere
- Thermosphere
- Exosphere



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*Fig. 3: A graphic illustrating the atmosphere's structure, starting with the troposphere at the Earth's surface.*

# **1. Changes in Atmospheric Composition**

**Units (non-SI units) and dry-air based:**

**ppm**

**ppb**

**ppt**

**Why?**

# 1. Changes in Atmospheric Composition

## Sources

**AGAGE** = Advanced Global Atmospheric Gases Experiment  
(1978, Sponsored by NASA's Atmospheric Composition Focus Area in Earth Science)

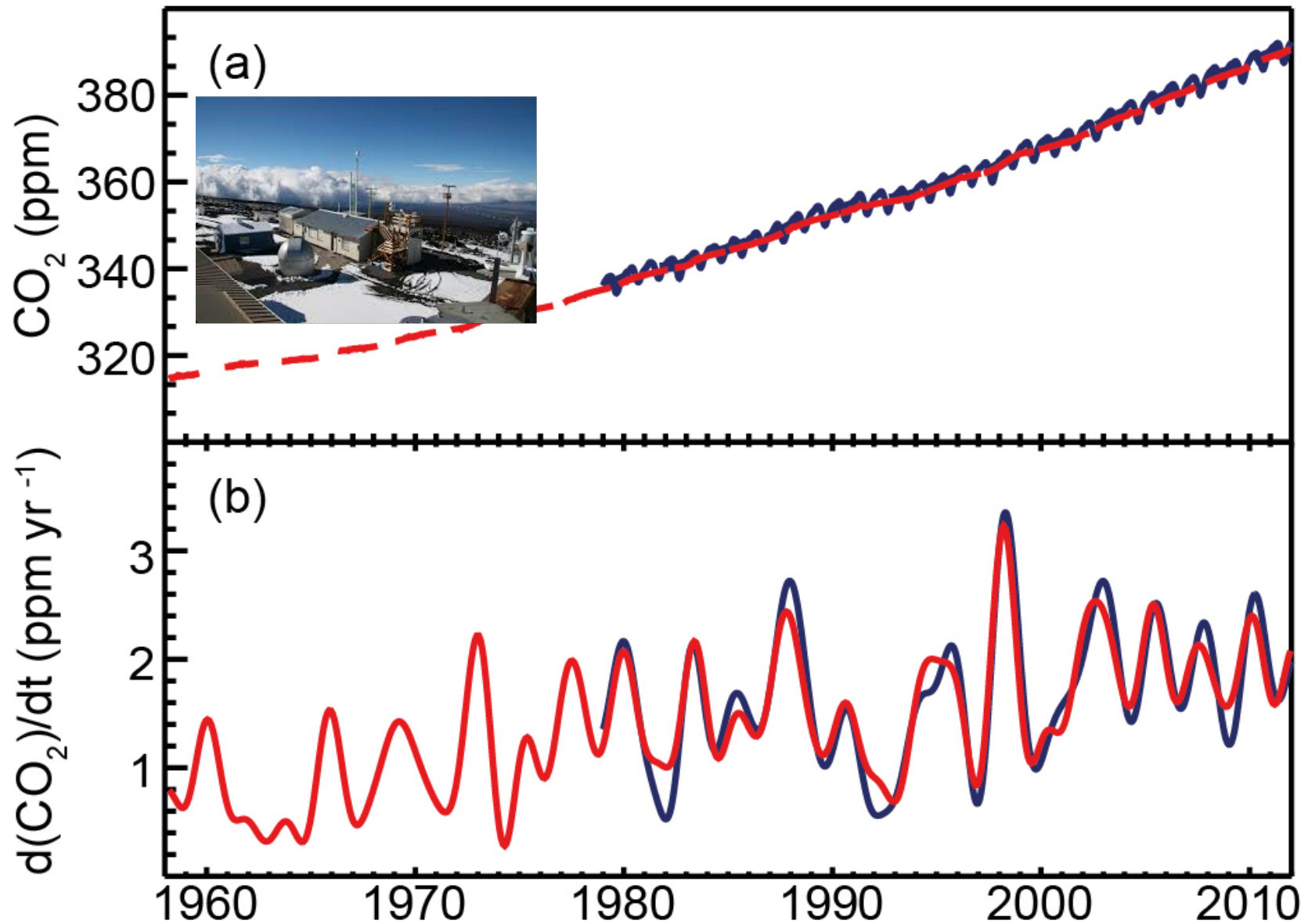
**NOAA/ESRL/GMD** = National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Global Monitoring Division

