

# ENS: Global Warming & Biodiversity Conservation

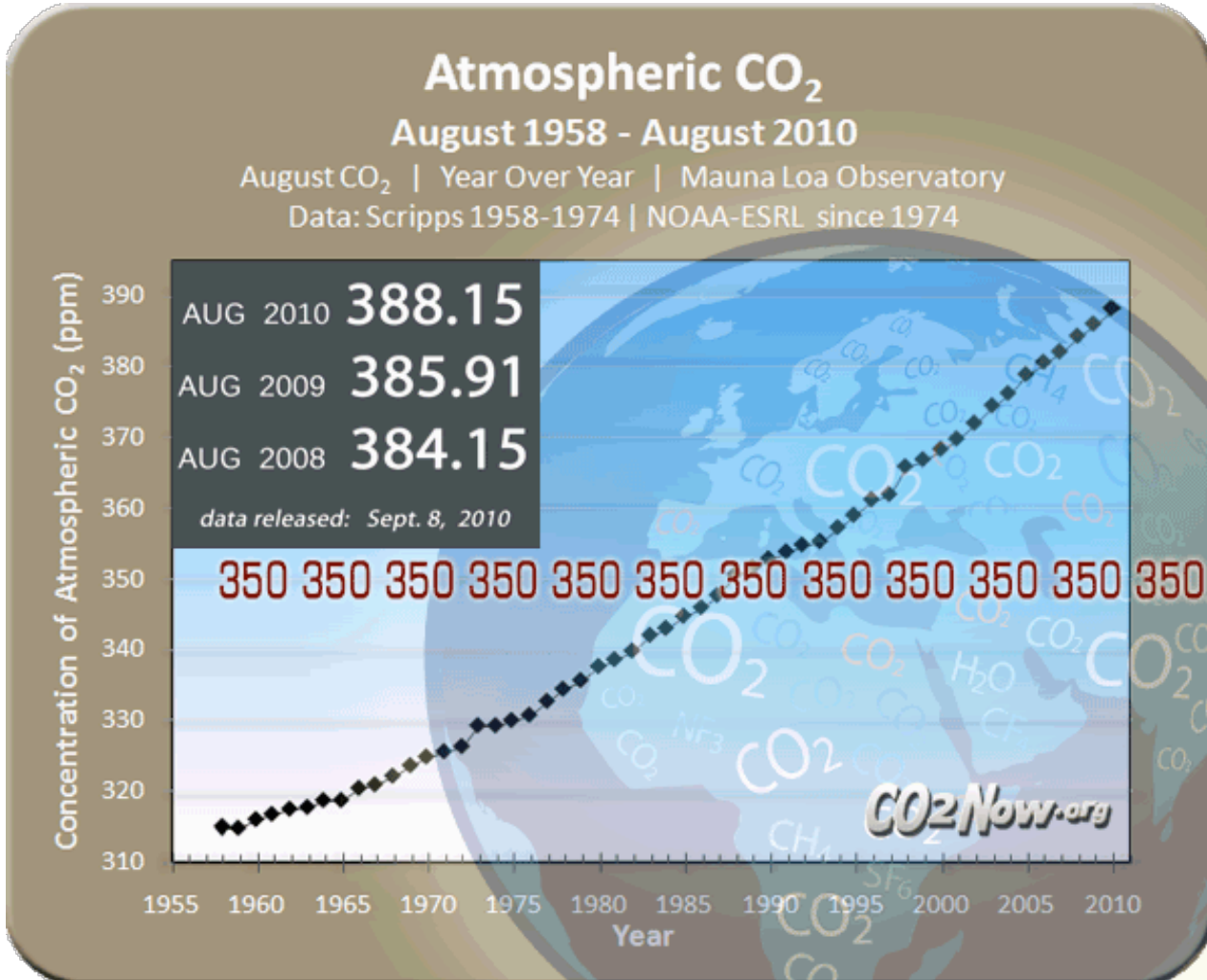


# Causes of Global Warming

- Earth has a natural greenhouse effect – the trapping of solar radiation by moisture and natural greenhouse gases: UV to IR
- Last 130 years: The Industrial Revolution Has led to sharp increases in the amount of these natural greenhouse gases

Iconic  
Images:

Mauna Loa  
Observatory  
Readings



## **Global Warming emissions: principal components**

**1. Carbon Dioxide – from the burning of coal, petroleum, gasoline**

- **1860: 280 parts per million**
- **2000: 370 parts per million**
- **2010: 380+**
- **2050: 400-600 parts per million (estimated)**

**2. Chlorofluorocarbons (CFCs) – from aerosol sprays, refrigeration, air conditioning**

- **Increasing at a rate of 4% per year**
- **absorbs a thousand times more infrared radiation from Earth per molecule than CO<sub>2</sub>**

**3. Methane – from vegetation burning (rainforest clearing), leakage from natural gas refineries & pipelines, and ‘natural’ leakage from cattle and sheep**

- **The atmospheric concentration of methane has increased by 151% since 1750 and is its highest in 420,000 years.**

## 4. Nitrous Oxide – from use of chemical fertilizers

5% of human-caused greenhouse gases

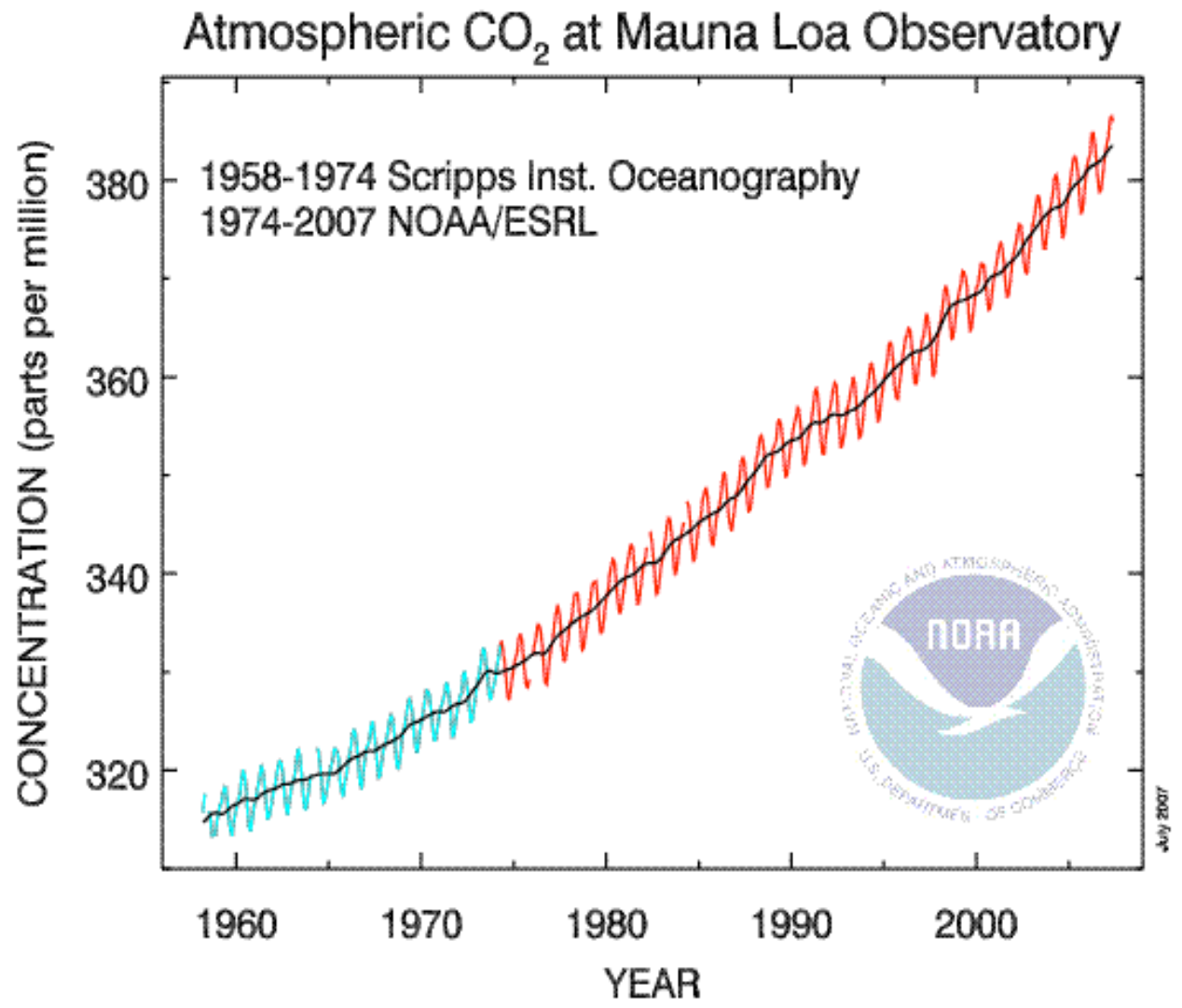
## 5. Water Vapor – largest greenhouse gas and naturally occurring —generally considered to increase with increased temperatures

