CLIMATE CHANGE RESOURCE GUIDE FOR FACULTY

PORTLAND COMMUNITY COLLEGE
APRIL 2007

PCC SERVICE-LEARNING PROGRAM
& SUSTAINABILITY INITIATIVE

WHAT IS CLIMATE CHANGE?

AND WHAT CAN I TELL MY STUDENTS ABOUT IT?

WHAT IS GLOBAL WARMING?

The Earth's atmosphere helps keep the planet habitable, not only by containing the air we breathe, but also by retaining a certain amount of the sun's radiant energy as heat. Increased levels of greenhouse gases in the atmosphere cause increased retention of solar energy on Earth. This, in turn, raises the average global temperature. Recent years have shown unmistakable signs of abnormal global temperature increase.

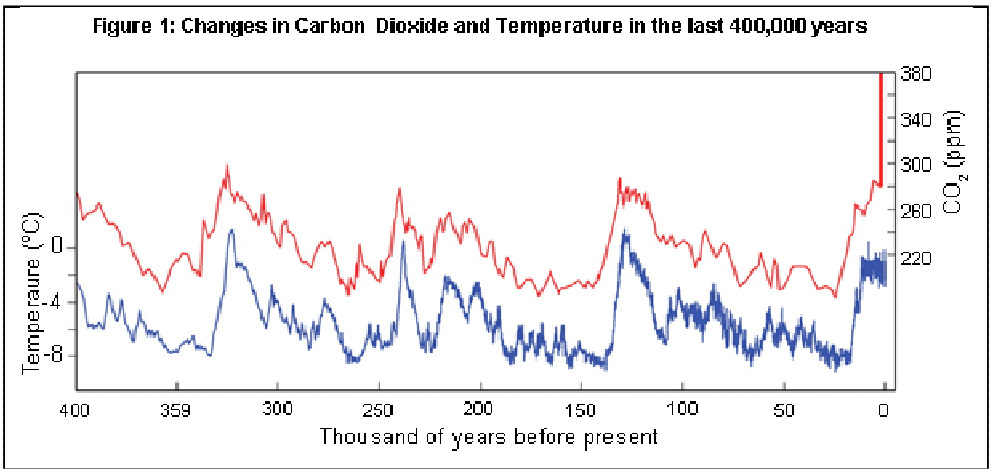


Figure 1: Fluctuations in temperature (blue) and in the atmospheric concentration of carbon dioxide (red) over the past 400,000 years as inferred from Antarctic ice-core records. The vertical red bar is the increase in atmospheric carbon dioxide levels over the past two centuries and before 2006. From A. V. Fedorov et al. Science *312, 1485 (2006).*

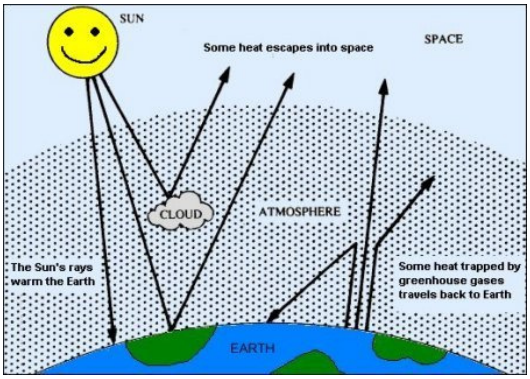


Figure 2: Diagram of the Greenhouse Effect from the Encyclopedia of the Atmospheric Environment http://www.ace.mmu.ac.uk/eae/english.html

THE GREENHOUSE EFFECT

Certain gases in our atmosphere trap heat energy from the sun that ordinarily would reflect off the surface of the Earth and exit into space. These are known as "greenhouse gases." Carbon dioxide, nitrous oxide, and methane are all examples of greenhouse gases. Currently, the Earth is experiencing an "enhanced greenhouse effect," where larger than normal concentrations of greenhouse gases are raising temperatures above global norms.

WHAT DOES THIS MEAN?

The earth is a complex network of biological, meteorological, and geological systems. A shift in one of the many balances in these systems, whether natural or man-made, affects the entire planet. A small increase in global

temperature can change weather and climate patterns, drastically alter ecosystems, and transform the landscape. Some of the changes recently noted by scientists have been:

- Melting of permafrost, glaciers, and polar ice caps.
- Increasing in frequency of "extreme" weather patterns such as floods, hurricanes, and droughts.
- Changing animal habitats causing new threats to already endangered species.
- Ecosystems shifting towards north and south poles.

SIGNS OF CHANGE

Figure 3: The retreat of the South Cascade Glacier, Washington State between 1928 and 2000. Images courtesy of USGS

Humans as well as animals rely on the ecosystem in which they live to be habitable. Changing habitat restrictions, such as mosquitoes being able to live at higher altitudes, have brought new diseases like malaria to regions that were previously unaffected.[1] Also, recent droughts and floods have destroyed homes and crops in areas unused to these weather patterns. Record high temperatures in the past few years have caused many deaths in the American West as well as around the world.