**SIO** = Scripps Institution of Oceanography, University of California, San Diego (late 1950s)

**UCI** = University of California, Irvine, Department of Chemistry

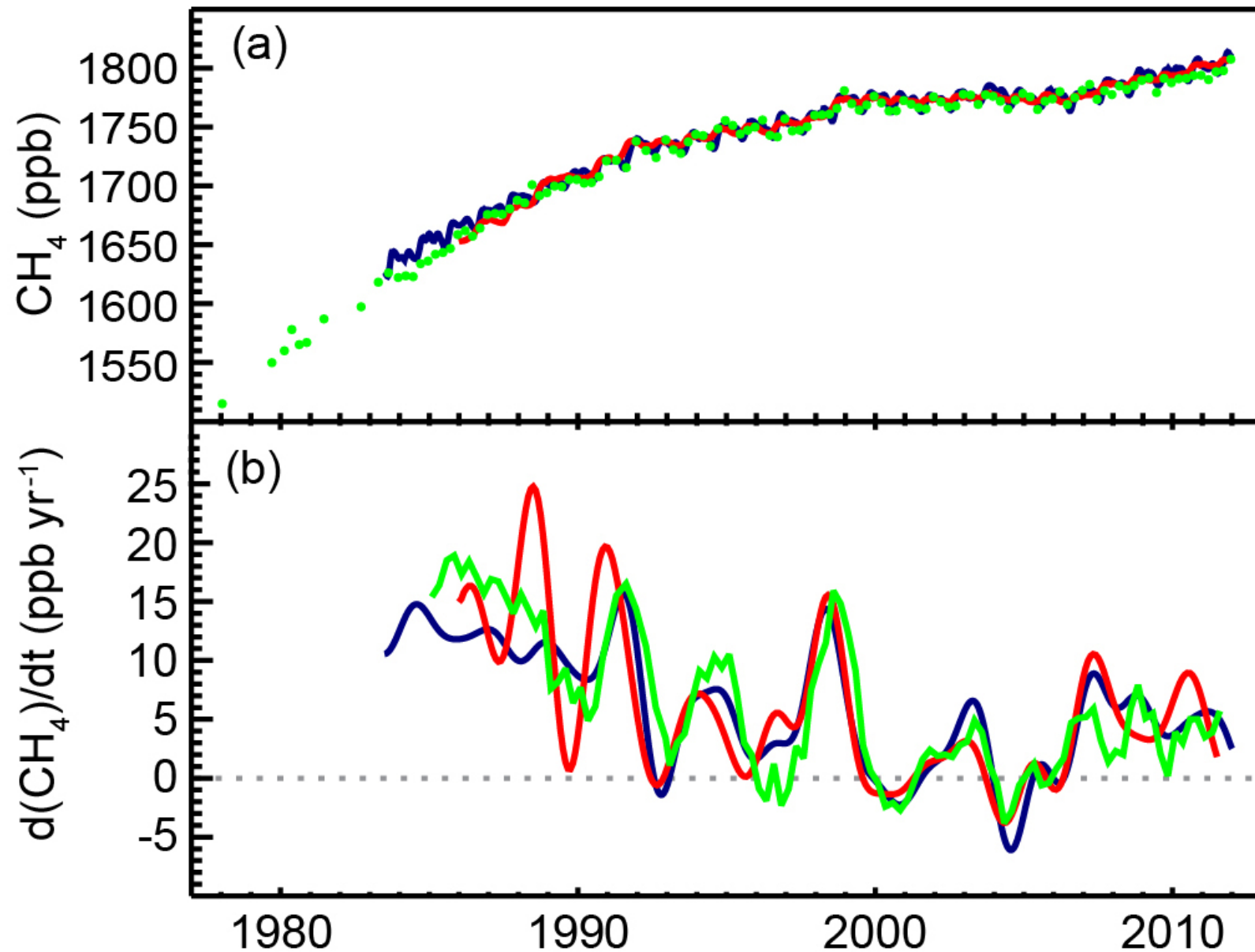
# 1. Changes in Atmospheric Composition

## CO<sub>2</sub>



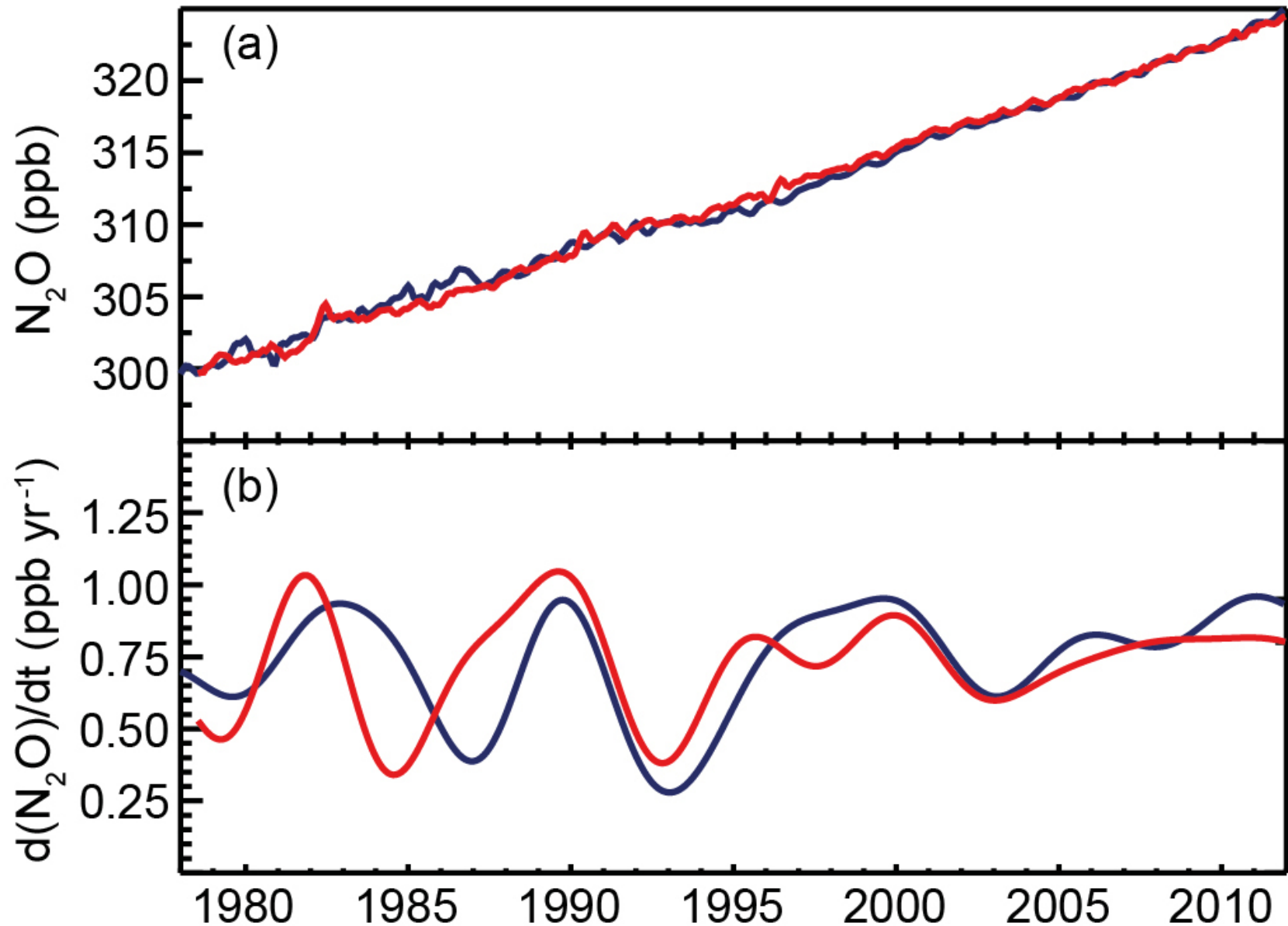