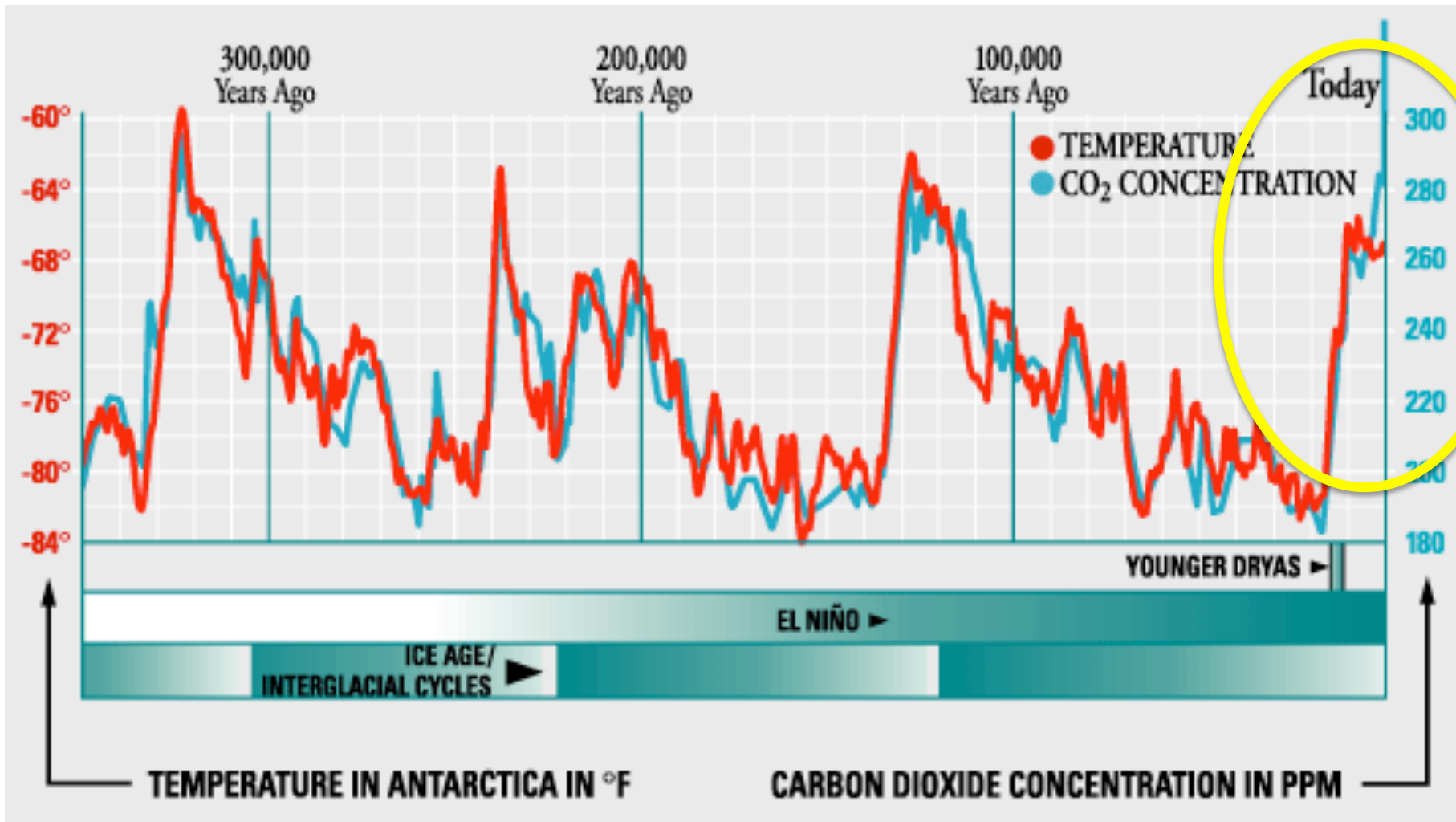
### Unanswered feedback questions:

- can water vapor lead to a feedback effect causing a 'runaway' greenhouse effect?
- can areas become more arid? allowing greater reflectance back into space?
- how will it vary across regions? some hotter, more humid, wetter...others more arid, dryer?
- Will a warming world with more CO<sub>2</sub> result in greater rates of carbon-capturing plant growth? Or will hotter, dryer soils release more CO<sub>2</sub>?

