

Ozone → Global Climate Change

28 March 2007
30th class meeting

READINGS

Wednesday 28 March:
Global Climate Change; 2 readings:
National Geographic Article, Nature Paper
Friday 30 March:
Swetnam Essay (<http://web.bri.arizona.edu/~swetnam/HCNEssay.htm>)



Lab 28/30 March:
meet in lab,
bring Mt Lemmon data, notes
Creativity Project Progress (02 April)

Environmental Biology (ECOL 206)
University of Arizona, spring 2007

Kevin Bonine, Ph.D.
Anna Tyler, Graduate TA

http://eebweb.arizona.edu/courses/Ecol206/206_Page2007.html

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SNR Special Seminar Information

Thanks to financial support from the Graduate Student and Professional Council, Institute for the Study of Planet Earth, and USGS, we are honored to welcome **Dr. Sharon Collinge** from The University of Colorado at Boulder for a visit to SNR on March 27th and 28th. Dr. Collinge will be giving a talk entitled **Got plague?: Links between landscape change and disease occurrence in western USA grasslands, as part of the School of Natural Resources Seminar Series (Wednesday, March 28th at noon in the Old Chem Bldg (across the quad) room 209)**. Dr. Collinge's current research focuses on the role of landscape spatial heterogeneity in shaping ecological processes, including responses of individual organisms, populations, and communities to spatial variation in landscape structure. More information on Dr. Collinge's lab can be found at <http://www.colorado.edu/eeb/EEBProjects/CollingeLab/index.html>.

A selection of Dr. Collinge's papers can be found by following this link (<http://www.u.arizona.edu/~obrien/research/collinge/collinge.html>).

Tuesday, March 27th

Undergraduate student luncheon, 12:00-1:00 pm, room 218 BSE

Break-out session (professional development and research), 1:15-2:15, room 218 BSE

Wednesday, March 28th

SNR Noon Seminar, 12:00-1:00, Old Chem Bldg room 209

Potluck social, 6:00-9:00 (more information to come)

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Upcoming Seminars

EEB Bioinformatics/Collections Postdoctoral Position

Date: Wednesday, March 28
Time: 12:00 Noon
Room: BSW 210

Adam D. Leache, Ph.D. candidate
Museum of Vertebrate Zoology
University of California, Berkeley

Evolutionary Studies of Phrynosomatid Lizards in the Desert Southwest & Baja California
Adam is a candidate for an EEB Bioinformatics/Collections Postdoctoral position and will be available to meet with faculty and students, Wednesday March 28. Please contact Peter Reinthal (peter@biology.arizona.edu) to set up an appointment. For more information, see Web: <http://ecocritics.berkeley.edu/~leache/> or <http://www.biology.ucberkeley.edu/~leache/>

PERT Program and Dept. of Entomology

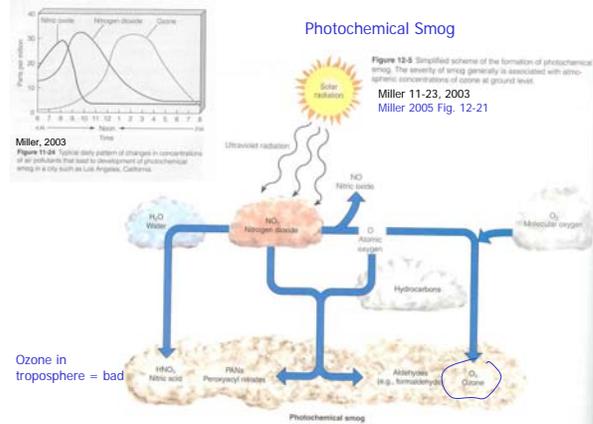
Date: Thursday, March 29
Time: 4:00 pm
Room: Marley, Room 230