# 1. Changes in Atmospheric Composition

## $\text{CH}_4$

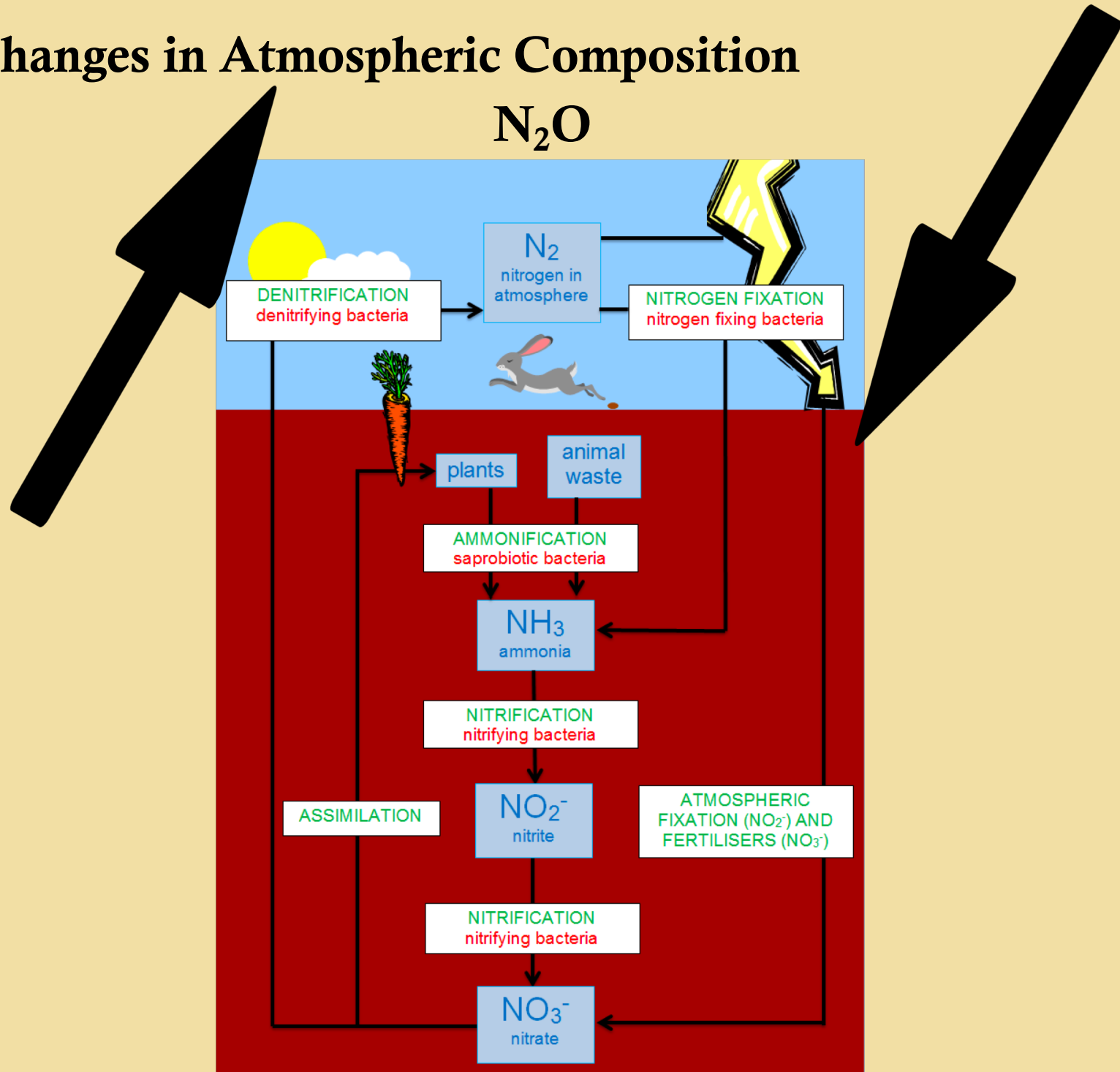


# 1. Changes in Atmospheric Composition

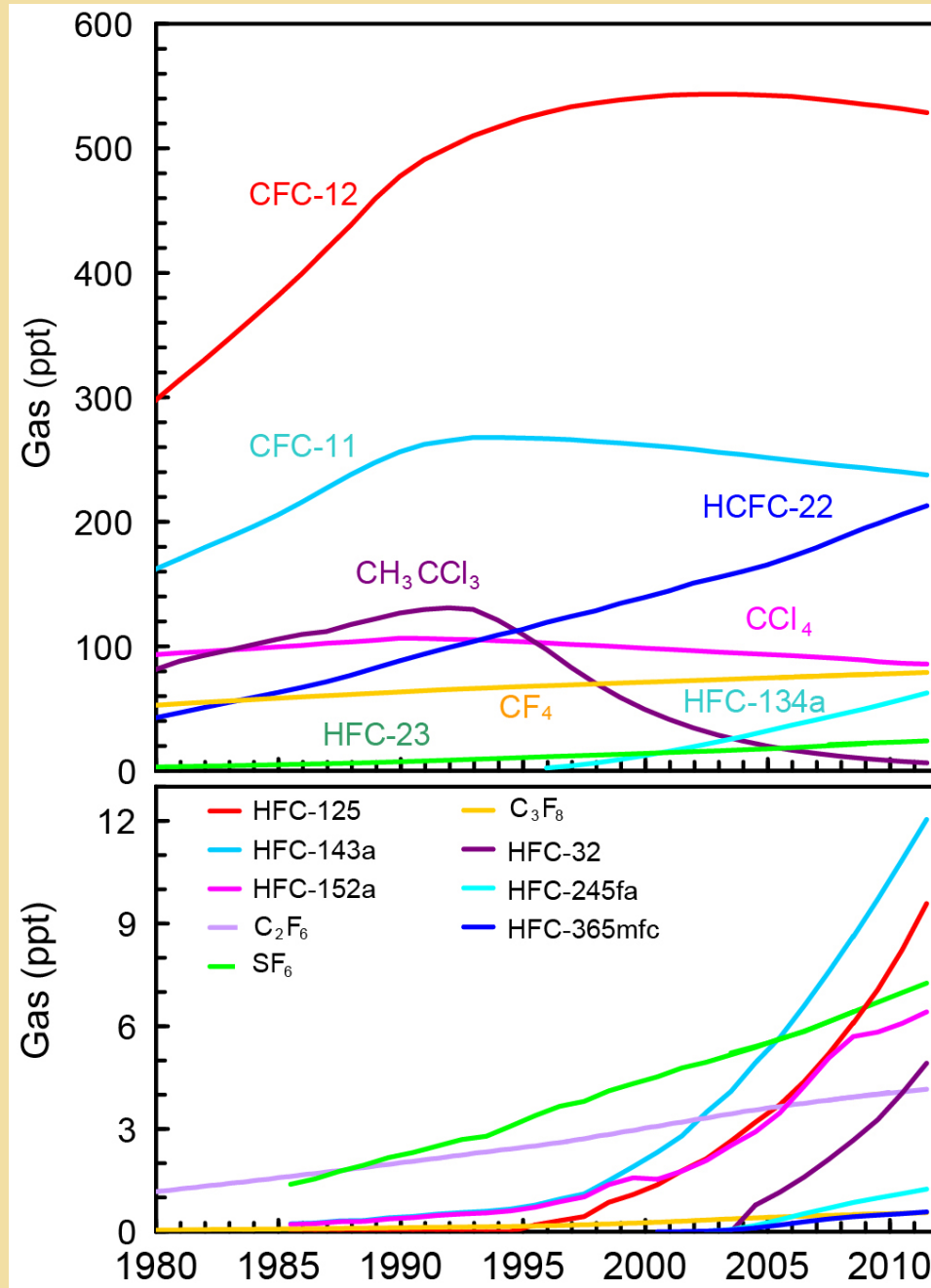
## $\text{N}_2\text{O}$



# 1. Changes in Atmospheric Composition



# 1. Changes in Atmospheric