



GEOL 484 A SP22: Paleoclimatology (Conroy, J)

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Overview

Syllabus

Welcome to GEOL/IB 484: Paleoclimatology

Time and Location

2:00-3:20 PM Tuesday and Thursday

Natural History Building (NHB) Room 2020B

Credit Hours:

4

Prerequisites:

None

This course meets requirements for the Geology Major or Minor as an elective.

Professor:

Jessica Conroy

jconro@illinois.edu

217-244-4855

Office hours:

Tuesdays 12:00-1:00 PM

NHB 3042

Attendance:

Week 1: 100 % Online and Asynchronous. You will complete the weekly tasks on your own and we will not meet in person or online as a class. Assignments due by 11:59 pm on due date. Late material receives credit at instructor discretion.

Week 2 to end of semester (to be updated if necessary): In-person lecture attendance is required. Please contact instructor if you will be absent due to illness or other circumstances.



Course Information:

This course surveys the history of climate change on Earth. We will consider evidence for past climate change on million-year to interannual timescales from a variety of natural climate 'archives'. The motivation for and lens of this inquiry will be current and future greenhouse-gas driven climate change.

Student Learning Outcomes:

By the end of this course, you will

- Have knowledge of the history of Earth's atmosphere and ocean variability on million-year to interannual timescales, and understand the forcings behind these climate responses
- Have learned about physical, chemical and biological paleoclimate archives, the measurements within each archive type that are used to reconstruct past climate change, and the strengths and weaknesses (uncertainties) of each
- Learn how to apply common statistical treatments to paleoclimate data
- Be able to read and evaluate primary scientific literature
- Understand and be able to communicate to both scientists and the general public how paleoclimate information can be used to inform projections of future climate change

Course Structure:

Each week has a main topic, denoted in the tabs and in the course roadmap below.

Week 1 is designed to be asynchronous: You can complete the work on your own time.

Grades will be posted promptly in Moodle.

There will be a midterm exam, final exam, and final project, which are explained in detail below.

Course Roadmap:

Week #	Dates	Title of Module	Main Topics	Module Objectives
1	1/18 - 1/21	Course Orientation and Introduction	<ul style="list-style-type: none"> ○ Course structure, nature of assessments ○ Introduction to the climate system 	1.1 Understand the structure of the course 1.2 Understand value of paleoclimatology 1.3 Learn key climate forcing factors 1.4 Understand Earth's energy balance 1.5 Become familiar with main components and variables that define climate
2	1/25, 1/27	Ice Cores	<ul style="list-style-type: none"> ○ Stable O and H isotopes ○ Ice core isotope, gas, dust records 	2.1 Learn how stable oxygen and hydrogen isotopes track climate 2.2 Understand how ice cores archive climate history 2.3 Understand relationship between CO ₂ and temperature on glacial and interglacial timescales
3	2/1, 2/3	Marine Sediments	<ul style="list-style-type: none"> ○ Marine sediment proxies, with focus on foraminifera ○ Orbital tuning ○ Thermohaline circulation 	3.1 Understand how marine sediment proxies archive ocean history 3.2 Learn about Earth's orbital cycles, the Milankovitch Theory of the ice ages 3.3 Understand fundamentals of thermohaline circulation and its impact on climate
4	2/8, 2/10	Loess	<ul style="list-style-type: none"> ○ Loess deposition ○ radiocarbon dating ○ Terrestrial signature of glacial/interglacial cycles 	4.1 Learn about processes that produce loess deposits 4.2 Understand how loess stratigraphy tracks glacial/interglacial cycles 4.3 Principles of radiocarbon geochronology



