GEOG – ENVIR ST – ATMOS OCN

331: CLIMATIC ENVIRONMENTS OF THE PAST

FALL 2006

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Office Hours: Mon 3:30pm-5pm,
Thurs 11am – 12pm
or by appointment

Lectures: 444 Science Hall, Tuesday/Thursday 9:30 – 10:45 am
URL: www.geography.wisc.edu/classes/geog331/Geog331.html

INTRODUCTION

This class focuses upon climatic changes during the Quaternary Period, which encompasses the last 1.6 million years, includes the rise of human civilizations, and extends to the present day. Climatically, the defining characteristics of the Quaternary are 1) regular cycles between glacial and interglacial periods and 2) abrupt shifts in the state of the climate system. Understanding the sources and causes of past climatic variability is a necessary precondition to making informed projections of future climate changes and impacts. The field is changing rapidly and new discoveries appear every week. The goals for this class are fourfold:

1) **History**: Review the major climatic events and trends during the Quaternary, spanning timescales from the last 1,000,000 years to the last 1,000 years. An emphasis will be placed on the global climate system, with some attention to regional climate changes.
2) **Mechanism**: Understand the physical processes controlling the behavior of the earth system and its components (atmosphere, oceans, cryosphere, biosphere, etc.). Understand also how climatic variability results from a combination of external forcings and internal dynamics within the earth system.
3) **Method**: Learn how paleoclimatologists collect, date, and analyze a staggering variety of paleoclimatic records, including ocean and lake sediment cores, ice cores, tree rings, corals, and speleothems. Learn how to analyze and critically evaluate climate model experiments.
4) **Communication**: Continue to develop skills in thinking and writing clearly, with particular attention to critically reading the scientific literature.

COURSE POLICIES

GRADING

Homework	20%
Term Project	30%
Exam I	25%
Exam II	25%

Readings and Homeworks

Readings are drawn from the course textbook Earth's Climate: Past and Future and from supplementary articles, available on reserve at the Geography Library or on-line through Learn@UW.

The homework exercises are designed to give hands-on experience analyzing paleoclimatic datasets, conducting experiments with models of the earth system, reading the scientific literature, and writing. Homework assignments should be turned in class on the due date. Overdue assignments will be penalized by 10% per day after the due date. Please contact me if any emergencies arise – but note that I get to decide what constitutes an emergency.

Examinations

There will be two non-cumulative exams during the semester. The exams will mostly be problem-solving or short essay.

Term Project

This project gives you the opportunity to learn more about the workings of general climate models (GCMs) and how climatologists use them to test hypotheses about the mechanisms governing past and potential future climates. We will use a model called EdGCM, specifically designed for educational applications. EdGCM is based on a NASA climate model called GISS (for the Goddard Institute of Space Science). NASA-GISS was developed in the 1980's, and became famous because it was used to provide some of the earliest quantitative estimates of 20^{th}-and 21^{st}-century global warming. EdGCM's 'guts' are identical to this version of NASA-GISS but extensive visualization and analysis tools have been added. Personal computers are powerful enough now that runs that once required weeks of supercomputer time now can be completed in a day on a desktop PC or Mac.

You will first learn how to use EdGCM and how to design climate model experiments through several homework exercises. Then, working in teams of 2-3 students, you will design your own experiment, run EdGCM, prepare visualizations of key results, and present your work to the rest of the class in an in-class poster session near the end of the semester. More details on the term project will be made available early in the semester.

RESOURCES

TEXTBOOKS

Earth's Climate: Past and Future by William F. Ruddiman. W. H. Freeman and Company, New York, 2001. (**Required**)

Paleoclimatology: Reconstructing Climates of the Quaternary by Raymond S. Bradley. Academic Press, San Diego, 1999. (**Optional**, available on reserve)

OTHER GOOD BOOKS

After the Ice Age: The Return of Life to Glaciated North America by E. C. Pielou, University of Chicago Press, Chicago, 1991.

Climate Modeling Primer (2nd ed.), by Kendal McGuffie and A. Henderson-Sellers. John Wiley and Sons, 1997

The Discovery of Global Warming by Spencer R. Weart, Harvard University Press, Cambridge, 2003.

Global Climates since the Last Glacial Maximum by Herbert E. Wright, Jr. et al. University of Minnesota Press, Minneapolis, 1993.

Ice Ages: Solving the Mystery by John Imbrie and Katherine P. Imbrie. MacMillan, London, 1979.

Principles of Paleoclimatology by Thomas M. Cronin. Columbia University Press, New York, 1999.

The Quaternary Period in the United States by A. R. Gillespie et al. Elsevier Science Ltd, Amsterdam, 2004.

The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change and Our Future by Richard B. Alley. Princeton University Press, Princeton, 2000.

Field Notes from a Catastrophe by E. Kolbert. Bloomsbury Press, 2006.

JOURNALS

Nature; Science; Geology; Quaternary Science Reviews; Quaternary Research; the Holocene; Palaeogeography, Palaeoclimatology, Palaeoecology; Global and Planetary Change…

Geography 331 Schedule, Fall 2006

Week	Date	#	Topic	Readings
1	9/5	1	Introduction, The Earth System	ECPAR CH 1
	9/7	2	Atmosphere - Radiation	ECPAF CH 2
2	9/12	3	Atmosphere - Dynamics	ECPAF CH 2
	9/14	4	Oceans	ECPAF CH 2
3	9/19	5	GCMs	Kolbert pp. TBA. Optional: Hansen et al. 1983
	9/21	6	EdGCM Tutorial	
4	9/26	7	Dating - Radiometric	ECPAF CH 3, Bradley 3.1-3.2.1, 3.2.3, 3.2.4
	9/28	8	Dating - Other	ECPAF CH 3, Bradley 4.1, 4.2.3, 4.3.2
5	10/3	9	Sedimentary Archives	Bradley 6.1-6.4.0, 6.6, 6.7
	10/5	10	Stable Isotopes	ECPAF CH 3
6	10/10	11	Biological Climate Proxies	ECPAF CH 3, Bradley 9.1-9.6, Webb 1993
	10/12	12	Ice Sheets, Ice Cores	Two Mile Time Machine, pp. 31-75
7	10/17	13	**Exam I**	
	10/19	14	Entering the Icehouse: The last 55 million years	ECPAR CH 7
8	10/24	15	Astronomical Controls on Climate	ECPAF CH 8
	10/26	16	Detecting Astronomical Controls in Climate Records	ECPAF CH 8, **EdGCM Proposal Due**
9	10/31	17	Insolation Control of Ice Sheets	ECPAF CH 10
	11/2	18	Insolation Control of Monsoons	ECPAF CH 9
10	11/7	19	CO2, CH4 and the Glacial-Interglacial Carbon Cycle	ECPAF CH 11, 12
	11/9	20	CO2, CH4 and the Glacial-Interglacial Carbon Cycle	ECPAF CH 11, 12
11	11/14	21	Millennial Oscillations	ECPAF CH 15
	11/16	22	The Last Glacial Maximum	ECPAF CH 13, COHMAP 1988
12	11/21	23	Deglaciation and the Holocene	ECPAF CH 14, 16
	11/23	24	*Thanksgiving*	
13	11/28	25	Welcome to the Anthropocene	ECPAF CH 17, Ruddiman 2005
	11/30	26	Historical Climate Change	ECPAF CH 16
14	12/5	27	**In-Class Poster Session**	
	12/7	28	Historical Climate Change	Mann et al. 1999, Hockey Stick Packet
15	12/12	29	20th-Century Climate Change	ECPAF CH 18, Kolbert articles (4)
	12/14	30	**Exam II**	