Ulrich Mueller

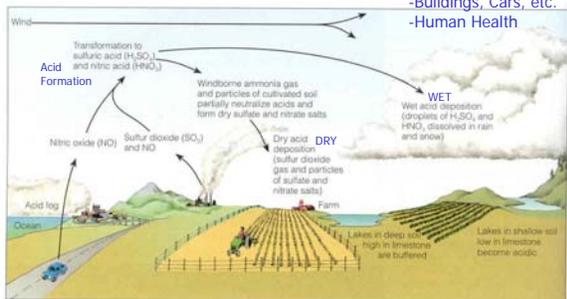
W.M. Wheeler Lost-Pines Professor of Integrative Biology
University of Texas at Austin

Principles of ant-microbe coevolution, symbiont choice, and the engineering of microbial consortia by fungus-growing ants

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Acid Deposition



Miller 11-26, 2003, Miller 2005 Figure 12-22
Figure 12-4 Acid deposition, which consists of rain, snow, dust, or gas with a pH lower than 5.6, is commonly called acid rain. Soils and lakes vary in their ability to buffer or remove excess acidity.

- Soil
- Water
- Fish
- Buildings, Cars, etc.
- Human Health

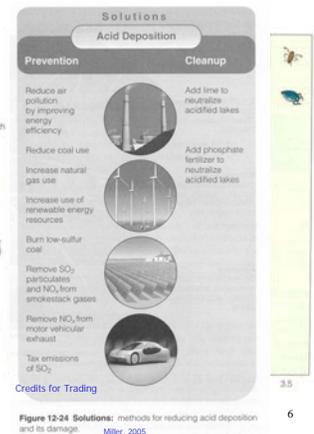


Figure 13-16 Fish and other aquatic organisms vary in their sensitivity to acidity. The figure shows the lowest pH (highest acidity) at which the various species can survive. Note that the greatest effects occur when the pH drops below 5.5.

Figure 12-24 Solutions: methods for reducing acid deposition and its damage. Miller, 2005

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What happens to the solar radiation that reaches the earth?

- 1 billionth solar output
- visible and ultraviolet (UV)
- greenhouse gases (water vapor, CO₂, methane, nitrous oxide, ozone)
- autotrophs/primary productivity

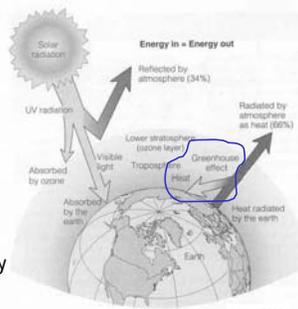


Figure 2-11 The flow of energy to and from the earth. Miller, 2003

Greenhouse Effect

- earth's surface absorbs or reflects
- reflected either into space or absorbed by gases
- greenhouse gases heat up and emit infrared radiation

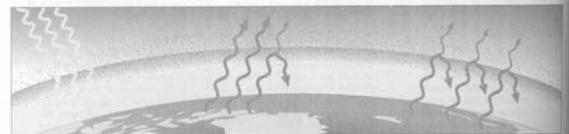


Figure 2-12 The greenhouse effect. Without the atmospheric warming provided by this natural effect, the earth would be a cold and mostly lifeless planet. According to the widely accepted greenhouse theory, when concentrations of greenhouse gases in the atmosphere rise, the average temperature of the troposphere also rises. (Modified by permission from Cecie Starr, *Biology: Concepts and Principles*, 4th ed., Pacific Grove, Calif.: Brooks/Cole, 2000)



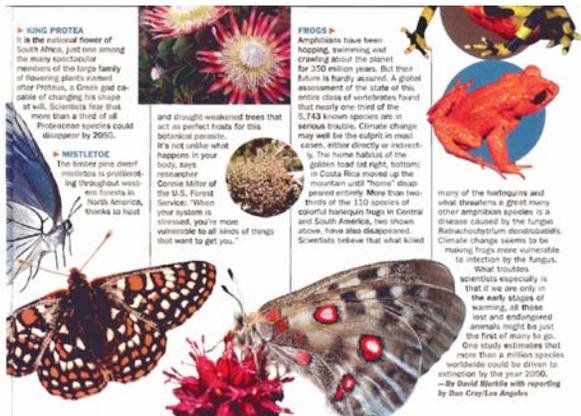
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FEELING THE HEAT

Global warming is already disrupting the biological world, pushing many species to the brink of extinction and turning others into invasive pests. But the worst is yet to come