5	2/15, 2/17	Speleothems	<ul style="list-style-type: none"> ○ Cave d18O record development ○ Paleomonsoon history 	<p>5.1 Be able to interpret cave d18O</p> <p>5.2 Understand relationship between monsoon strength and speleothem d18O</p> <p>5.3 Understand fundamentals of U/Th dating</p>
6	2/22, 2/24	Lake Sediments	<ul style="list-style-type: none"> ○ Geologic evolution of lake basins ○ Basic limnology ○ Geochemical and physical proxies in lake sediments 	<p>6.1 Understand how and where lakes form</p> <p>6.2 Understand lake sediment deposition, nature of lake sediments</p> <p>6.3 Learn about some key physical and geochemical measurements that provide information on past climate and environmental changes</p>
7	3/1, 3/3	Biotic Terrestrial Proxies MIDTERM IN CLASS 3/3	<ul style="list-style-type: none"> ○ Lake C-cycle ○ biotic components lake sediments ○ fossil preservation ○ climate/environmental reconstruction 	<p>7.1 Biological environment of lakes</p> <p>7.2 Biological lake proxies</p>
8	3/8, 3/10	Tree Rings	<ul style="list-style-type: none"> ○ dendrochronology ○ dendroclimatology 	<p>8.1 Understand how trees record time</p> <p>8.2 Understand how trees record climate</p>
9	3/22, 3/24	Corals	<ul style="list-style-type: none"> ○ Coral d18O records ○ paleoENSO history 	<p>9.1 Understand relationship between coral d18O, SST, and seawater salinity</p> <p>9.2 Holocene ENSO history</p>
10	3/29, 3/31	Climate Models	<ul style="list-style-type: none"> ○ GCMs ○ Paleo data-model comparison 	<p>10.1 Become familiar with fundamentals of climate models</p> <p>10.2 Learn about results and value of paleoclimate simulations</p> <p>10.3 Assess value of paleoclimate data-model comparisons</p>
11	4/5, 4/7	PETM	<ul style="list-style-type: none"> ○ PETM records ○ Driver of PETM ○ PETM as analogue for anthropogenic climate change 	<p>11.1 Understand the records of the PETM and the cause of the event</p> <p>11.2 Be able to explain how the PETM is/is not an analogue for anthropogenic climate change</p>
12	4/12, 4/14	Icehouse and Greenhouse Worlds	<ul style="list-style-type: none"> ○ Variability in Earth's climate on million-year timescales ○ Drivers of climate changes on million-year timescales 	<p>12.1 Understand controls on earth's climate on million-year timescales</p> <p>12.2 Assess deep time periods that can serve as analogues for future anthropogenic climate change</p>
13	4/19, 4/21	LGM	<ul style="list-style-type: none"> ○ Milankovitch mysteries ○ LGM boundary conditions ○ CO₂ and glacial temperature change 	<p>13.1 Refine understanding of mismatch between insolation periodicity and ice age periodicity</p> <p>13.2 Understand why greenhouse gas concentrations vary on orbital timescales</p> <p>13.3 Boundary conditions and climate of the LGM</p>



14	4/26, 4/28	Abrupt Climate Change	<ul style="list-style-type: none"> ○ Younger Dryas ○ 8.2ka event ○ Anthropocene 	<p>14.1 Be able to define and provide examples of abrupt climate change, and the hypothesized drivers of abrupt climate change</p> <p>14.2 Be able to explain how the Anthropocene is defined, and comprehend this period of abrupt climate change in the context of natural abrupt changes in the earth's climate.</p>
15	5/3	Plagues, Disease, and Climate Change	<ul style="list-style-type: none"> ○ Past and current changes in climate related to plagues and population declines and changes in human activity, role of climate variability in disease 	<p>15.1 Be able to explain hypotheses linking climate change to plague-induced changes in human activity</p> <p>15.2 Understand climate controls on disease outbreaks</p>

Course Materials:

- Papers/book chapters made available for download as pdfs on the course webpage
- Two textbooks will be used but not required to purchase: *Earth's Climate, Past and Future* by William Ruddiman, and *Paleoclimatology: Reconstructing Climates of the Quaternary*, by Raymond Bradley. *Paleoclimatology: Reconstructing Climates of the Quaternary* is available through the UIUC library as an E-book.
- Videos and other online materials, with links posted on the course webpage
- Data analysis will be done with datasets made available to you in Excel and online using [KNMI Climate Explorer](#).

Technology Requirements:

- Moodle Learning Management System (LMS) course page at learn.illinois.edu
- Microsoft office suite: Word, Excel, and Powerpoint

Grading:

Assessment type	Number	Points per assessment	Total Points
Weekly discussion participation	13 possible, lowest score dropped	10	120
Weekly quizzes	13 possible, lowest score dropped	10	120
Weekly assignment	13 possible, lowest score dropped	20	240
Class Project	1	220	220
Midterm	1	100	100
Final exam	1	200	200
TOTAL COURSE POINTS			1000

Discussion:

In week 1 you will write one discussion forum post. The topic and question(s) to respond to will be provided in detail. After writing your post, you will then comment on one of your classmate's posts. The [Forum Rubric](#) details how your post will be scored.

In weeks 2-14, with the exception of midterm week 7, we will have a discussion in class on a paper you will be required to read each Thursday. You will then write a 1 paragraph summary that covers

- 1) the topic of the paper
- 2) the motivation for the work
- 3) main findings and conclusions of authors
- 4) at least 1 key discussion point covered in class.

Summaries will be due Fridays of each week.



Your lowest score is dropped.**Quizzes:**

Short answer, multiple choice and true-false questions will comprise a weekly quiz for each week (1-14, excluding week 7) to assess your comprehension of the course material. These will be completed independently on moodle and should be completed after Thursday's lecture and before Friday at 11:59PM. **Your lowest score is dropped.**

Assignments:

Each week (1-14, with the exception of midterm week 7) will have one main activity or assignment, typically based on analysis of actual paleoclimate data in excel or using an online website that allows data uploading, plotting, and analysis. Some of this work will be done together in class, some on your own, and the assignments are due on Fridays at 11:59PM. **Your lowest score is dropped.**

Exams:

A mid-term and final exam will be given. The exam questions will include fill in the blanks, short answers and essays.

