Quaternary Climate
GEOL 459/559 WI 2012

http://web.pdx.edu/~chulbe/COURSES/QCLIM

lecture: Tuesday 8:00 to 9:50 am CH S17
lab: Thursday 8:00 to 9:50 am CH 1
final: Thursday 22 March 8:00 to 9:50 am CH S17

prerequisite: upper-division standing in a physical or natural science curriculum
text: *Quaternary Environments* Williams and others (Oxford University Press)

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office hours: M 11:00 to 13:00 and Tu 11:00 to 13:00 pm (or by appointment)

1 overview

Study of the causes and consequences of changes in Earth's climate through the Quaternary (the last 2 million years). Following from an overview of climate system dynamics, we will use the the geologic record of Quaternary climate and its profound glacial to interglacial cycles to develop conceptual models of paleoclimate interactions among land, ocean, atmosphere, and biosphere. Time permitting, we will also consider how geologic changes during the Cenozoic (the last 65 million years) set the stage for the Quaternary. The course includes computer laboratory exercises using modern and paleoclimate data sets and a term project involving paleoclimate data analysis.

The textbook for this class is out of print. It is on reserve at Millar Library and I own several copies. You are encouraged to borrow one of my copies for reading or photcopying in the Geology department office.

If you are a student with a documented disability and registered with the Disability Resource Center, please contact me so that we can arrange whatever academic accommodations you need.

2 key topics

- climate system basics
  change through the Cenozoic (prelude to the Quaternary)
  atmosphere and ocean circulation
  orbital cycles and solar radiation
- geologic record of Quaternary climate
  stratigraphic records: sea-floor sediments, ice cores
  other terrestrial records: stratigraphic, geomorphic, more

- system interactions
  carbon cycle
  ocean-ice-atmosphere connections
  the tropics

3 the data

3.1 lab exercises

This class will devote a significant amount of time to computer laboratory work, including both assigned lab exercises and in a term project of your own design. We will use the Matlab programming environment for the lab exercises and in each case you will be guided in how to use the software (you will not be required to write your own programs). Basic familiarity with Matlab is helpful, but not necessary. Due dates for lab assignments will be announced in class.

3.2 term project

The variety, resolution, and accuracy of paleoclimate proxy records are increasing rapidly. In step with this data revolution, U.S. federal funding agencies now require scientists to make the data publicly available once a research project is complete. During the course of the term, you are asked to study a paleoclimate proxy record (for example, pollen in a lake, sea level, or foraminfera assemblages in sea floor sediments) for a geographic location that interests you. Undergraduate students should choose one record at one location. Graduate students are asked to choose at least two different records. They may be different proxies for the same location or the same type of proxy at two or more locations. The record(s) may cover any part of the Quaternary but keep in mind that longer and higher resolution signals are more easily studied than shorter, coarser signals. The data set(s) should be identified by 26 January.

Your goals are:

1. identify and describe changes or cycles in the record and what they indicate about regional climate (for example, changes in the dust concentration in mid-Atlantic sea floor sediments indicate changes in north African aridity),
2. develop a hypothesis that places those changes in a global climate context (for example, does north African aridity keep pace with northern hemisphere ice volume, and if so, why?), and
3. write a short paper that addresses the above two goals.

The report should contain figures that display the data and illustrate your hypothesis. You are encouraged to read and reference any scientific literature that is useful to your study but the hypothesis should be based on your own analysis of the data.

4 the literature

As in most fields of study, our understanding of paleoclimate is always improving and the literature relevant to the topic is always growing. Over the course of the term, you will be asked to read several papers relevant to the lecture material (see the schedule below) in addition to materials in the textbook. You are not required to prove that you have read these papers but your experience in this class will be much richer if you do than if you don't. Please ask questions about these readings in class. If you need help figuring out how to read journal articles, please ask.

5 evaluation

data exercises 35%
midterm 20%
final 15%
term project 30%

6 schedule

week	*topics*	*reading*	*other events*
1/10,12	Earth's climate: the Cenozoic; atmosphere & ocean	Zachos et al, 2001, *Science* *QE:* Ch 12 p 244 to 247; Ch 7 p 127 to 132	lab: Matlab introduction & the atmosphere
1/17, 19	Earth's climate: atmosphere & ocean; modes of variability	Rahmstorf, 2006, *EQS*	lab: the atmosphere
1/24, 26	Earth's climate: orbital cycles	*QE:* Ch 5	lab: the world ocean
1/31; 2/2	geologic record of climate: methods	*QE:* Ch 7 p 132 to 141; Ch 10 p 185 to 199	lab: the world ocean project: identify data set by 2/7
2/ 7, 9	geologic record of climate: methods and data	*QE:* Ch 9; Ch 10 p 215 to 225	midterm on 2/9
2/14, 16	geologic record of climate: data	*QE:* Ch 6; Raymo and Huybers, 2008, *Nature*	lab: paleoclimate time series
2/21, 23	Quaternary cycles: forcings & feedbacks	*QE:* Ch 4; Rahmstorf, 2002, *Nature*	lab: paleoclimate time series
2/28; 3/1	Quaternary cycles: forcings & feedbacks	Sigman, 2010, *Nature*	lab: projects
3/6, 8	Quaternary cycles: low latitude processes	Ravelo, 2004, *Nature*	lab: projects
3/13,15	Pliocene: climate transition		

7 references

Complete references for papers identified in the class schedule.

Rahmstorf, S. 2002, Ocean circulation and climate during the past 120,000 years, *Nature*, 419, 207-214.

Rahmstorf, S., 2006, Thermohaline Ocean Circulation, In: Encyclopedia of Quaternary Sciences, Edited by S. A. Elias, Elsevier, Amsterdam.

Ravelo, A.C. and 4 others, 2004, Regional climate shifts caused by gradual global cooling in the Pliocene epoch, *Nature*, 429, 263-267.

Raymo, M. and P. Huybers, 2008, Unlocking the mysteries of the ice ages, *Nature*, 451, 284-285.

Sigman, D.M., M.P. Hain and G.H. Haug, 2010, The polar ocean and glacial cycles in atmospheric CO_2 concentration, *Nature*, 466, 47-55.

Zachos, J., M. Pagani, L. Sloan, E. Thomas, K. Billups, 2001, Trends, rhythms, and aberrations in global climate 65 Ma to present, *Science*, 292, 686-693.

8 a story

Once upon a time, a student in this course decided it was appropriate to sit at his computer and work on a project while one of his peers was presenting her ideas to the class. Much to rude student's surprise, the grade the he received in the class accounted for this disrespectful behavior. Much to your gentle instructor's surprise, it had not occurred to the rude student that it was his obligation, as a member of the class, to treat his peers with respect. The morals of the story are two: as members of this class, it is our obligation to respect each other, and what surprises your gentle instructor may surprise you as well.