- QUIVER TREE** This striking desert tree was given its name by the San people of southern Africa, who saw the tree's hollow branches as quivers for their arrows. Scientists have discovered that other trees are starting to die off in parts of their traditional region. The species might be in the early stages of moving southward, trying to escape rising temperatures closer to the equator.
- PIÑON MOUSE** This tiny resident of the southwestern U.S. has long spent its life in juniper woodlands, but in California it is heading for higher, cooler altitudes in the High Sierra conifer forests. The mouse is one of several small mammals in the region that have moved their homes 1,000 to 2,000 ft. higher in elevation over the past century.
- RED-BEASTED GOOSE** Twenty-six bird species, including this goose, which breeds in the Arctic, are listed by the World Conservation Union as "threatened" by global warming. Half are seabirds whose food supplies are diminished because of climate changes. The rest are terrestrial species, including several whose coastal habitats are at risk because of rising sea levels.
- AFRICAN ELEPHANT** Global warming might not only shrink the elephant's range within Africa but may also usurp habitats with the animal's key life. The relative abundance—or scarcity—of food affects the social hierarchy of the herd, which in turn can determine which animals get to breed.
- BUTTERFLIES** Researchers have documented shifts in the ranges of many butterflies. One study looked at 35 species of non-migratory butterflies whose ranges extended from northern Africa to northern Europe. The scientists found that individuals of the species had shifted their home ranges northward by 20 to 150 miles. In the U.S., researchers have closely tracked the movements of the butterfly known as Edith's checkerspot (left). Though butterflies might be sturdier than they look, scientists believe many species will not survive the impact of climate change.



Published 03/24/2008

Global warming's sea-level rise would doom cities, 2 studies say

By Anne Minard

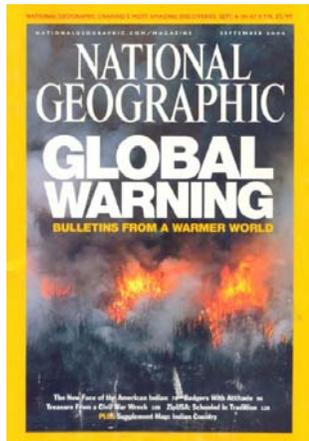
FOR THE ARIZONA DAILY

Climate changes may increase sea levels by more than 10 feet — and entire countries —

That's the finding of a U.S. and his colleagues. The issue of the *Journal of Science* degrees by 2100, heating collapse.

In one of the papers, Bert for Atmospheric Research climate data to determine contributed 7 to 11 feet of ages, about 130,000 years paper, which says conditions century to cause that melt sheet — plus melting and sheet.

*Probably our estimates



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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.

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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



Average temperature increase on the West Antarctic Peninsula since 1950:
 ■ winter: 8.2°F
 ■ annual: 4.5°F

"Some of the ice we have here is already gone from the mountains."

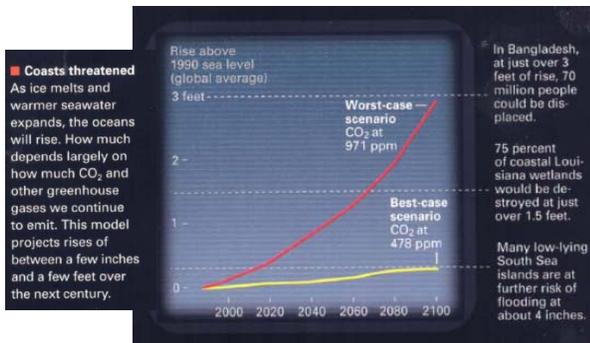
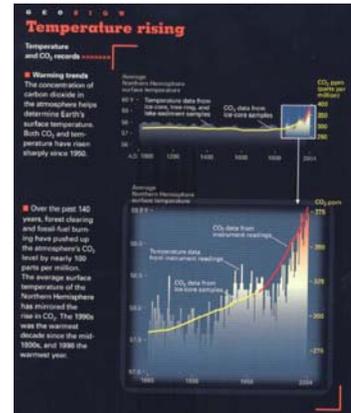
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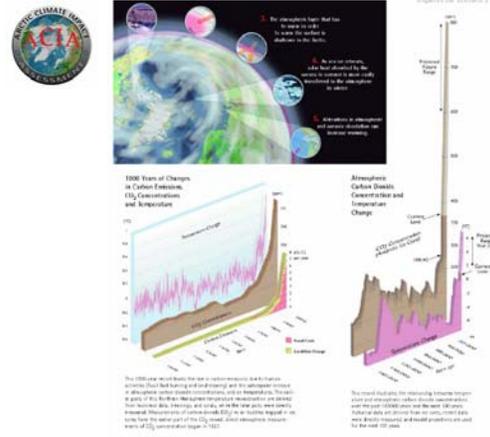
A Coastal Redress
The sea surface at a 1200 square mile section of the Lomonosov Sea Shelf had just over a month to reach 2000. Mud ponds—visible as dark stippling on the floating ice—had begun to break up. Scientists are racing to find out what the further abandonment of Lomonosov and other Arctic sea shelves might have on the sea level's rise. Without ice shelves to act as dams, these glaciers might retreat faster, ultimately contributing to rising sea level.