# Keeling Curve

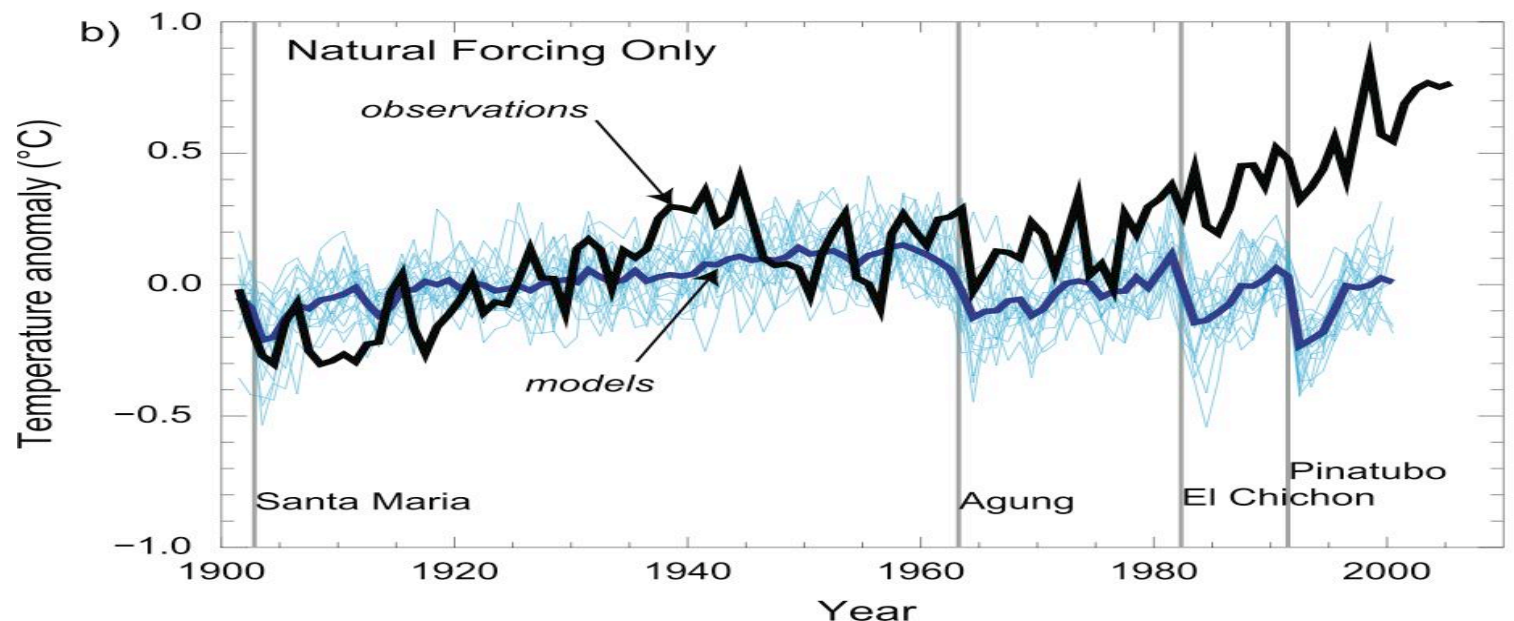
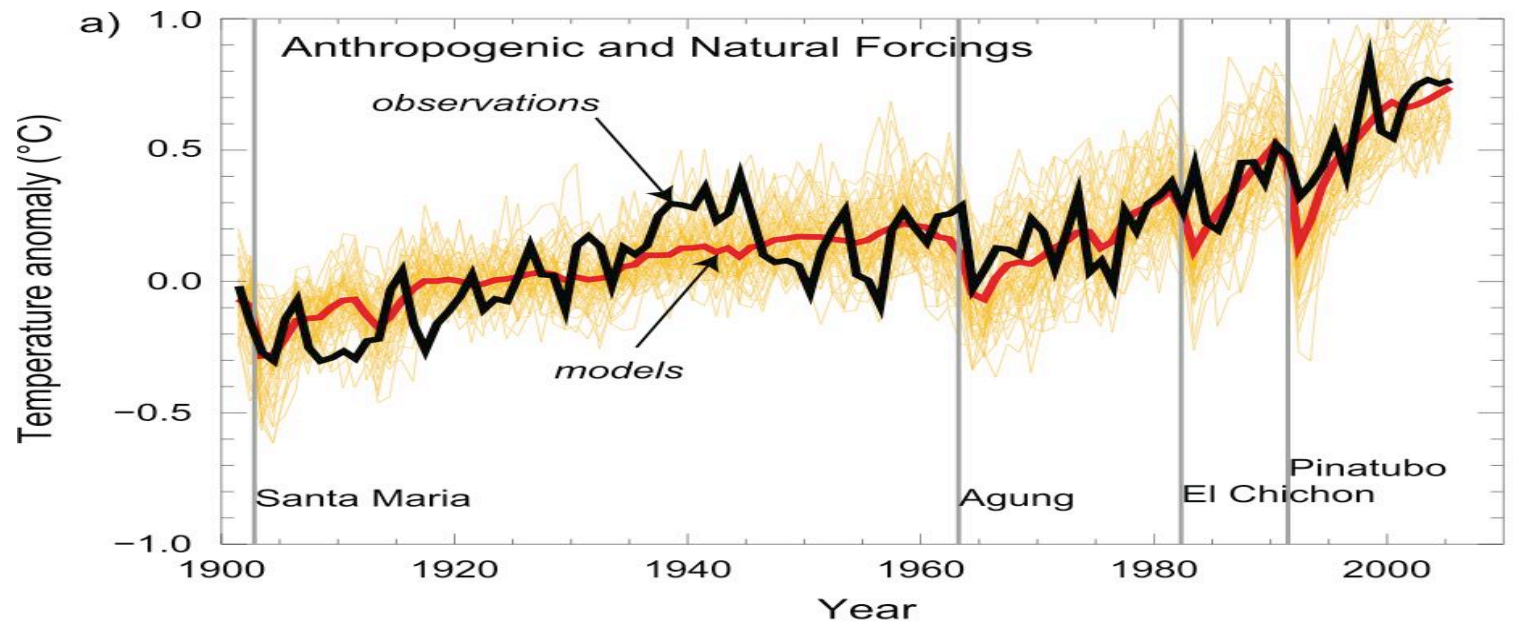
Totals: increase in overall atmospheric content  
Annual amplitude (a bit hard to see on this graph): 'greening' of North America and Siberia with Global Warming





Big difference between CO<sub>2</sub> and temperature today. Far greater than at any time in the last 300,000 years. Temperatures have not shown the same **recent** correlation, however. We hope they will not I suppose...