Composition

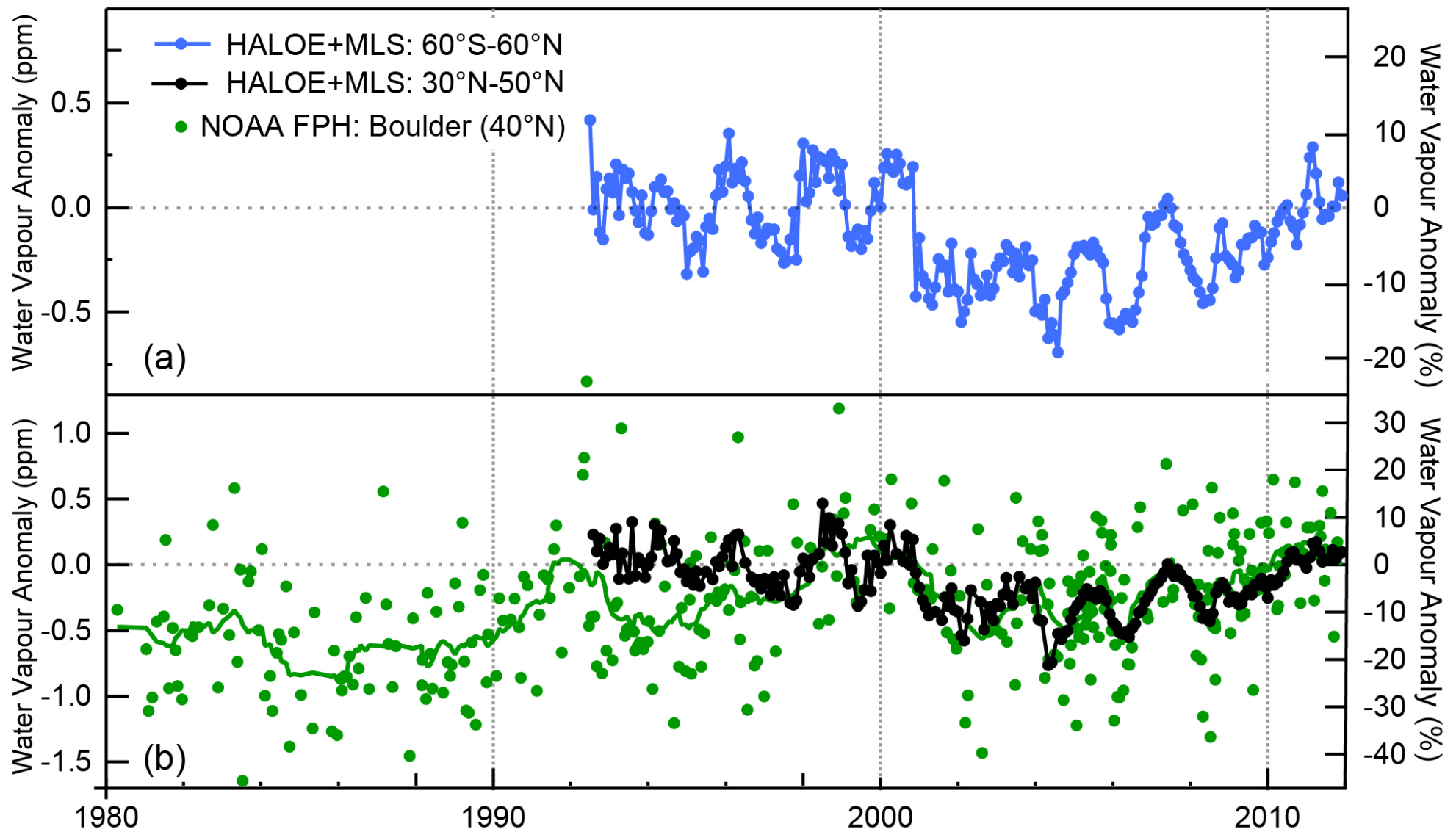


**Montreal Protocol**



# 1. Changes in Atmospheric Composition

## Stratospheric Water Vapor



# 1. Changes in Atmospheric Composition

## O<sub>3</sub>

Stratospheric O<sub>3</sub> concentration is expressed in **Dobson units**.