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Selected Greenhouse Gases

- **Carbon Dioxide (CO₂)**
 - Source: Fossil fuel burning, deforestation
 - ✳ Anthropogenic increase: **30%**
 - ✳ Average atmospheric residence time: **500 years**
- ✳ **Methane (CH₄)**
 - Source: Rice cultivation, cattle & sheep ranching, decay from landfills, mining
 - ✳ Anthropogenic increase: **145%**
 - ✳ Average atmospheric residence time: **7-10 years**
- ✳ **Nitrous oxide (N₂O)**
 - Source: Industry and agriculture (fertilizers)
 - ✳ Anthropogenic increase: **15%**
 - ✳ Average atmospheric residence time: **140-190 years**

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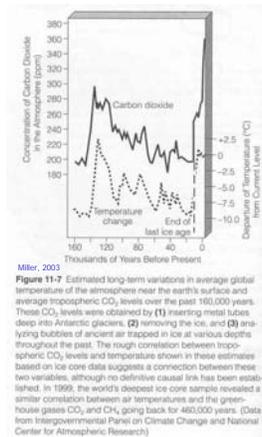
Global Warming

[CO₂] higher than in past 420,000 years

20th Century hottest in last 10

Temperature has increased 0.5 C since 1950

Since 1861, 9 of the 10 warmest years occurred since 1990



GeoSigns (2004)

Hottest Years on Record

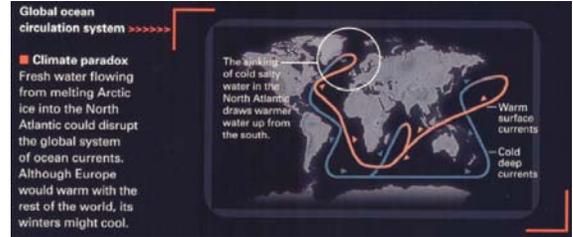
1. 1998
2. 2002
3. 2003
4. 2001
5. 1997

Albedo Feedback

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

North Atlantic Thermohaline Circulation

(transfers heat around planet, keeps Europe warm)



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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)



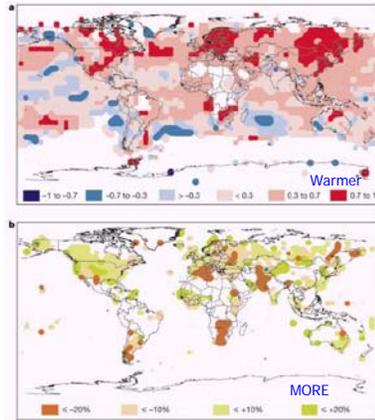
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Degree C per decade

(Spatial heterogeneity)

