Global Climate Change

GeoSigns, EcoSigns, Time Signs
National Geographic September 2004

We are changing our planet's climate and the evidence is to be found in the geological, biological, and climatological records available for study.

- Carbon Dioxide, Methane, Nitrous Oxide

- Deforestation, etc.
GeoSigns

Glaciers
(disappearing; water and electricity for humans)

Sea Level
(>100 million people live within 3’ mean sea level)
(1” sea level → 8’ beach loss)

Permafrost
(melting and causing subsidence; drunken forests)

Rate of Change
“Some of the ice we have here is already gone from the mountains.”
A Coastline Redrawn

The next collapse of a U.S.-quarantine section of the Larsen Ice Face just over a month in early 2002 will place a large number of walruses as the flooding continues. If the warming is the underlying factor, the increasing trend of ice loss will continue. Scientists are reassessing what effect the further disintegration of the ice sheets and the Antarctic ice shelves might have on the remaining glaciers. Without ice shelves to act as dams, these glaciers might experience faster retreat toward the coast, which may lead to rising sea levels.

Temperature rising

- Warming trends: The concentration of carbon dioxide in the atmosphere helps boost Earth's surface temperature. Both CO₂ and temperature have risen sharply since 1950.
- Over the last 140 years, forests have thickened, and the average amount of CO₂ in the atmosphere has increased by nearly 100 parts per million. This trend has been particularly pronounced in the Northern Hemisphere.

Sea level rising

- Coasts threatened: As ice melts and warmer seawater expands, the oceans will rise. How much depends largely on how much CO₂ and other greenhouse gases we continue to emit. This model projects rises of between 2 feet and a few inches by 2100 in the next century.

- In Bangladesh, at just over 10 feet of rise, 70 million people could be displaced.
- 79 percent of coastal Louisiana wetlands would be destroyed at just over 1.5 feet.
- Many low-lying South Sea islanders are at further risk of flooding at about 4 inches.
Weather turning wild?

Projected weather and climate changes

- Storm warnings
  Higher global temperatures could fuel extreme weather. On the right are computer model projections of the chance that various weather events will be more frequent in a warmer world.

- Higher maximum temperatures and more hot days
- Higher minimum temperatures and fewer cold days
- Higher heat index (heat plus humidity)
- Higher nighttime temperatures
- More drought
- More intense rainfall
- More intense hurricanes

Very likely
Likely

Shorter winters

Lake-ice freeze and breakup dates

- Less ice
  Many lakes are freezing later in the fall and thawing earlier in the spring than in the 19th century.

<table>
<thead>
<tr>
<th>Lake</th>
<th>Year</th>
<th>Days frozen over</th>
</tr>
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<tbody>
<tr>
<td>Mendota</td>
<td>1960</td>
<td>119</td>
</tr>
<tr>
<td>(U.S.)</td>
<td>2004</td>
<td>80</td>
</tr>
<tr>
<td>Kajavesi</td>
<td>1838</td>
<td>178</td>
</tr>
<tr>
<td>(Finland)</td>
<td>1992</td>
<td>167</td>
</tr>
<tr>
<td>Baikal</td>
<td>1873</td>
<td>128</td>
</tr>
<tr>
<td>(Russia)</td>
<td>1992</td>
<td>105</td>
</tr>
</tbody>
</table>
GeoSigns

Hottest Years on Record
1. 1998
2. 2002
3. 2003
4. 2001
5. 1997

Albedo Feedback
(poles changing more rapidly [7-9 F]; 1 F globally)

North Atlantic Thermohaline Circulation
(transfers heat around planet, keeps Europe warm)
EcoSigns

Adelie Penguins, Polar Bears
(ice shelves for nesting and foraging on krill)
(thinner bears b/c feeding season shortened)

Timing of Migration, Reproduction (incl. TSD)

Shifting Ranges
(sky islands, invasives, decoupled food webs)

Anthropogenic Barriers
(restrict movements)

Coral Bleaching
(1998, 16% corals killed or bleached)
Nature changing its habits

Cycles out of sync

- Off schedule
Flycatcher birds that migrate from Africa to the Netherlands to nest still arrive at the same time now as they did two decades ago. But because of warming, moth caterpillars on which nestlings feed emerge two weeks earlier than before. The birds' peak hatching date has shifted too, but not enough. Nestlings now miss peak caterpillar hatching and may go hungry.

- Plants shift
Warming in the mountains of southern Switzerland (thus fewer days of frost) has forced some plants upslope and allowed exotic plant species to invade.

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Coral Necropolis
A bleached coral reef in the Indian Ocean offers poor habitat for parrotfish. Increasingly, the planet’s coral is in hot water, punctuated in periods of el nino events. Most triggers cycle to shed the algae that turn it white in a bleaching event that leaves coral white. Some reefs recover from bleaching while others become bleaching white. In 1998 the world’s coral suffered its worst year on record, which left 46 percent bleached or dead.
**TimeSigns**

Stalagmites, Coral Rings  
(evidence of cave flooding; annual variability)

Tree Rings  
(sophisticated recorders of environmental fluctuations)

Ice Cores  
(data going back >100,000 years)  
(ice cores as conservation tools?)

Sediment Cores  
(mud, pollen)

Pack Rat Middens  
(hoarders, urinaters, climate fluctuation)