EARTH SCIENCE/ENVIRONMENTAL STUDIES 335 PALEOCLIMATOLOGY: EARTH'S HISTORY OF CLIMATIC CHANGE

Kirsten Menking Office: Ely 115, Phone: x5545, Email: kimenking@vassar.edu Office Hours: Thurs. 9-12, or by appointment

Textbook: Ruddiman, 2014, Earth's Climate: Past and Future, 3rd Edition Additional readings on Moodle – see below

COURSE DESCRIPTION

Climate change became a hot topic in the 1990s as record high temperatures led scientists and policy makers to grapple with the probability that human activities are having profound impacts on the climate system. The '90s also saw an explosion in research into natural climatic variability. Scientists have come to realize that the climate system is capable of undergoing dramatic shifts in a matter of decades in the absence of human intervention. Paleoclimatology as a field, therefore, has become very important since it aims to:

1) Understand the causes and reconstruct the history of natural climatic variability that may have strong implications for human civilization, and

2) Establish the baseline climatic variation on top of which anthropogenic climate changes are occurring.

In this course we discuss how Earth's climate system operates and what natural processes have led to climate change in the past. We examine the structure and properties of the atmosphere and oceans and how the general circulation of these systems redistributes heat and moisture throughout the globe. In addition, we study how cycles in Earth's orbital parameters, plate tectonics, and the evolution of plants have affected climate in the past. Students will become familiar with methods of paleoclimatic reconstruction, using climatic indicators such as pollen and carbon content, through work with sediments from Dyken Pond in Rensselaer County, New York.

A sizeable portion of the class will be devoted to hands-on laboratory work in the Paleoclimatology lab. Depending on how long it takes us to do different analyses, the syllabus may require change. I'll pass out updated syllabi as needed. While we conduct analyses of our lake sediments, we will examine a variety of related studies done in the Northeast in the last 40 years. These readings (coded in blue below) are a critical part of the course, as we will use them to learn about how different proxies can be used in climatic reconstruction and because many will serve as comparisons to our own work. Students will present these readings every week in the manner of a graduate seminar.

Toward the end of the semester, each class member will be responsible for writing up the results of our Dyken Pond sediment studies. These papers will be written in a standard geological journal format to give you practice with this style of writing, and multiple assignments during the semester will allow you to write the paper in chunks (see green coded homework sections below). You will also present some aspect (pollen, LOI, sedimentology, etc.) of the study in a Geological Society of America style poster session during finals week.

CLASS CALENDAR

Feb. 3:

<u>Background Topic</u> - Introduction to the Climate System: Earth's Temperature and Differential Heating

Background Readings: Aguado and Burt, p. 25-48, 56-70 Ruddiman, Chp. 1, p. 19-31

Project – STELLA modeling of planetary temperatures

Feb. 10:

Background Topic - Atmospheric properties and structure, general circulation

Background Readings: Aguado and Burt, p. 159-161, 166-182, 185-200 Ruddiman, p. 32-39

Feb. 17:

Background Topic - Ocean properties and circulation

Background Readings: Segar, p. 199-234 (skim to pg. 213 and then read the rest), 239-273 Ruddiman, p. 40-45, 69-76

Presentation topic: the ocean's role in climate

<u>Presentation Readings:</u> Lippsett, L., 2000, Beyond El Niño: Climate in Flux, Scientific American, p. 77-83.

Sijp, W.P., England, M.H., and Huber, M., 2011, Effect of the deepening of the Tasman Gateway on the global ocean, Paleoceanography, v. 26, p. 1-18.

Feb. 21/22

Weekend coring expedition to Dyken Pond, date contingent on weather and ice conditions.

Feb. 24:

Background Topic – Long term causes of climatic change

Background Readings: Ruddiman, Chp. 4, Chp. 5, 122-126, 138-152

<u>Project</u> - What was climate like in the ancient past?

Feb. 28/Mar. 1

Backup weekend coring expedition to Dyken Pond, date contingent on weather and ice conditions.