# Models versus observations: global warming



# **Future scenarios?**

**How will greenhouse emissions alter over time?**

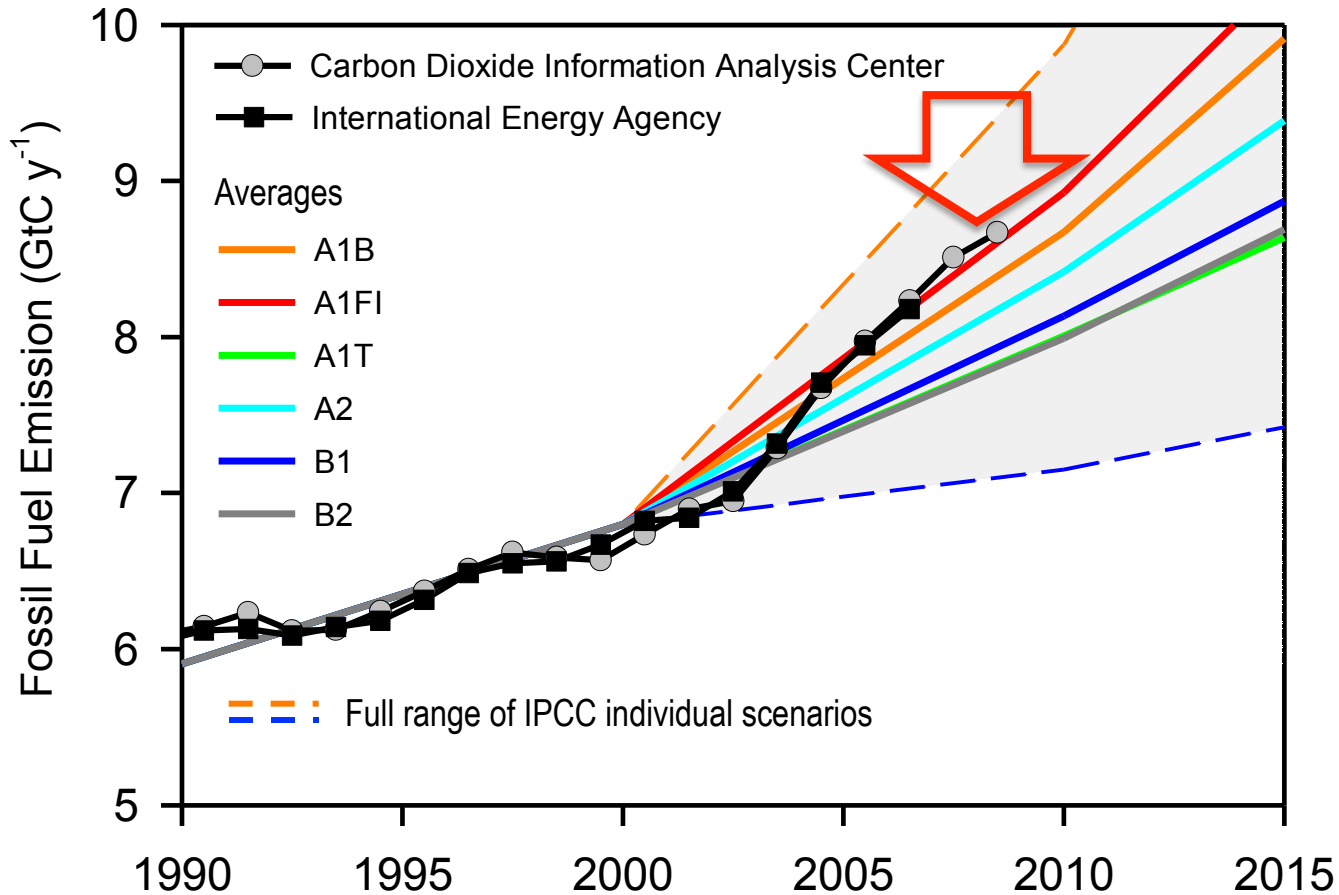
**What will happen to natural sinks?**

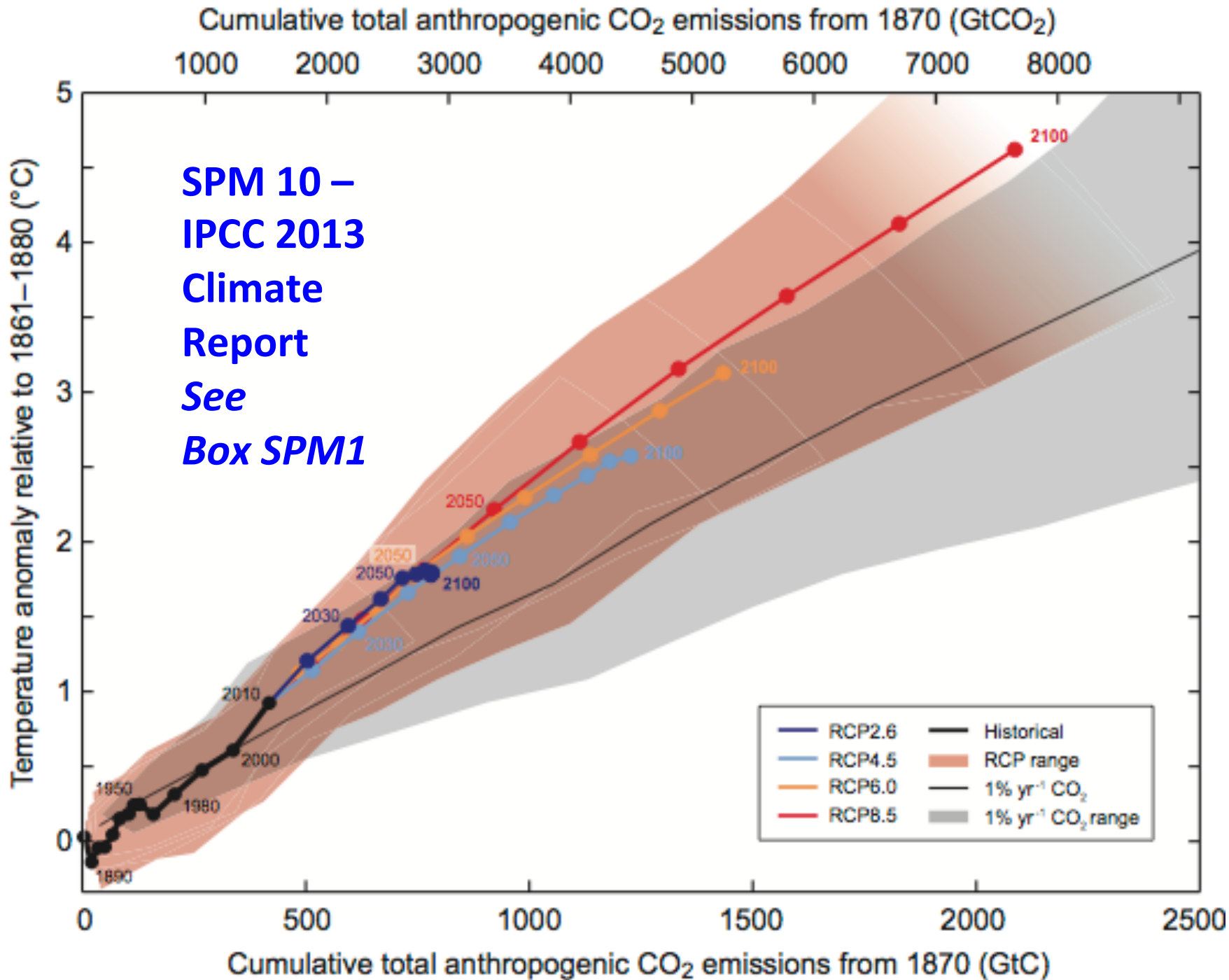
**Soil? huge reservoirs of CO<sub>2</sub> are held in surface deposits such as soils, peats, etc.**

**What is the Present Effect of this Buildup of Greenhouse Gases?**



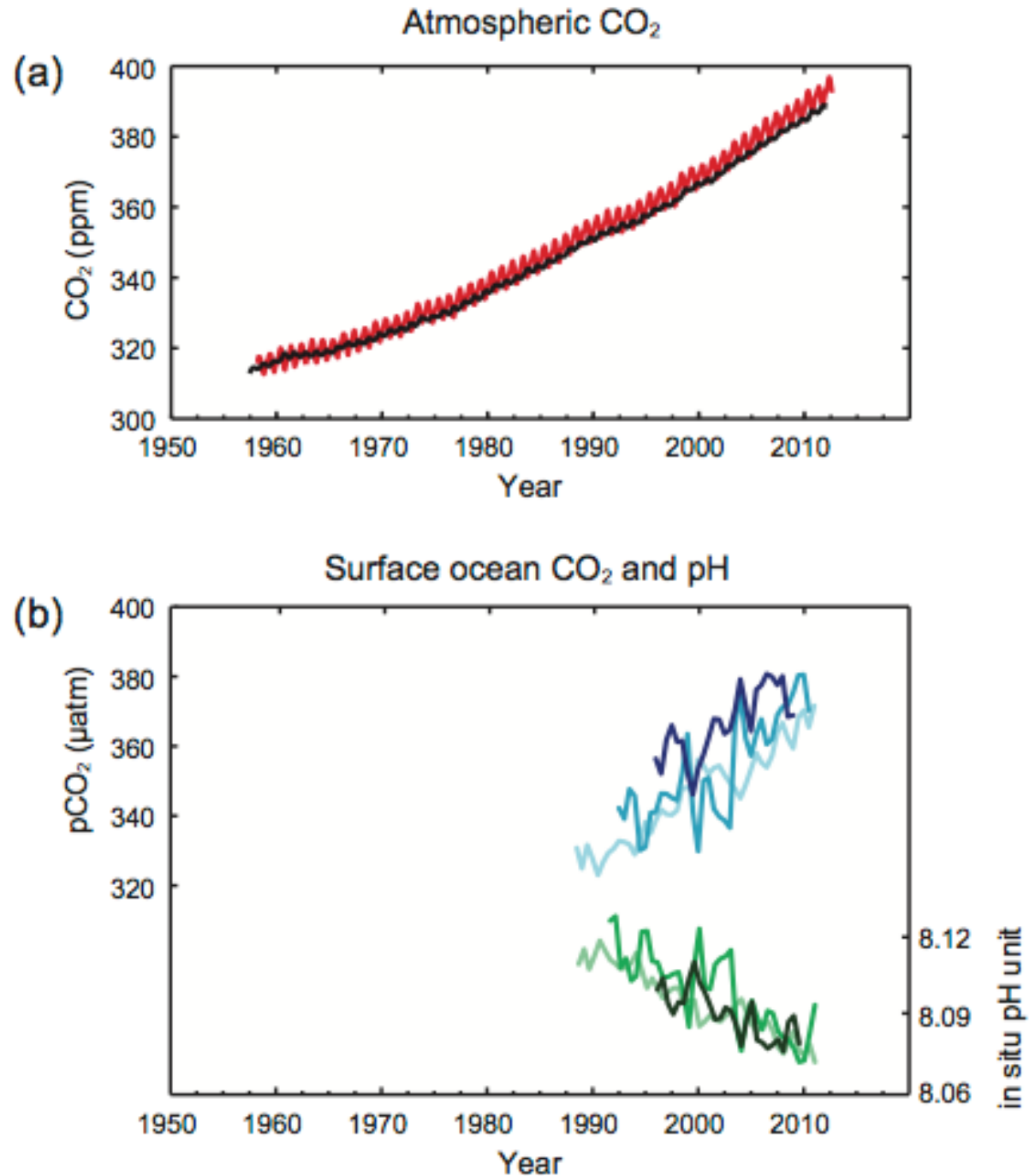
# Fossil Fuel Emissions: Actual vs. IPCC Scenarios