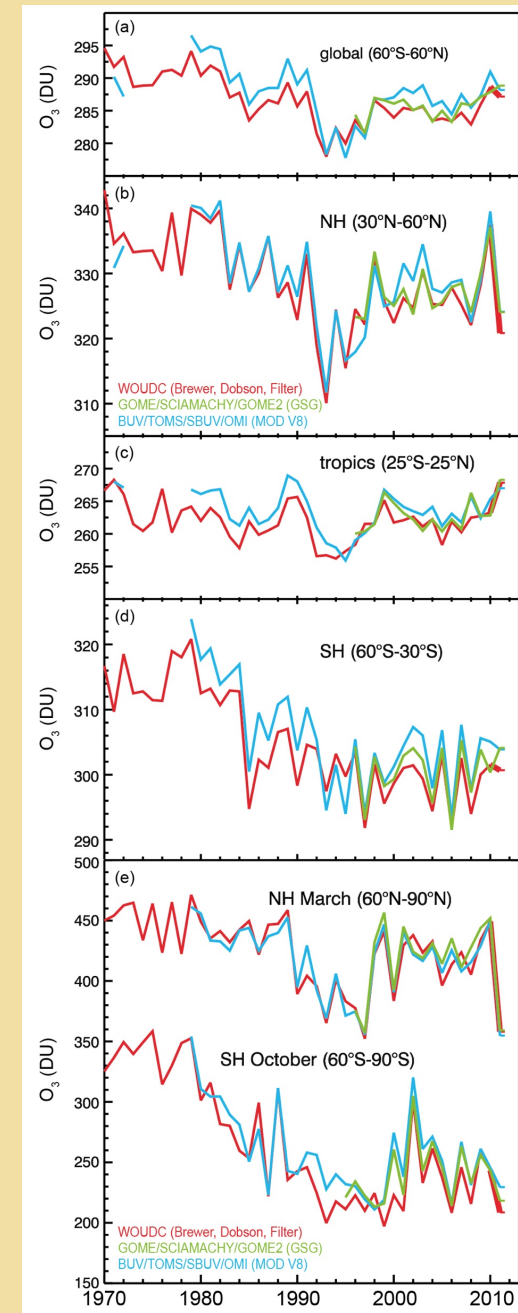
*1 Dobson unit = 0.01 mm at STP*  
*100 Dobson units = 1 mm at STP*

- If **all stratospheric O<sub>3</sub> molecules** were uniformly distributed around the globe, they **would make a layer 3 mm thick** (at 0 °C and 1 atm, standard temperature and pressure or STP).



