The End of Nature

Global Change is More Than Global Warming

CO₂ Concentrations Have Increased
CO₂ Has Increased Primarily from Fossil Fuel Burning

Total World Emissions

Carbon Emissions Per Person
Are current levels of 390 ppmv of CO₂ abnormally high?

True or False?
Under Optimal Conditions
the Growth of Plants May Increase

Conditions Are Not Always Optimal
Which set of bars are plants growing under more optimal conditions?

Plants May Loose Less Water
What is causing the difference shown here?

Effects May Change Over Time And Be Species Specific

Changes in Tissue Composition Could Effect Herbivory
High CO$_2$ Can Speed Flowering & Senescence

Near Ambient CO$_2$

Elevated CO$_2$

Recent Discoveries

The effects may be something to sneeze at!

Production of allergenic pollen by ragweed (Ambrosia artemisiifolia L.) is increased in CO$_2$-enriched atmospheres

Mohan et al. 2006

Assess of Allergy, Asthma & Immunology 2006:8:270-282

Background: The potential effects of global climate change on allergenic pollen production are still poorly understood.

Objectives: To study the direct impact of rising atmospheric CO$_2$ concentrations on ragweed (Ambrosia artemisiifolia L.) pollen production and growth.

Methods: Two independent experimental gardens, each of equal area, were managed to the same degree of soil fertility and equal ambient CO$_2$ levels. One of the gardens was then exposed to an elevated CO$_2$ concentration of approximately 700 ppm. Pollen production and pollen concentration in the pollen shed was measured in both gardens, and pollen production and pollen concentration in the pollen shed were measured in both gardens.

Results: A doubling of the atmospheric CO$_2$ concentration increased ragweed pollen production by 19% (p < 0.0001).

Conclusions: These results suggest that there may be significant increases in exposure to allergenic pollen under the present scenario of global warming. Further studies may enable the development of effective measures for controlling pollination allergies.
And reduce soluble carbonate because ...
Interactive Effects Can Lead to Unexpected Changes

The Greenhouse Effect is Real & Real Important

Concentrations of Greenhouse Gases from 0 to 2005
Current levels of GH gases are abnormally high. What else do we know about global climate change? Many changes over the last century are consistent with an enhanced greenhouse effect.
Strings of warm temperatures are unlikely to be due to chance
From The Best Available Evidence
70% of some glaciers in Glacier National Park have melted.

Sea Level is Rising
Table T4.3. Contributions to sea level rise based upon observations (left column) compared to models used in this assessment (right column). See Section 5.3 and Appendix 13.4 for details. Values are presented for 1990 to 2000 and for the last four decades, including observed trend. (adapted from Tables M.3 and M.5)

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Glacial ice caps</td>
<td>0.08 ± 0.12</td>
<td>0.08 ± 0.12</td>
<td>0.07 ± 0.12</td>
<td>0.07 ± 0.12</td>
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<tr>
<td>Drowned Ice Shelves</td>
<td>0.07 ± 0.03</td>
<td>0.07 ± 0.03</td>
<td>0.07 ± 0.03</td>
<td>0.07 ± 0.03</td>
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<tr>
<td>Antarctic Ice Sheet</td>
<td>0.14 ± 0.01</td>
<td>0.14 ± 0.01</td>
<td>0.21 ± 0.08</td>
<td>0.21 ± 0.08</td>
</tr>
<tr>
<td>Sum of individual climate contributions to sea level rise</td>
<td>0.3 ± 0.1</td>
<td>0.3 ± 0.1</td>
<td>0.5 ± 0.1</td>
<td>0.5 ± 0.1</td>
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<tr>
<td>Difference (Observation - Model)</td>
<td>0.7 ± 0.7</td>
<td>0.7 ± 0.7</td>
<td>0.3 ± 1.0</td>
<td>0.3 ± 1.0</td>
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Note: See Section 5.3.3 for more details.
Total loss possible by 2030 during the summer.

If it becomes warmer earlier and stays warmer longer, how might living things respond?

How do you think the distribution of species will respond to an overall increase in temperature?
“The Natural Cycles of Interdependent Creatures May Fall Out of Sync”

In 7 of 11 studies with sufficient data, the temporal asynchrony increased between interacting species in response to climate warming.  

Montaigne 2004  
National Geographic

9 predator-prey relationships  
2 insect-host plant interactions  

Parmesan 2006

We must rely on computer models to forecast future changes
Lectures 7-10

**Current Models Predict**

![Graph showing global temperature projections](image)

1. GH gases only
2. GH gases + aerosols
3. GH gases + aerosols + changes in solar output

*Figure 3.33: Projected surface temperature changes for the early and late 21st century relative to the period 1991-2000. The central curve represents the A1B2 climate model. The upper and lower projections represent the A1T2 and A2 climate model scenarios, respectively.*
Other Model Predictions

Impacts Could be Severe

Impacts on species

Impacts on humans
  Direct
  Indirect
Impacts on Species

Each 1°C of warming will shift temperature zones ca. 100 miles north or 500 feet in elevation.
- Plants & animals may not be able to migrate fast enough
- Barriers (natural or human) may block migration routes
- There may be no where left for them to go

Polar bears & high elevation species

A 3°C increase could threaten 7-11% of North America’s plant species.

Northern limits of many birds are associated with climate.

Loss of cold-water fish habitat of 1.7-2.3 million acres by 2060.

Loss of Brown Trout Habitat from Doubling of CO₂
Forecast Change in Sugar Maple Importance

Direct Impacts on Humans

What do you think some of the direct impacts on humans may be?
Indirect Effect on Humans

Range & life-cycles of pathogens & vectors which transmit disease are affected by climate.

Climate change should increase the potential transmission of many vector-borne diseases.

Outbreaks of infectious diseases have been associated with specific weather patterns:

- Malaria
- Hantavirus
- St. Louis Encephalitis
Climate change appears to already be a killer.

If half of Greenland and West Antarctica melted

Southern Florida Present Sea Level

Southern Florida 20 Foot Sea-Level Rise

Gore 2006

tenthingsstodo

Want to do something to help stop global warming?
Here are 10 simple things you can do and how much carbon dioxide you’ll save doing them.

- Change a light
  - Replacing one regular light bulb with a compact fluorescent light bulb will save 100 pounds of carbon dioxide a year.
- Drive less
  - Minimize, carpool or take mass transit more often. You’ll save one pound of carbon dioxide for every mile you don’t drive.
- Recycle more
  - You can save 4,400 pounds of carbon dioxide per year by recycling just half of your household waste.
- Check your tires
  - Keeping your tires inflated properly can improve gas mileage by more than 1%. Every gallon of gasoline saved keeps 50 pounds of carbon dioxide out of the atmosphere.
- Use less hot water
  - It takes a lot of energy to heat water. Use less hot water by installing a low flow showerhead (200 pounds of CO2 saved per year) or washing your clothes in cold or warm water (200 pounds saved per year).
- Avoid products with a list of packaging
  - You can save 2,200 pounds of carbon dioxide if you use fewer plastic “grip” bags.
- Adjust your thermostat
  - Lowering the thermostat just 2 degrees in winter and up 2 degrees in summer.
  - You could save about 200 pounds of carbon dioxide a year with this simple adjustment.
- Plant a tree
  - A single oak tree absorbs one ton of carbon dioxide over its lifetime.
- Turn off electronic devices
  - Simply turning off your television, DVD player, phone and computer while you’re not using them will save you thousands of pounds of carbon dioxide a year.
www.time.com/time/specials/2007/environment/