**EFFECTS**

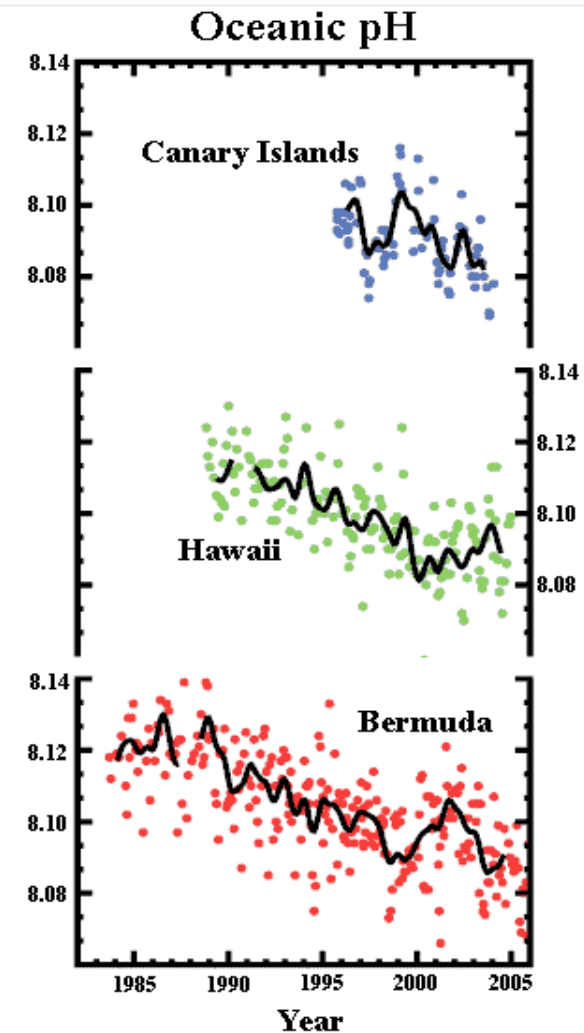
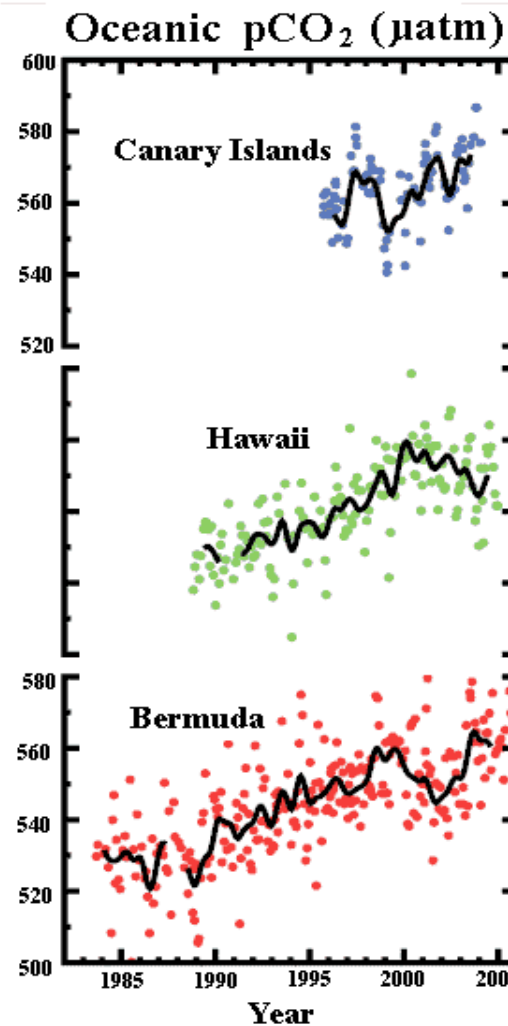
# SPM 4, From 2013 report



Extra CO<sub>2</sub> has effects as well

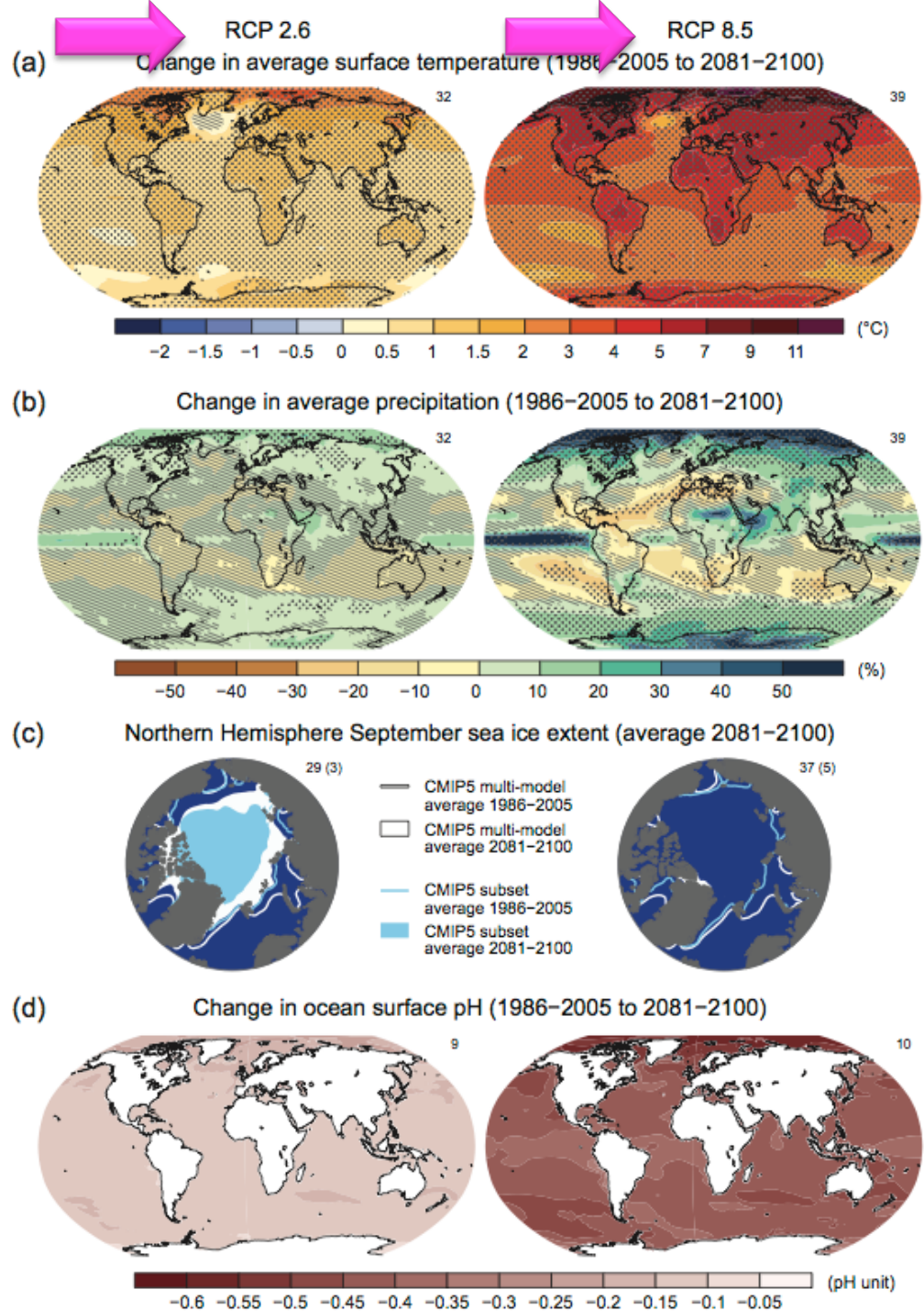
- Acidification of the Ocean
- Coral Bleaching (Die-Offs): warming AND difficulty of building shells of calcium

Coral Reef bleaching leads to loss of dependent fish populations



**Bottom Line: Massive Ecological Changes & Social Impacts**

# SPM8 2013 IPCC Climate Report: 2 scenarios



# Potential Effects of Greenhouse Gases Buildup?

Some Impacts... Habitat Destruction and Biodiversity Loss

Changes in Temperature affect glaciers and oceans

Increase in Sea Level due to Thermal Expansion of the Ocean and Melting of Ice Sheets: Continental (Greenland, Antarctica), Mountain (Rockies, Kilimanjaro, Andean)

Millions of species potentially displaced.



Good News! KY beach!

Bad News: It's going to be crowded...



**Southeast Asia  
if West sheet melted (17-foot/  
5m rise)**



**Southeast Asia  
if East sheet melted (170-  
foot/50m rise)**



## 2. Loss of Ice Sheets and associated ecosystems

- Polar Bears,
- Vast under-ice ecosystem of Krill and the related ecosystem (sea lions, penguins)
- Mountain Ecosystems: many pockets of biodiversity are dependent upon snowmelt.