<u>Mar. 3:</u>

Background Topic – Introduction to paleoclimate proxies

Background Reading: Ruddiman, p. 55-69

Presentation topic: New York in the Late Pleistocene

Presentation Readings:

- Bloom, A.L., 2008, The late Pleistocene glacial history and environment of New York state mastodons, in Allmon, W.D. and Nester, P.L. (eds.), Mastodon Paleobiology, Taphonomy, and Paleoenvironment in the Late Pleistocene of New York state: Studies on the Hyde Park, Chemung, and North Java sites, Palaeontographica Americana, v. 61, p. 13-23.
- Menking, K.M., Peteet, D.M., and Anderson, R.Y., 2012, Late-glacial to Holocene climate variability and drought in the mid-Hudson Valley region of New York state, Palaeogeography, Palaeoclimatology, Palaeoecology, v. 353-355, p. 45-59.

Lab work – Photograph, describe and sample Dyken Pond core

<u>Homework</u> – Write up core description and study setting section of future journal article. Draft location map figure.

Mar. 10:

Background Topic - Orbital-Scale Climate Change and Milankovitch Cycles

Background Reading: Ruddiman, Chp. 8

Presentation topic: Physical properties of lake sediment records that indicate climatic change

Presentation Reading:

Brown, S., Bierman, P., Lini, A., Davis, P.T., and Southon, J., 2002, Reconstructing lake and drainage basin history using terrestrial sediment layers: analysis of cores from a post-glacial lake in New England, USA, Journal of Paleolimnology, v. 28, p. 219–236.

Newby, P.E., Shuman, B.N., Donnelly, J.P., and MacDonald, D., 2011, Repeated century-scale droughts over the past 13,000 yr near the Hudson River watershed, USA, Quaternary Research, v. 75, p. 523-530.

Lab work – Process samples for pollen, plant macrofossil, LOI, and stable isotope analyses

SPRING BREAK (3/14 – 3/29), HAPPY VACATION!

Mar. 31:

Background Topic – Insolation Control of Monsoons

Background Reading: Ruddiman, Chp. 9

Presentation topic: Vegetation change recorded in pollen

Presentation Readings:

Toney, J.L., Rodbell, D.T., and Miller, N.G., 2003, Sedimentologic and palynologic records of the last deglaciation and Holocene from Ballston Lake, New York, Quaternary Research, v. 60, p. 189-199.

Lab work – Identify pollen and plant macrofossils, carry out LOI analyses.

Homework – Write up methods for pollen, plant macrofossil, LOI, and stable isotope work.

<u>Apr. 7:</u>

Background Topic - Insolation Control of Ice Sheets

Background Reading: Ruddiman, Chp. 10

Presentation topic: Forest fire reconstruction from charcoal

Presentation Reading:

Maenza-Gmelch, T.E., 1997, Late-glacial – early Holocene vegetation, climate, and fire at Sutherland Pond, Hudson Highlands, southeastern New York, U.S.A., Canadian Journal of Botany, v. 75, p. 431-439.

Oswald, W.W., Foster, D.R., Doughty, E.D., and MacDonald, D., 2010, A record of Holocene environmental and ecological changes from Wildwood Lake, Long Island, New York, Journal of Quaternary Science, v. 25, p. 967-974.

Lab work – Identify pollen and plant macrofossils, carry out LOI analyses.

Apr. 14:

Background Topic - Orbital-Scale Changes in Carbon Dioxide and Methane

Background Reading: Ruddiman, Chp. 11

Presentation topic: Micropaleontological evidence of climate change (ostracodes)

Presentation Reading:

Miklus, N.M., Smith, A.J., Palmer, D.F., and Nester, P., 2008, Tracking the code: climateinduced shifts in ostracode biogeography at three fossil mastodon sites in New York state, in Allmon, W.D. and Nester, P.L. (eds.), Mastodon Paleobiology, Taphonomy, and Paleoenvironment in the Late Pleistocene of New York state: Studies on the Hyde Park, Chemung, and North Java sites, Palaeontographica Americana, v. 61, p. 73-83. Lab work – Identify pollen and plant macrofossils, carry out LOI analyses.

<u>Homework</u> – Begin writing up results section of article with as many data as have been collected to this point. Draft figures to be finalized later.