Percent change in precipitation



Walther et al. 2002, Fig. 1

Walther et al. 2002

Walther et al. 2002, Fig. 3

Ecological Responses to Recent Climate Change

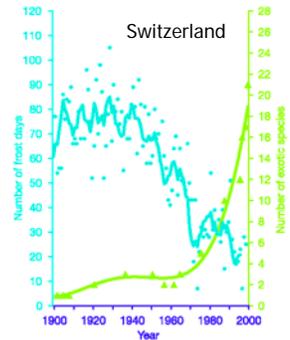
Community Changes

- Plant structure
- animal community
- Bleaching
- Antarctic

Ecosystem Changes

- Recruitment
- Trophic interactions

Synergistic Effects (cod, coral)



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)

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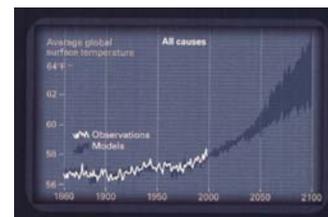


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(rate of change)

Ice caps
Glaciers
Migrations
Floods
Droughts

Figure 11-14 Some possible effects of a warmer atmosphere. Most of these effects could be harmful or beneficial depending on where we live. Current models of the earth's climate cannot make reliable projections about where such effects might take place and how long they might last.



<http://fightglobalwarming.com/index.cfm> (CLICK HERE)

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U.S. wants to bury CO₂ to slow global warming

By Sarah Cohen
Los Angeles Times

GAITHER, Wis. — The government is trying to take some steps at its Super-Dome oil field, but it's not sure if it will do anything to slow the global warming, the carbon dioxide.

The Energy Department wants to fund the government to bury underground oil reserves to slow the global warming, but it's not sure if it will do anything to slow the global warming, the carbon dioxide.



Super-Dome oil field in Gaither, Wis., where the government wants to fund carbon dioxide storage.

The Super-Dome project will store oil that would otherwise be burned. The government wants to fund the project to store oil that would otherwise be burned. The government wants to fund the project to store oil that would otherwise be burned.

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ENVIRONMENT

States Sue Over Global Warming

In a legal gambit aimed at global warming, the attorney general of eight states last week sued the five largest emitters of carbon dioxide in the United States for creating a public nuisance. The states are asking that the electric utility companies cut emissions by 7% each year for a decade. Legal experts predict the states' case will be an uphill battle.

Carbon dioxide litigation is heating up. In 2002, environmental groups sued the Overseas Private Investment Corp. and the Export-Import Bank of the United States for not conducting environmental reviews on the power plants they financed. And last year, Maine, Massachusetts, and Connecticut sued the Environmental Protection Agency for not regulating CO₂ as a pollutant under the Clean Air Act. Now, the states have taken the first legal action directly against CO₂ emitters.

The plaintiffs—California, Connecticut, Iowa, New Jersey, New York, Rhode Island, Vermont, and Wisconsin, along with the

City of New York—claim that the CO₂ that utility companies release contributes to global warming, which will harm state residents. The alleged fits include increased numbers of deaths from heat waves, more asthma from smog, beach erosion, contamination of groundwater from rising sea level, and more drought and floods. "The harm to our states is increasing daily," Eliot Spitzer, the attorney general of New York, states, said at a press conference.

The defendants together own about 610 million tons of CO₂ a year. Their 174 fossil fuel-burning plants contribute roughly 10% of the anthropogenic CO₂ in the United States. The suit maintains that annual cuts of 7% are feasible through making plants more efficient, promoting conservation, and using wind and solar power—without substantially raising electric bills. "All that is now lacking is action," Spitzer said.

That claim hits American Electric Power of Columbus, Ohio, a defendant. Spokenperson Melissa McHenry says that the company had already committed to reducing its emissions by 10% by 2006. "Filing lawsuits is not constructive," she says. "It's a global issue that can't be addressed by a small group of companies."

It will also be a tough suit to win, says Richard Howes of Vermont Law School in South Royalton, who studies the legal issues of air pollution. The fact that global warming is a planetwide phenomenon will make it difficult to establish how much these companies are contributing to the claimed harm. And under public-nuisance law, the plaintiffs must show that their citizens are suffering significantly more than the nation as a whole. "I would be totally amazed if the court gave this a serious response," Howes says. "This makes me imagine that this is more of a symbolic suit."

—Ann Stross