### Arctic sea ice set to hit record low within days

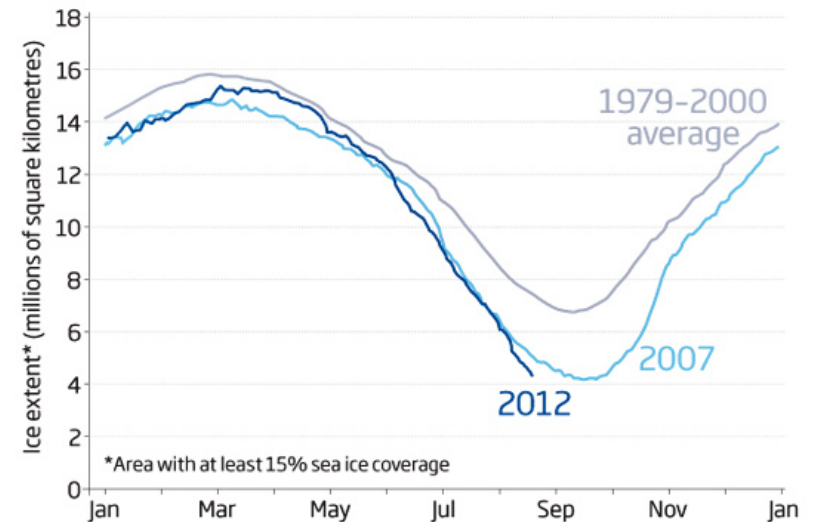
15:36 22 August 2012

Environment

Michael Marshall, environment reporter

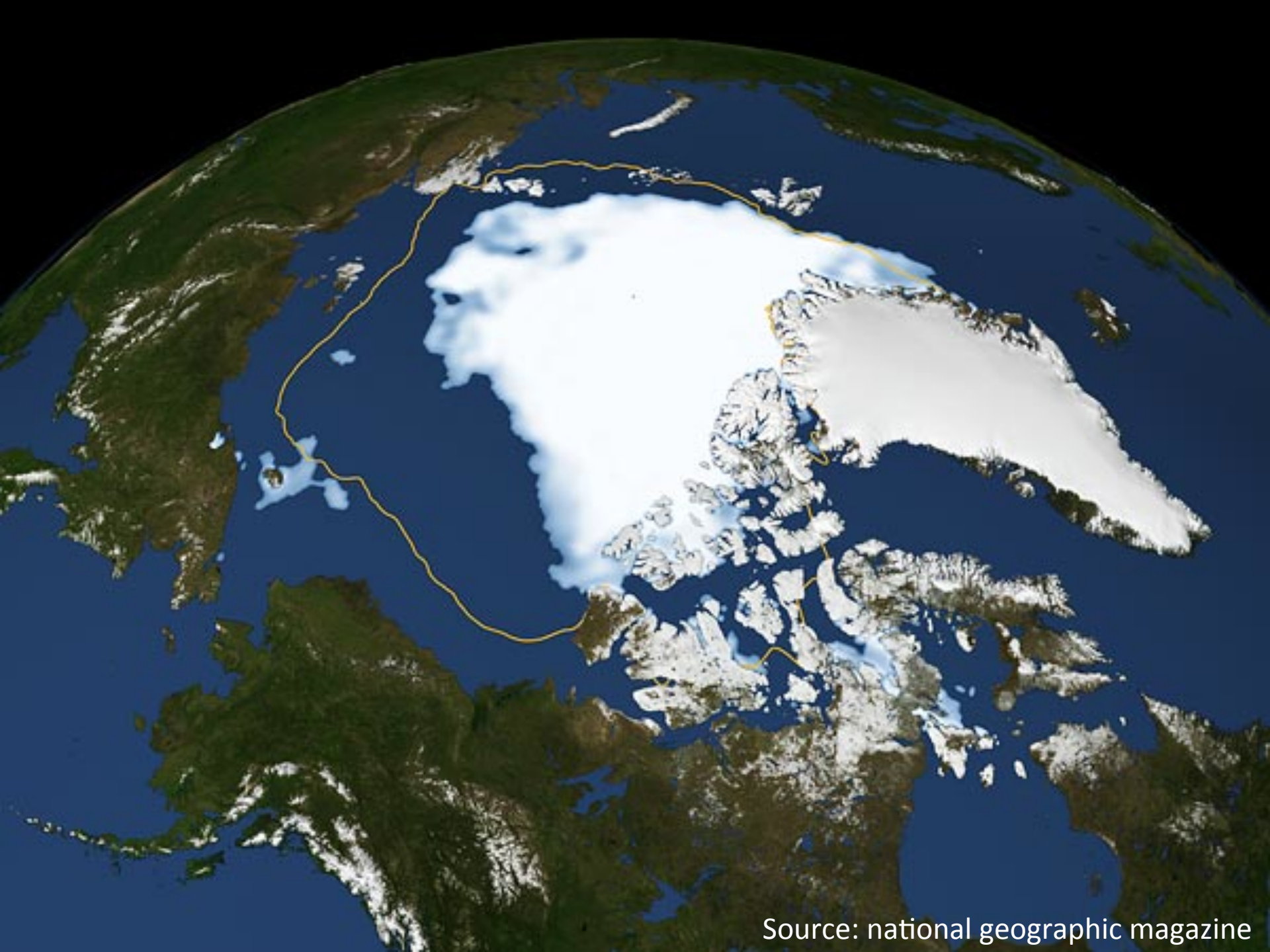
#### Arctic sea ice extent

©NewScientist



As Arctic summers go, 2012 is on track to be a record breaker. Both the sea ice and the Greenland ice sheet are shrinking to new lows this year.





Source: national geographic magazine

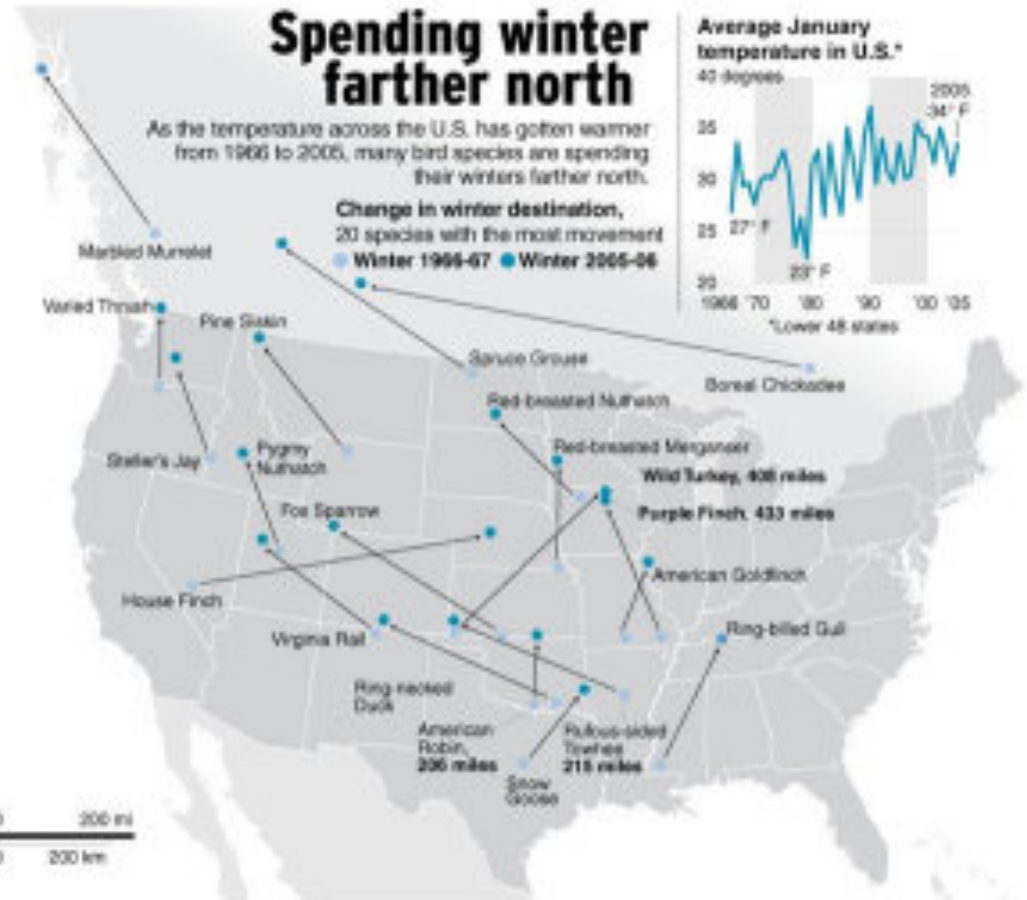
### 3. Global Warming alters terrestrial Ecosystems

