GEOG – ENVIR ST – ATMOS OCN

331: CLIMATIC ENVIRONMENTS OF THE PAST

FALL 2008

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Office Hours: Tues 1:30-3:30pm,
Thurs 11am-noon
or by appointment

Lectures: 350 Science Hall, Tuesday/Thursday 9:30 – 10:45 am
URL: www.geography.wisc.edu/classes/geog331/

INTRODUCTION

This class focuses upon climatic changes during the Quaternary Period, which encompasses the last 1.8 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 (ECPAF) and from supplementary articles, available 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 at 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 decide what constitutes an emergency.

Examinations

Two non-cumulative exams, with mostly short-answer or problem-solving questions.

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 given early in the semester.

Missed Lectures

If you miss a lecture, and would like to learn about what you missed, either visit me during office hours or talk to a classmate. I will not respond to email queries about missed lecture content. All lecture slides will be available at Learn@UW.

RESOURCES

TEXTBOOKS

Earth's Climate: Past and Future (ECPAF), 2nd Edition by William F. Ruddiman. W. H. Freeman and Company, New York, 2008. (**Required**) Note: you may also use the first-edition version of ECPAF. The two editions are similar, except that Chapter 2 from the first edition was deleted from ECPAF (and moved online) and the chapters in Part V were reorganized and augmented. Chapters 2-14 in the second edition are directly equivalent to Chapters 3-15 in the first edition.

Paleoclimatology: Reconstructing Climates of the Quaternary by Raymond S. Bradley. Academic Press, San Diego, 1999. (**Optional**, available on reserve. Selected readings are available on-line at Learn@UW.)

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.

JOURNALS

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

ON-LINE RESOURCES

www.geography.wisc.edu/classes/geog331/ -- public website for course. Includes a copy of syllabus, a brief description of course, and links to Learn@UW and other external websites of interest.

https://learnuw.wisc.edu/ -- password-protected website that I use to post lecture slides and course-related announcements. Please make a habit of checking this website at least once a week.

www.whfreeman.com/ruddiman2e -- Publisher's website accompanying the Ruddiman textbook. It includes the Chapter 2 excised from the first edition, found at: http://bcs.whfreeman.com/ruddiman2e/content/cat_010/EarthsClimate_Web_Chapter.pdf

Geography 331 Schedule, Fall 2008

Week	Date	#	Topic	Readings	HWs and Due Dates
1	9/2	1	Introduction, The Earth System	ECPAF CH 1	
	9/4	2	Review: Earth System Processes	ECPAF1 CH 2 (1st Edition)*	Hand out Daisyworld HW
2	9/9	3	Review: Earth System Processes	ECPAF1 CH 2 (1st Edition)*	
	9/11	4	Dating - Radiometric	ECPAF CH 2, *Optional: Bradley 3.1-3.2.1, 3.2.3, 3.2.4*	Daisyworld HW Due. Hand out CALIB HW.
3	9/16	5	Dating - Other	ECPAF CH 2, *Optional: Bradley 4.1, 4.2.3, 4.3.2*	
	9/18	6	GCMs	Kolbert, Field Notes from a Catastrophe pp. 97-110. *Optional: Hansen et al. 1983*	CALIB HW due.
4	9/23	7	EdGCM/EVA Workshop		Hand out EdGCM HW1.
	9/25	8	EdGCM/EVA Workshop		
5	9/30	9	Sedimentary Archives	Bradley 6.1-6.4.0, 6.6, 6.7	EdGCM HW1 Due. Hand out HW2. **Choose a Partner**
	10/2	10	Biological Climate Proxies	ECPAF CH 2, Bradley 9.1-9.6, Webb 1993	
6	10/7	11	Stable Isotopes	ECPAF CH 2	EdGCM HW2 Due. **Choose a Project**
	10/9	12	Ice Sheets, Ice Cores	Alley, *Two Mile Time Machine*, pp. 31-75	
7	10/14	13	**Exam I**		
	10/16	14	Entering the Ice House: The Last 55 million years	ECPAF CH 4, 6	
8	10/21	15	Astronomical Controls on Climate	ECPAF CH 7	
	10/23	16	Detecting Astronomical Controls in Climate	ECPAF CH 7	
9	10/28	17	Insolation Control of Ice Sheets and the Mystery of the 100kyr Cycle	ECPAF CH 9, Raymo & Huybers 2008	**Term Project: Initial Results**
	10/30	18	CO2 and the Glac.-Interglacial Carbon Cycle	ECPAF CH 10,11	
10	11/4	19	CO2 and the Glac-Interglacial Carbon Cycle	ECPAF CH 10,11	
	11/6	20	Insolation Control of Monsoons	ECPAF CH 8	
11	11/11	21	Millennial Oscillations	ECPAF CH 14	
	11/13	22	The Last Glacial Maximum	ECPAF CH 12, COHMAP 1988, Toggweiler & Russell 2008	
12	11/18	23	The Last Deglaciation	ECPAF CH 13	
	11/20	24	*Thanksgiving*		
13	11/25	25	The Holocene	ECPAF CH 13	
	11/27	26	**In-Class Presentations**		**Presentations**
14	12/2	27	Climate Changes During the Last 1000 years	ECPAF CH 16	
	12/4	28	Climate Changes During the Last 1000 years	Mann et al. 1999, Hockey Stick Packet, NAS 2006 Exec. Summary	**Term Papers due**
15	12/9	29	Welcome to the Anthropocene	ECPAF CH 15, Ruddiman 2005	
	12/11	30	20th-Century Climate Change	ECPAF CH 17,18, Kolbert 'Climates and Man (I, II, III)'	
	12/14		**Exam II**	12:25pm-2:25pm, room TBA	

*Chapter 2 in the 1st ed. provides an overview of the climate system. It was cut from the printed version of the 2nd ed. but is available at http://bcs.whfreeman.com/ruddiman2e/content/cat_010/EarthsClimate_Web_Chapter.pdf