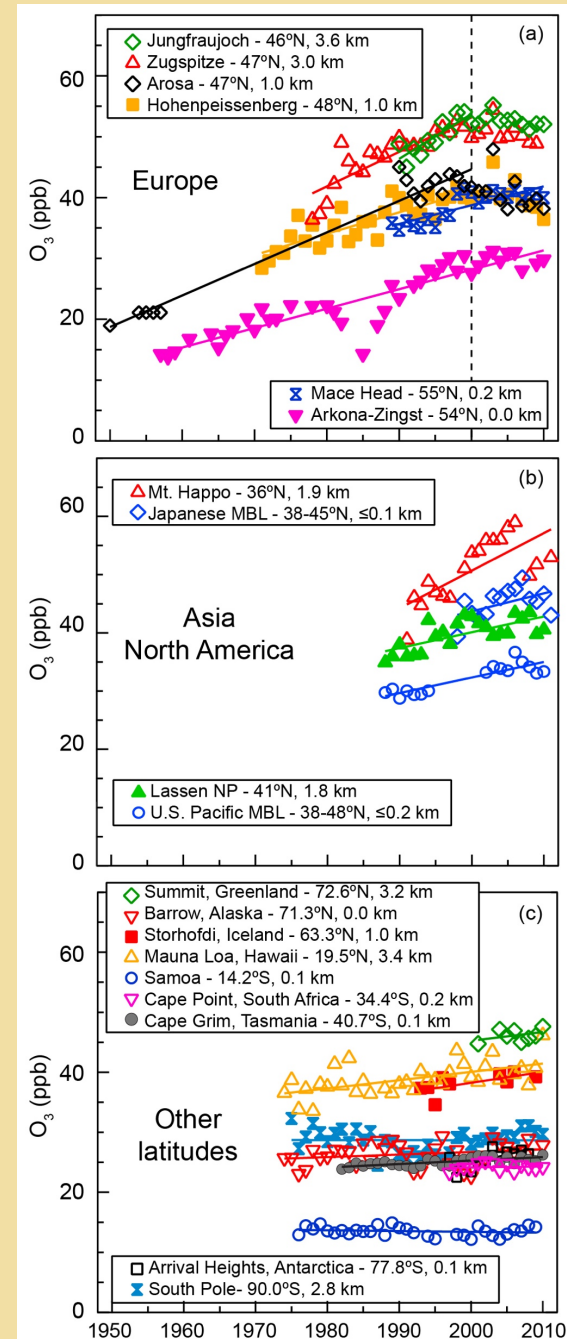
# 1. Changes in Atmospheric Composition

## Stratospheric O<sub>3</sub>



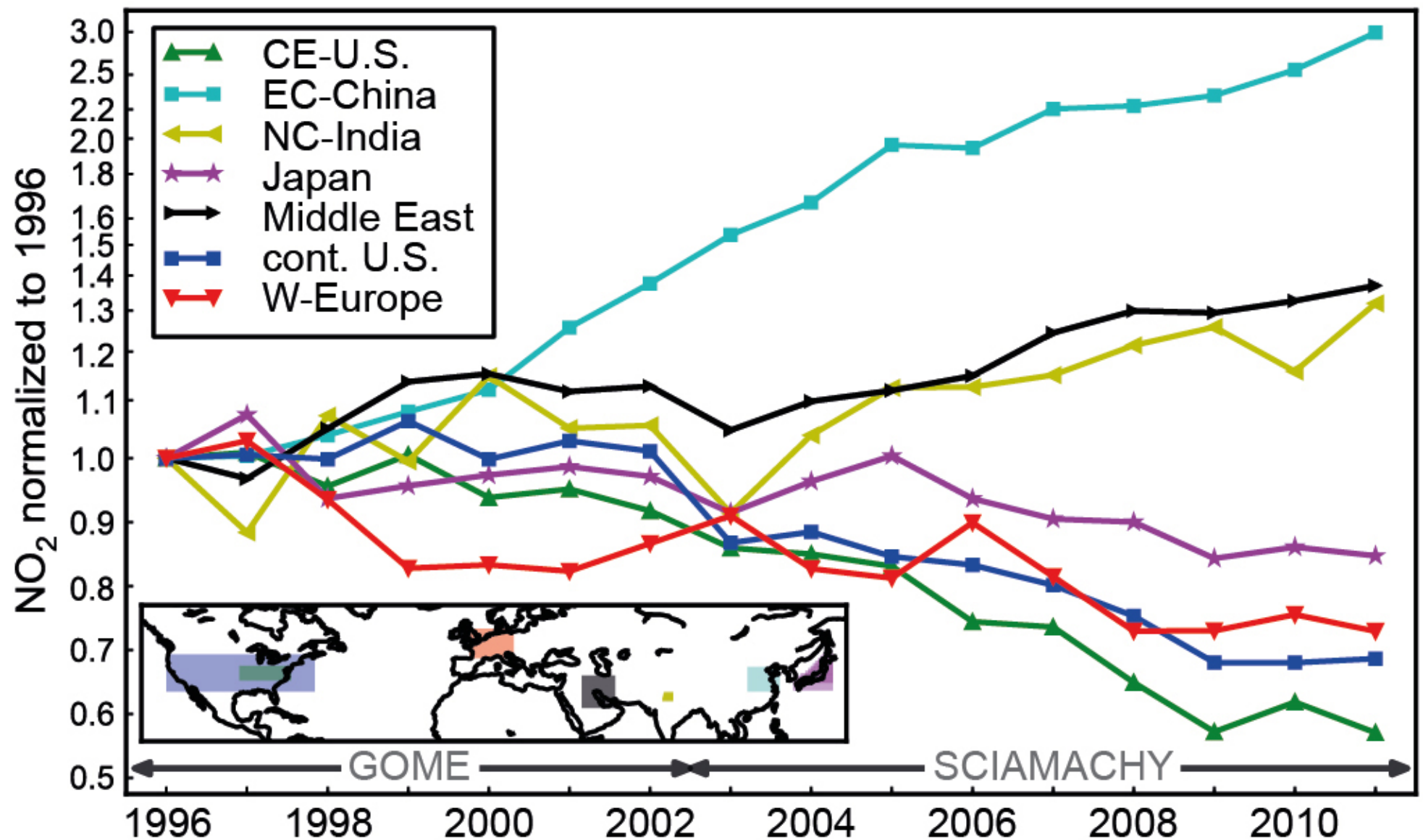
# 1. Changes in Atmospheric Composition

## Troposphere $O_3$



# 1. Changes in Atmospheric Composition

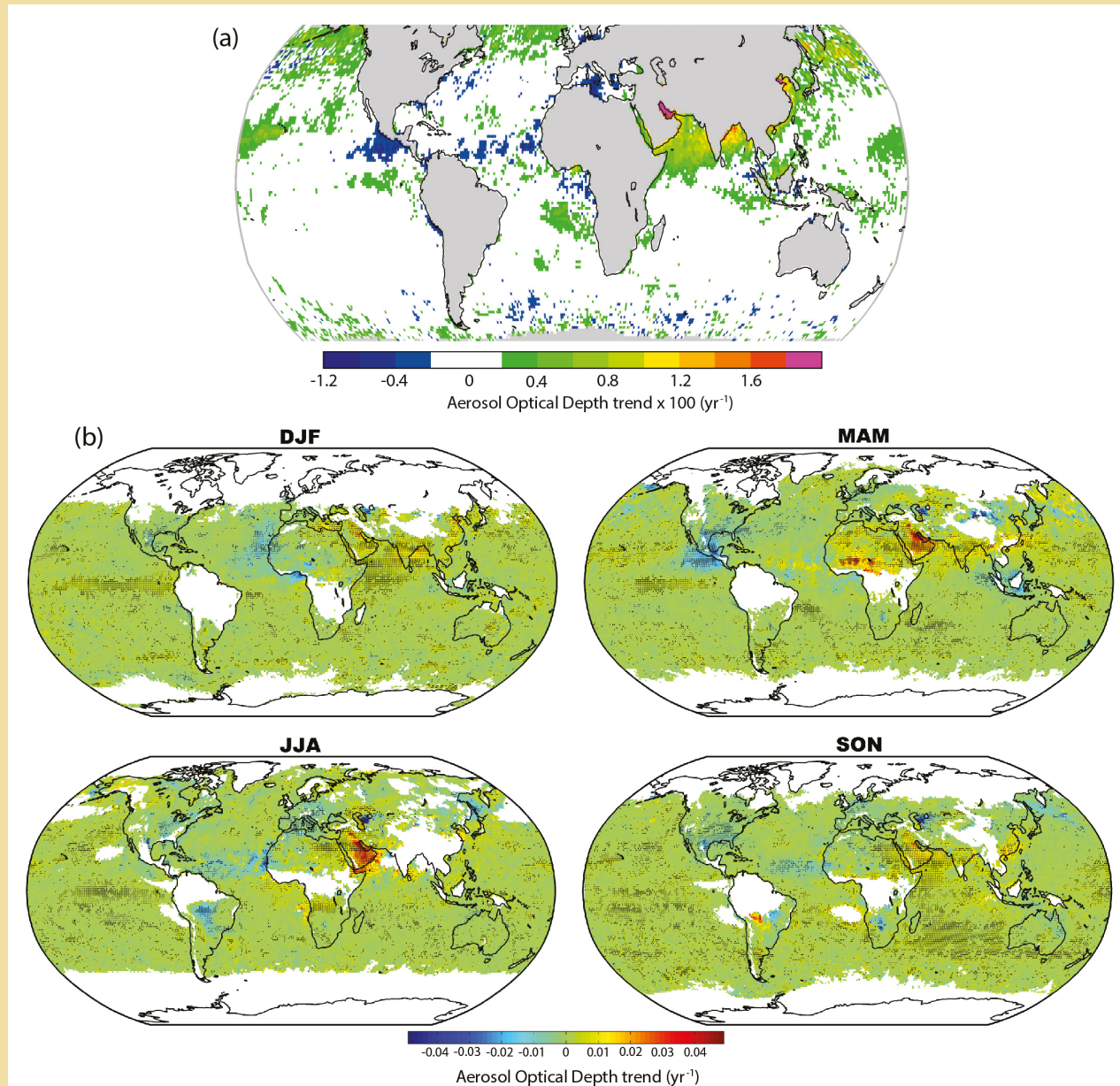
$\text{NO}_2$



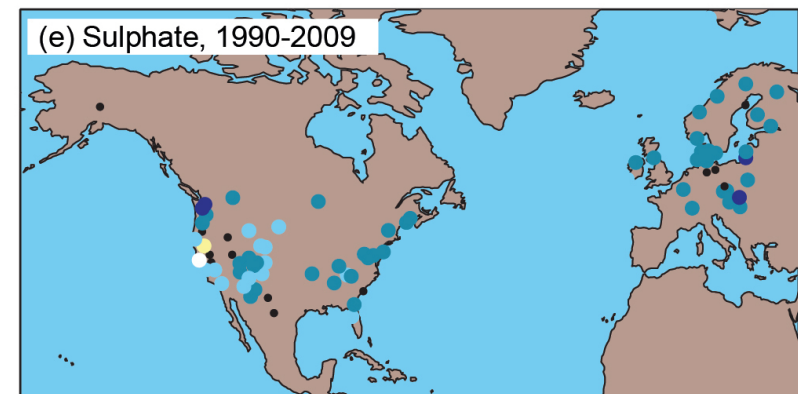