#### Change in Animal / Plant Cycles

Earlier Migration and Breeding of Birds, Animals, and Plants

Change in CO2 concentrations may increase crop yields

Change in weather patterns may harm crop yields



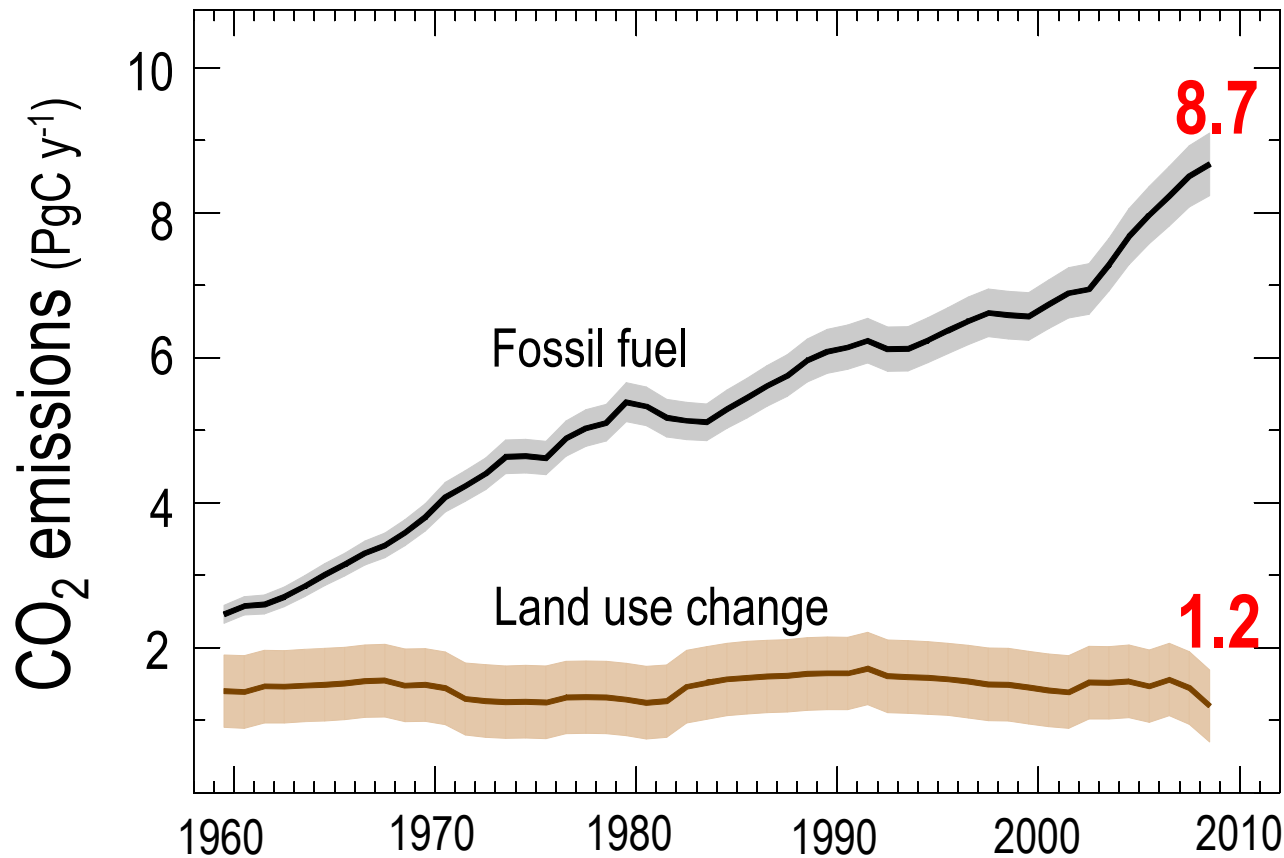
# Sources and Sinks:

**Sources:** where do climate-affecting gases originate?

**Sinks:** how do they disappear from the atmosphere?

(looking at CO<sub>2</sub>...)