Perhaps one of the most troubling signs of the significant impact of global warming on the planet is the trend of glacier and permafrost melt in the Polar Regions and mountains all over the world. Melting glaciers in mountainous areas means that less water is stored throughout the year at high altitudes. This causes summer droughts in the river valleys historically fed by these glaciers. This is happening even in areas that have seen a recent increase in winter snowfall. If this precipitation is not stored in glacial ice, it leaves the region in spring floods, leaving no extra water to melt during the summer.

These floods, of course, carry water that historically has been stored on the land through rivers to the ocean. Increased ice melt means raised ocean levels around the world. This rise can be very significant. There are large portions of the world under ice at the moment. If this ice melts, as is happening indisputably right now, scientists estimate that sea levels could rise by up to a meter or more in the next century.[2] An increase of a few feet could bring the ocean several miles inland in many areas of the world. In countries like the Netherlands and Bangladesh, these few feet are the difference between existence and total submersion.

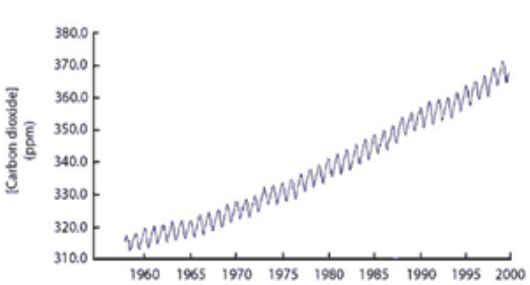
Large amounts of freshwater being dumped into the oceans also have the affect of disrupting oceanic currents. One such current that has been disrupted in the past is the warm-water current that keeps most of Europe temperate despite its northerly latitude.[3] London, for example, is at the same latitude as Calgary, Canada, with a much warmer climate. Geologists and climatologists have shown that the last great ice age in Europe could be attributable to rapid glacial melt in North America. As vast quantities of freshwater entered the oceans, it is believed to have stopped the currents from cycling warm water into the north Atlantic.[4]

A THRESHHOLD

A final troubling fact about Global Warming is that the pace of climate change becomes more rapid as it progresses. In systems theory, "positive feedback" occurs when a perturbation takes place in a system that amplifies changes in that direction. Natural climactic responses to Global Warming tend to perpetuate the cycle of warming. For example, as more light-reflecting ice turns into water, more solar heat is absorbed by darker-colored oceans, leading to greater evaporation and increased water vapor in the atmosphere. Although clouds are capable of providing some reflective cover, water vapor is in fact a more effective greenhouse gas than carbon dioxide. Additionally, both the seas and the land serve as "carbon sinks" trapping greenhouse gases like carbon dioxide and methane and storing them at cold temperatures (in deep water, arctic permafrost). When confronted by higher temperatures, these areas begin releasing the greenhouse gases they once stored.[5] In Alaska, this process is happening as unusually high temperatures melt the permafrost, turning tundra into bogs and marshes.[6] In short, the longer we do nothing to curb greenhouse gas emissions, the harder it becomes to stop this self-perpetuating cycle.

BUT COULDN'T GLOBAL WARMING BE PART OF A NATURAL CYCLE?

It is very unlikely. The earth does indeed follow cycles of heating and cooling, and these cycles mirror increases and decreases in atmospheric carbon levels. However, scientists suggest that we are entering an era unparalleled in recorded geologic history in terms of carbon levels in the atmosphere. These same scientists also agree that these increased levels of carbon can only be attributable to mankind and that increased atmospheric carbon means higher global temperatures.[7] We can predict some, but not all of the repercussions that this will have for humans. The Earth constantly undergoes cyclic changes in order to maintain a balance among living things and the nonliving resources they consume. However, we don't know what will happen to the Earth's balance when pressures such as the ones our society is creating are applied to it. We do know, however, that we will have to adapt with it: either to less carbon production, or to a drastically altered climate. We are not destroying the Earth, as some claim. Rather, we are rendering it less livable to ourselves.



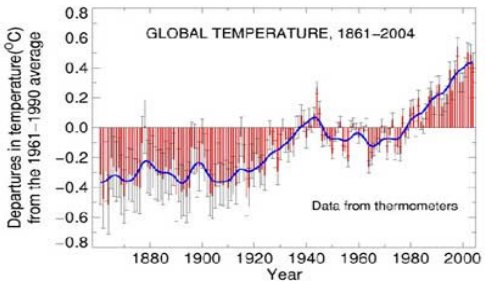


Figure 4: the concentration of carbon dioxide measured at Mauna Loa Observatory in Hawaii and Figure 5: Average Global temperature since 1861. http://www.metoffice.gov.uk/education/higher/climate_change.html

OTHER KEY TERMS AND CONCEPTS RELATED TO GLOBAL WARMING

PEAK OIL

> *"The term "peak oil" refers to the idea that the rate of global oil production is near or past its peak and will soon begin a long-term decline… Oil is a finite, non-renewable resource. As a limited resource, it is inevitable that the ability to extract it will eventually peak and begin to decline. The only question is when... Some experts believe the peak is imminent or has already happened. Others believe it will occur in the next 10 to 15 years. The most optimistic opinions place the peak around 2030 to 2040."*[8]
>
> *PCC has a Peak Oil Education Task Force: http://pccpoet.radnoesis.info/*

SUSTAINABLE DEVELOPMENT

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*[9] *It recognizes the needs of humans and societies to use resources and inhabit the planet, but posits that we can do so without destroying our own environment.*

WHERE CAN I GET MORE INFORMATION?