Apr. 21:

Background Topic - Orbital-scale interactions, feedbacks, and unsolved problems

Background Reading: Ruddiman, Chp. 12

Presentation topic: The record in plant macrofossils and fish scales

Presentation Reading:

Peteet, D.M., Daniels, R.A., Heusser, L.E., Vogel, J.S., Southon, J.R., and Nelson, D.E., 1993, Late-glacial pollen, macrofossils and fish remains in northeastern U.S.A. – The Younger Dryas oscillation, Quaternary Science Reviews, v. 12, p. 597-612.

Lab work – Identify pollen and plant macrofossils, carry out LOI analyses.

<u>Homework</u> – Write introduction to journal article.

Apr. 28:

Background Topic - the Last Glacial Maximum

Background Reading: Ruddiman, Chp. 13

Presentation topic: Use of fungal spores as a proxy for megafauna

Presentation Reading:

Robinson, G.S., Burney, L.P., and Burney, D.A., 2005, Landscape paleoecology and megafaunal extinction in southeastern New York state, Ecological Monographs, v. 75, p. 295-315.

<u>Lab work</u> – Identify pollen and plant macrofossils, carry out LOI analyses.

Homework – Finalize results and write up discussion section of journal article.

<u>May 5:</u>

<u>Background Topic</u> – Climate During and Since the Last Deglaciation and Millennial Oscillations of Climate

Background Reading: Ruddiman, Chp. 14, 15

Lab Work – Begin work on posters

May 12: Last Day of Classes

Lab Work – Finish posters. Finish revisions on journal article.

Turn in completed journal article by midnight on May 15.

Finals day: Student presentations in mock geological conference

15%
15%
10%
10%
10%
40%

A NOTE ABOUT READING SUMMARIES:

Scientific reading, like science writing, is a skill that can only be developed through a lot of practice. To motivate you to acquire this skill, I'll be asking you to answer the following questions on each of the journal articles we'll be reading:

- 1) What is this article about?
- 2) Why should anyone care about this topic? I.e., why is it important?
- 3) How did the authors investigate this topic?
- 4) What were their primary findings?
- 5) What did you find most interesting or confusing?

I don't mean for you to write more than a couple of sentences on each of these questions, but I am going to have you hand them in at the end of the class period for which these readings were assigned. Ten percent of your grade will be based upon your completion of these summaries, with each summary given equal weight. If you complete 100% of them, you'll receive a 100% score on this part of the class. If you don't do any of them, you'll get a 0%, etc.!

A tip for when you start reading – take a look at the abstract of the paper, the figures, and the conclusions first. Then go back and read the whole paper. If you make this a habit, your comprehension of the article will increase greatly.

We'll also be discussing the textbook readings in class. 10% of your grade will be based on your contributions to discussion, so please make sure to do all the reading.

A NOTE ABOUT MY GRADING OF WRITTEN WORK:

When grading writing, whether essays or answers to questions on problem sets, I make a lot of comments on grammar and style in addition to content. I have a repressed copy editor living inside my body, and your writing assignments will probably be returned to you covered in ink regardless of whether your final grade is a C- or an A+. I simply can't help myself! Please do not take it personally or think that I don't like you when you get a paper back full of comments. One of the most important skills you can take away from Vassar is the ability to write well, and as your professor, it is my job to help you hone a clear and engaging style to go along with your argument.

LATE POLICY

Homework is due at the end of the following week's class period unless otherwise noted. Each student will be allowed to hand in 3 homework assignments 1 day late without penalty. If

assignments are more than 1 day late, 1% of the final grade will be deducted for each day the assignment is overdue.

SUSTAINABILITY POLICY

Students are welcome to submit work on recycled paper or to use double-sided printing.

ACADEMIC ACCOMMODATIONS

Academic accommodations are available for students with disabilities who are registered with the Office for Accessibility and Educational Opportunity. Students in need of disability accommodations should schedule an appointment with me early in the semester to discuss any accommodations for this course that have been approved by the Office for Accessibility and Educational Opportunity, as indicated in your AEO accommodation letter.