# Total Anthropogenic Emissions 2008 (2008 only)



**9.9 PgC**



12% of total anthropogenic emissions

**1 PgC.yr<sup>-1</sup> = 1 billion tons of carbon/year = 3.7 billion tons of CO<sub>2</sub>/year**

# Fate of Anthropogenic CO<sub>2</sub> Emissions ( Avg. years 2000-2008)

1.4 PgC y<sup>-1</sup>



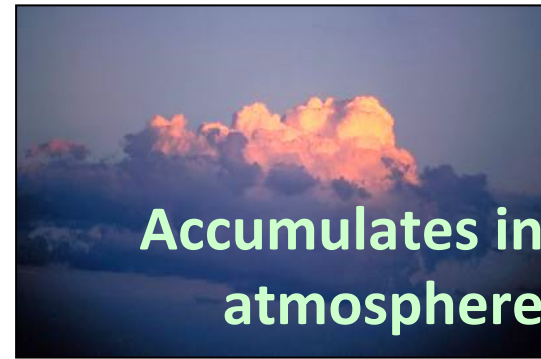
7.7 PgC y<sup>-1</sup>

+



4.1 PgC y<sup>-1</sup>

45%



3.0 PgC y<sup>-1</sup>

29%

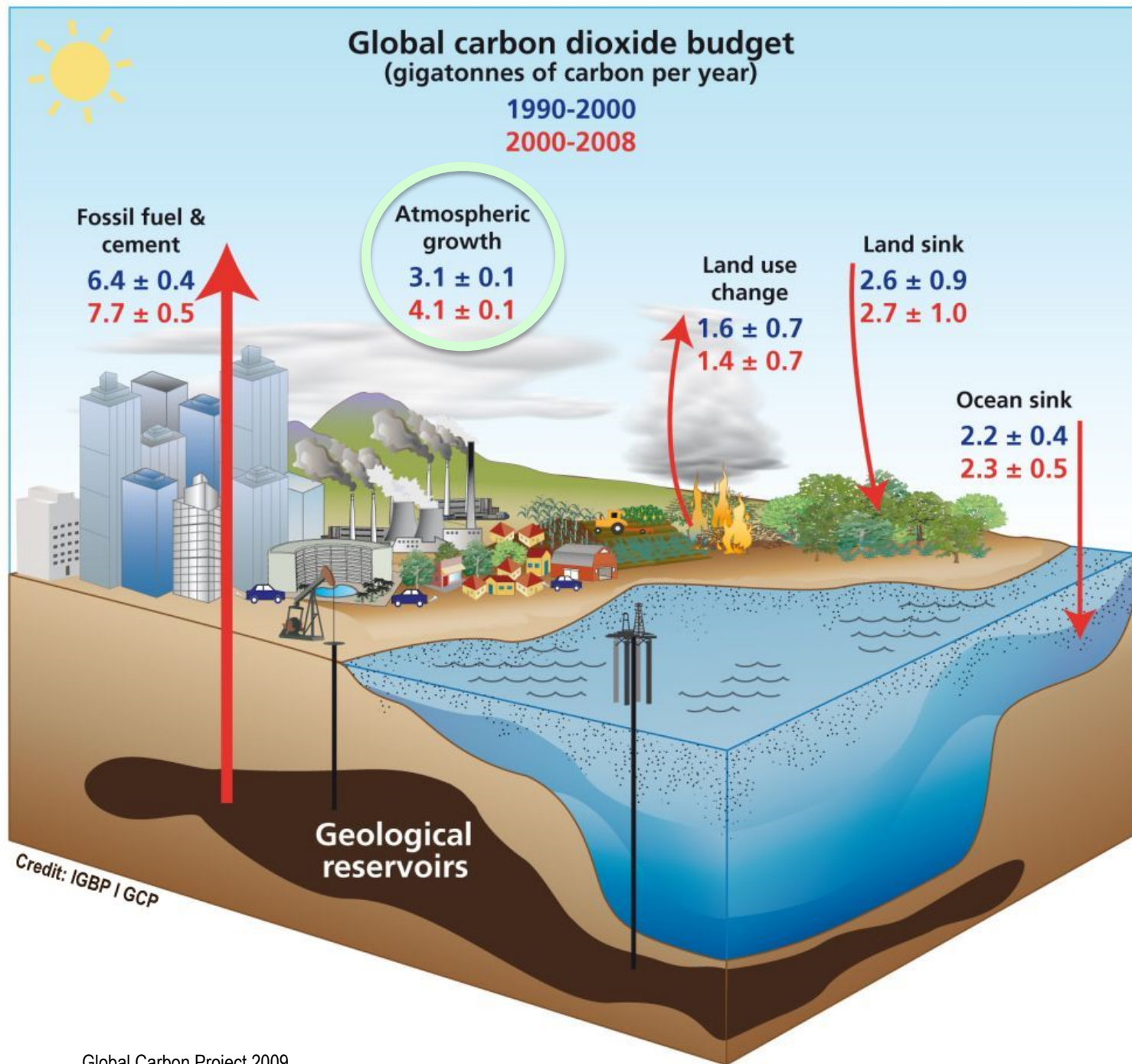


26%

2.3 PgC y<sup>-1</sup>

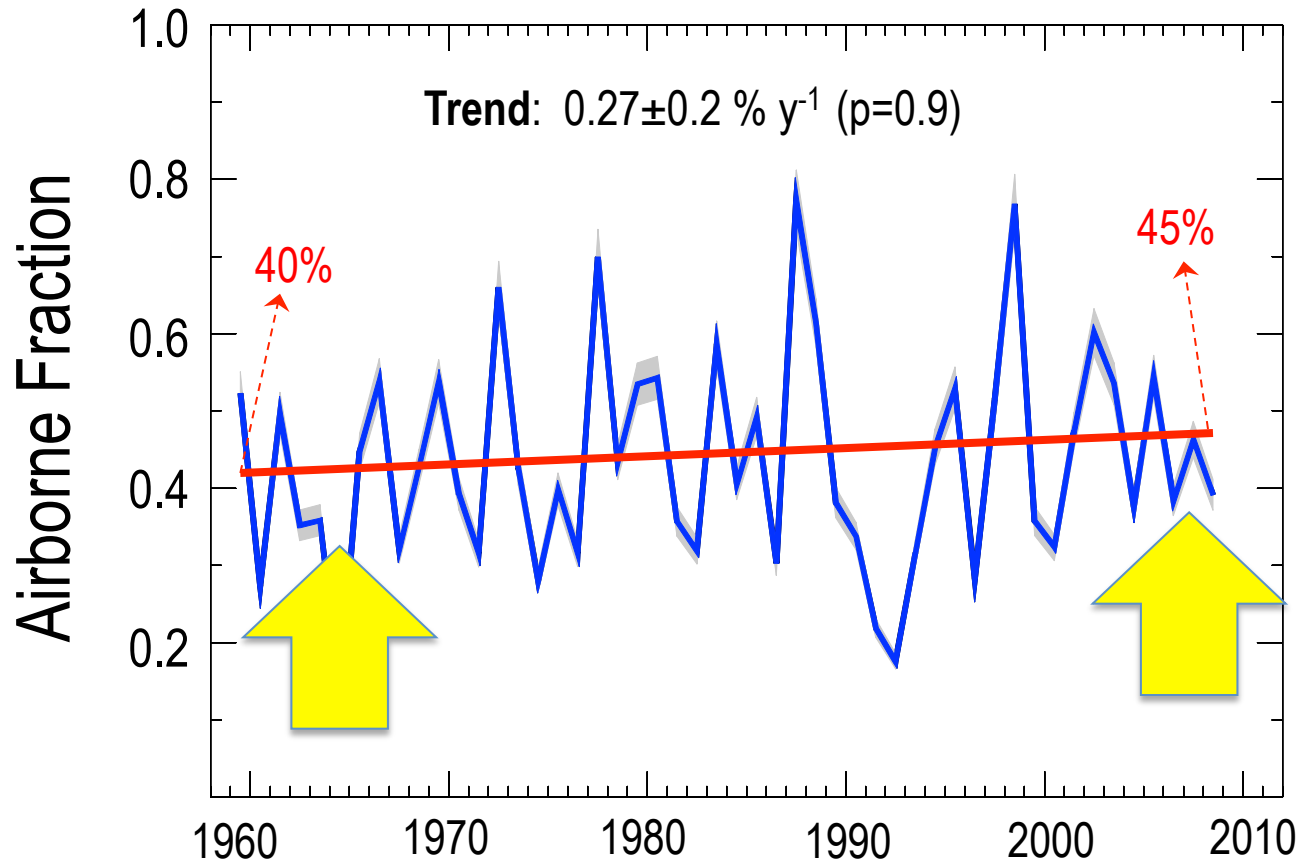


Another way of looking at sources and sinks



# Airborne Fraction

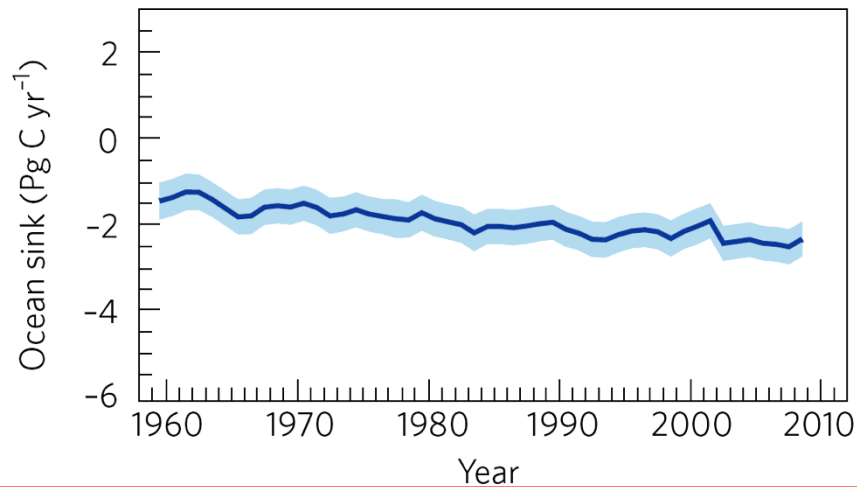
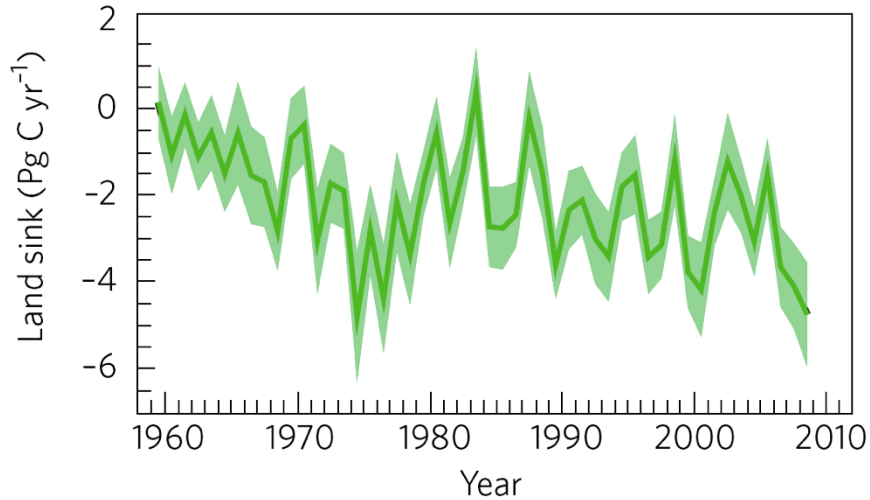
Fraction of total CO<sub>2</sub> emissions that remains in the atmosphere



PROBLEM: as CO<sub>2</sub> output increases, a larger share stays in the air



# Modelled Natural CO<sub>2</sub> Sinks



**'nature' is less able to clean up our waste with each passing year...**

## Summary:

- i. Global greenhouse gasses are increasing
- ii. This increase is at the high end of projections
- iii. 'nature' is less able to absorb the increases
- iv. Environmental impacts are also increasing more quickly than anticipated
  - a. sea-level rises displace biodiversity
  - b. Changing local climates also place a squeeze on nature
  - c. Early migrations, changes in blooming, plant cycles
  - d. Ocean acidification and coral bleaching from temperature increases