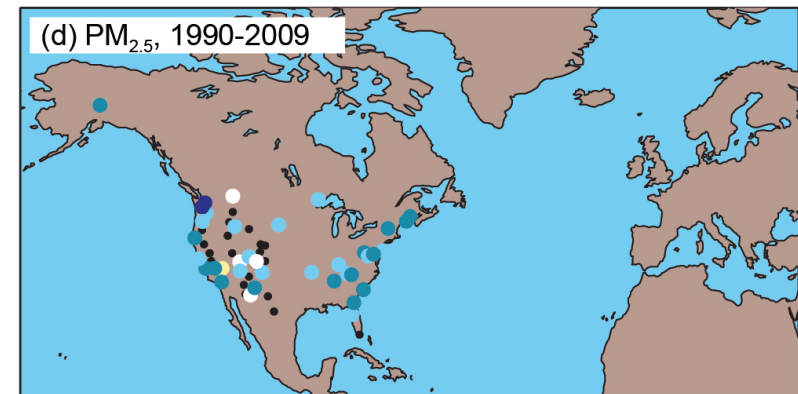
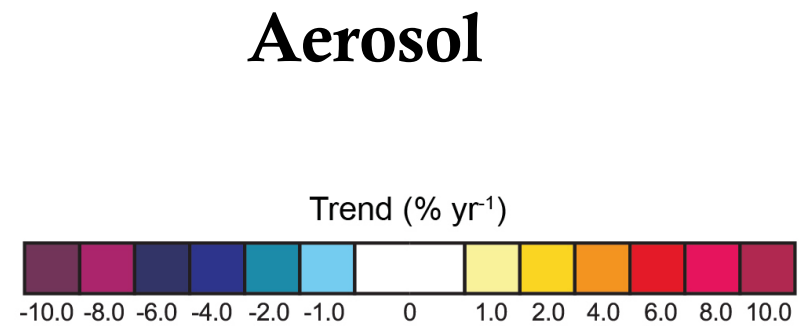
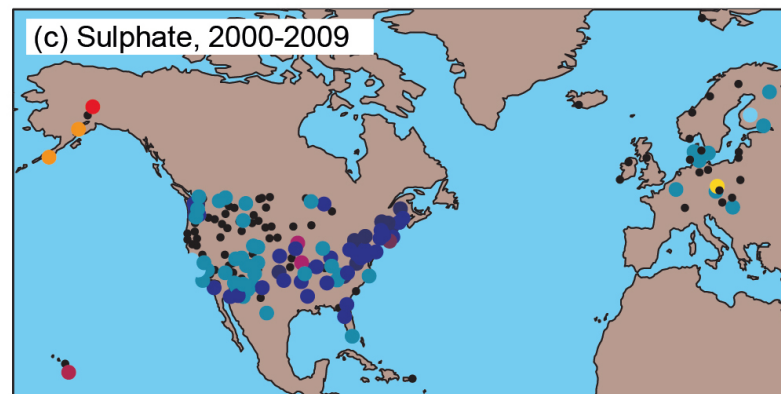
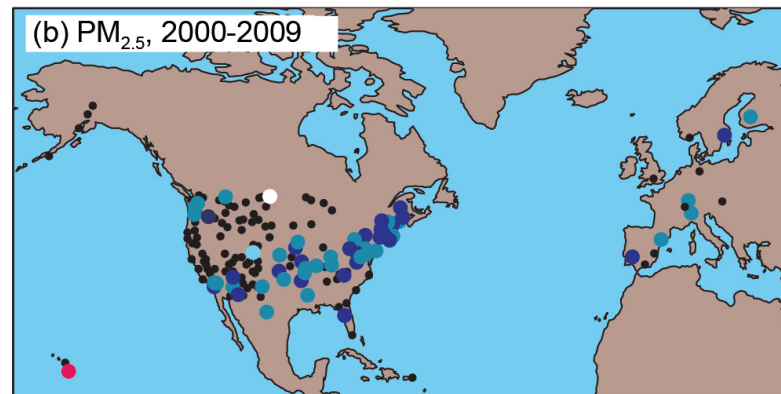
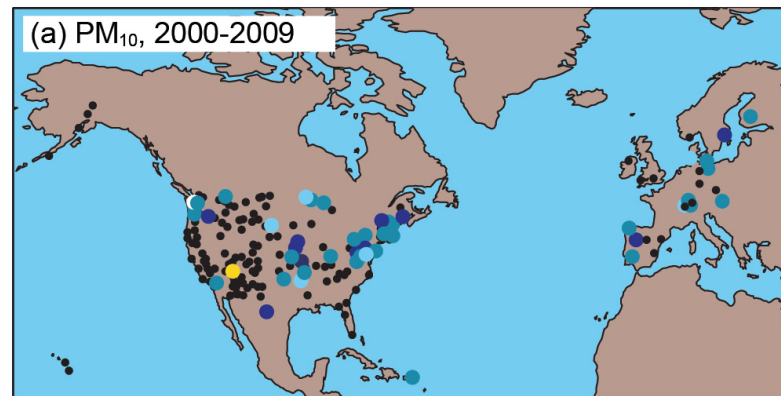


# 1. Changes in Atmospheric Composition

## Aerosol



# 1. Changes in Atmospheric Composition

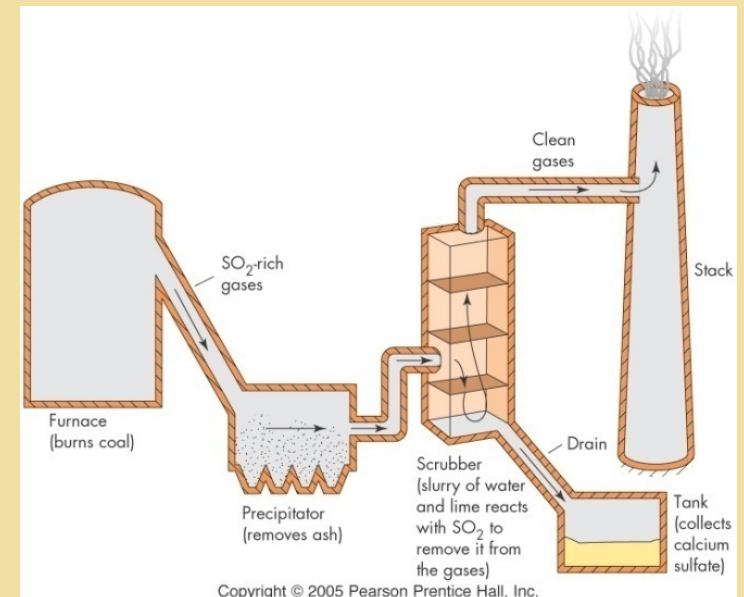
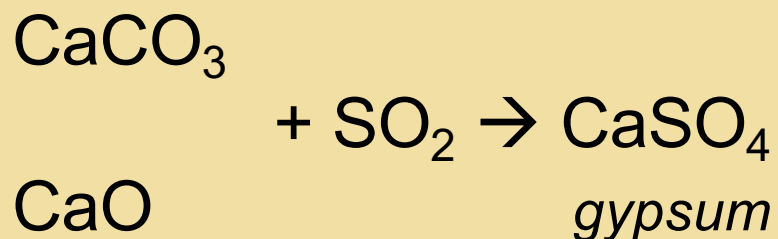


# 1. Changes in Atmospheric Composition

**Clean Air Act:** adopted in 1970, amended in 1977 and 1990

## Mandates:

- Cars to be equipped with **catalytic converters** (to convert carbon monoxide and hydrocarbons into carbon dioxide and water)
- Installation of **scrubbers** in smokestacks.





# Reading Assignment

**WG1AR5\_Chapter02\_FINAL**