The mid-term is scheduled for **March 3.**

The final is scheduled for **[awaiting university scheduling for final exams].**

Class Project:

The class project will be the creation of a 'Wiki' Page on Plagues and Climate Change and discussion of our findings in week 15 of the course. You will be divided into four groups, and each group will be given a different topic to research related to the project subject. In week 15 groups will give 15 minute presentations on their research, followed by a class discussion. Detailed information is provided under the "Week 15: Class Project: Plagues and Climate Change" tab.

Grading Scale:

Grade	Points	Percent
A+	≥967	≥96.7
A	933–966	93.3–96.6
A–	900–932	90.0–93.2
B+	867–899	86.7–89.9
B	833–866	83.3–86.6
B–	800–832	80.0–83.2
C+	767–799	76.7–79.9
C	733–766	73.3–76.6
C–	700–732	70.0–73.2
D+	667–699	66.7–69.9
D	633–666	63.3–66.6
D–	600–632	60.0–63.2
F	≤599	≤59.9

Academic Integrity:

Cheating of any kind is not tolerated. Examples of cheating include (but are not limited to): using an exam from a previous year to study, soliciting answers to exam questions in online forums, working with classmates on exams if not explicitly told this is permitted. If you have



any questions about what constitutes cheating or if you observe someone cheating, talk to an instructor.

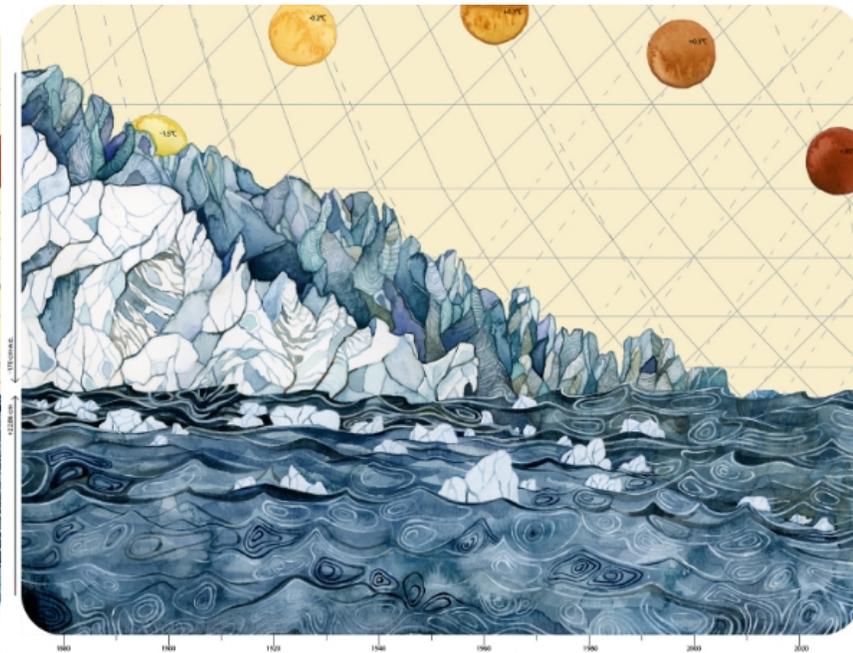
Disability Accommodation:

To obtain appropriate accommodation, students with disabilities (physical or learning) must contact Division of Disability Resources and Educational Services (DRES) at Beckwith Hall, 201 E. John St., Champaign (333-4603, disability@illinois.edu, <<http://www.disability.illinois.edu/>>). Students must complete a form provided by DRES and deliver it to Prof. Conroy explaining what accommodation is needed. No accommodation can be made without this form.

 [Forum Rubric](#)

Available but not shown on course page

Week 1: Course Orientation and Introduction



This image is a work of art entitled "Climate Change Data" by Jill Pelto.

Overview

This week will set you up for a semester of learning about the history of climate variability as recorded by the Earth's rich variety of natural climate 'archives.' After you have reviewed the course syllabus in detail, we will go over the basics of how the Earth's climate system operates. You can take entire courses on aspects of earth's climate system, so realize this is only a brief overview. Major topics we will consider are 1) considering how the earth's energy balance creates climate patterns, 2) what factors control, or 'force' climate variability and 3) the major variables that climate scientists use to understand changes in climate. Finally, in our discussion forum, we will have a chance to reflect on why it may be useful and important to understand how Earth's climate has changed in the past, prior to the period of instrumental observations.

Learning Goals

- Understand the structure of the course
- Learn key climate forcing factors
- Understand Earth's energy balance
- Become familiar with main components and variables that define climate
- Understand value of paleoclimatology