GUIDES AND OTHER CLASSROOM RESOURCES

Classroom viewing guide for *An Inconvenient Truth:* http://www.toddalbert.com/files/AIT_guide.pdf

Sustainable Education Handbook (designed primarily for K-12 but highly recommended): http://www.urbanoptions.org/SustainEdHandbook/CustomizeYourCurriculum.htm

A Wealth of Climate Change Education Resources: http://www.climatechangeeducation.org/educators.html

Association for the Advancement of Sustainability in Higher Education. Includes links to sample syllabi and other resources by discipline. (Note: PCC is a member, simply register your PCC email to access members only information): http://www.aashe.org/

Marion Koshland Science Museum teaching activities: http://www.koshland-science-museum.org/teachers/postvisit.jsp

Lesson Plan by Debra Rowe from Oakland Community College teaching sustainability can be found by searching her name here: http://www.eduref.org/Virtual/Lessons/index.shtml

Module for teaching about Hydrogen Fuel Cells: http://www1.eere.energy.gov/hydrogenandfuelcells/tech_validation/h2_manual.html

Second Nature: Education for Sustainability: http://www.secondnature.org/index.htm

Resources for Teaching Energy Service Technology: http://www.ateec.org/energy/

For students and others who want to spearhead change at the campus level: http://climatechallenge.org/

USEFUL WEBSITES

An Inconvenient Truth website: http://www.climatecrisis.net/

Climate Scientists discuss Global Warming: http://www.realclimate.org/

Information on how you can take action and why: http://www.stopglobalwarming.org/

The Intergovernmental Panel on Climate Change: http://www.ipcc.ch/ and the UN Framework Convention on Climate Change: http://unfccc.int/2860.php

FAQs on Global Warming from the National Oceanic and Atmospheric Administration: http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html#Q8

Useful dictionary of environmental terms: http://www.ace.mmu.ac.uk/eae/english.html

History of climate change science: http://www.aip.org/history/climate/summary.htm

How do we get temperature data for hundreds of thousands of years ago? http://www.pbs.org/wgbh/warming/stories/

Photographs by Portland artist suggesting evidence of Global Warming: http://www.worldviewofglobalwarming.org/ Similar photographic records: http://www.canary-project.org/

Pacific Northwest specific Global Warming information: http://www.climatesolutions.org/pubs/inHotWater.html

RESOURCES AT PORTLAND COMMUNITY COLLEGE?

Visit PCC's Sustainability website for more ways to get involved on campus, and for additional resources: http://www.pcc.edu/sustainability/

Each of PCC's main campuses has a Green Team to improve recycling systems, build awareness about transportation alternatives, and strengthen the network of people concerned about PCC's ecological footprint. Contacts:

- Cascade: Rosie Sweetman rosie.sweetman@pcc.edu, Jan Underwood jan.underwood@pcc.edu
- Sylvania: Alliyah Mirza alliyah.mirza@pcc.edu
- Rock Creek: Yvonne Norman yvonne.norman@pcc.edu

USEFUL BOOKS

Global climate change / edited by Paul McCaffrey. 363.73874 G562 2006
Global warming ; opposing viewpoints / James Haley, book editor. 363.73874 G562 2002
The Greenhouse effect / edited by Matthew A. Kraljic. 363.7387 G813
Global warming : personal solutions for a healthy planet / Christopher Spence. 363.738748 S744g 2005
Is the temperature rising? : the uncertain science of global warming / S. George Philander. 551.52 P544i 1998
Climate affairs : a primer/ Michael H. Glantz. 551.6 G545c 2003
Cartoon Guide to the Environment / Larry Gonick and Alice Outwater 363.7 G66 1996

Works Cited:

---

[1] Christianson, Gale. 1999. *Greenhouse.* New York. Walker and Company. pp 240.
[2] http://www.grida.no/climate/vital/24.htm. Higher estimates based on the Antarctic shelf melting place sea level increase at 4-6 meters (12-18 ft.) Bindschadler, Robert. 1998. Future of the West Antarctic Ice Sheet. *Science* 282, 428-429.
[3] http://www.realclimate.org/index.php/archives/2005/10/saltier-or-not/
[4] This study is still under debate. http://science.nasa.gov/headlines/y2004/05mar_arctic.htm
[5] Christianson, 217-8.
[6] Egan, Timothy. "The Race to Alaska Before it Melts." *The New York Times* June 26, 2005.
[7] http://www.nasa.gov/worldbook/global_warming_worldbook.html
[8] City of Portland Office of Sustainable Development. 2006. *Peak Oil Task Force Briefing Book.* Available at http://www.portlandonline.com.
[9] Brundtland, Gro, ed. 1987. *Our Common Future.* New York. Oxford University Press and World Commission on Environment and Development. pp 43.