PALEOCLIMATE MODEL-PROXY SYNTHESIS
ATMO 752/ GEOL 593
Spring 2018
University of Hawaii at Mānoa & University of Illinois at Urbana-Champaign

Instructors:

Hawaii:
Dr. Christina Karamperidou
Tel: (808) 956-2565
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Office hours: after class or by appointment (@ HIG 335).

Illinois:
Dr. Jessica Conroy
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Office hours: by appointment (@ NHB 3042)

Illinois:
Tue-Thu 2:00-3:15PM CST
NHB 2020A

Hawaii:
Tue-Thu 10:00-11:15AM HST until March 8th, 2018
Tue-Thu 09:00-10:15AM HST on and after March 13th, 2018 (IL enters daylight savings time)

Required Materials:

1) lecture notes and papers distributed by the instructors.
2) Laptop with R, Matlab, EdGCM model, Paleoview, and datasets distributed by instructors

Information on obtaining required software
R: R is freely available online at
https://www.rstudio.com/products/rstudio/download/

Matlab: Illinois students can download Matlab for free via the online web store if they are using a university laptop. If you need to borrow a university laptop for the semester, please let me know. Hawaii graduate students should have Matlab access via RCF.

EdGCM Model: http://edgcm.columbia.edu/download-edgcm/

Paleoview: https://github.com/GlobalEcologyLab/PaleoView/releases

Course Description
This course is designed for both Geology and Atmospheric Sciences graduate students, with a goal of creating a future generation of paleoclimatologists willing to bridge the divide between the proxy and modeling worlds. It includes three sections devoted to:

1. **Introduction to climate modeling**: Discusses basics of earth system model development, parameterizations, intermodel variability, types of model experiments and how to pose hypotheses that can be tested in climate models. This portion of the course will also include exercises using edGCM (http://edgcm.columbia.edu/).
2. **Paleoclimate proxies**: Introduces different types of proxies and their respective advantages and limitations. This section of the course also presents tools and techniques for paleoclimate record development and reconstruction, including chronology development.
3. **Proxy-model synthesis**: Trains students in hypothesis testing using both proxies and models and the types of statistical tools useful in proxy-model comparison studies.

Grades:
30%: In-class participation & attendance
10%: mid-term project presentations
20%: Final exam (take home)
20%: Final project paper
20%: Final project presentation

Note: Grading will not necessarily be on a curve. Everyone has the chance to get an A if they work for it and deserve it!

Classroom Conduct:

- You are expected to show up on time and participate in class. This is an 'active' learning course, and will require your full engagement to be successful. Be respectful of other students and your professors.

Attendance policy:
Attendance is mandatory and is taken in each class. 30% of your grade will be based on attendance and in-class activities, so any unapproved absence will hurt your grade.

Course/Student Learning objectives:
Upon successful completion of this course, students will be able to:

- Understand the basic principles of building and running climate models of increasing complexity (from one-dimensional to state-of-the-art climate models) to simulate Earth's past climates.
- How to develop hypotheses about past climate changes and design model experiments to assess them.
- Understand the features, advantages, and limitations of various paleoclimate proxies.
- Use tools and techniques for paleoclimate record development and reconstruction, including chronology development.
- Perform proxy-model comparison studies and proxy-model syntheses.

- Assess and effectively communicate uncertainty in climate model simulations and paleoclimate records.

Term Projects

A final, capstone data-model comparison will be 40% of your grade. This will include both a paper (8-10 pages, double spaced, 12-pt font, including figures, excluding references) and a final presentation to the class. Each individual project will be part of a large data-model comparison project proposed by the professors. Your midterm presentation will be a short proposal to the class stating your research problem and science plan, worth 10% of your final grade.

Final Exam

The final exam (20% final grade) will be *take home* and will test your ability to reproduce the results of a published proxy model-comparison using paleoclimate data, model data, and statistical techniques covered in the course.

Disability Access:

If you have a disability or related access need, the Instructor will make every effort to assist and support you.

Hawaii:

For confidential services students are encouraged to contact the Office for Students with Disabilities (known as "KOKUA") located on the ground floor (Room 013) of the Queen Lili'uokalani Center for Student Services:
KOKUA Program • 2600 Campus Road • Honolulu, Hawaii 96822 • Voice: 956-7511 • Email: kokua@hawaii.edu www.hawaii.edu/kokua

Illinois:

UIUC: 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.

Title IX:

The University of Hawai'i and University of Illinois are committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the confidential resources available here:
http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact: Dee Uwono Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.

Syllabus:
Lectures will follow the ***tentative*** course outline below. This syllabus is subject to change; any changes will be disclosed in class beforehand.

Red font indicate Conroy will lead lectures. **Blue** font indicates Karamperidou will lead lectures, Black font indicates student lead or campuses meeting separately.

Week	Date	Topic	Comments/Readings
1	1/9		
	1/11		**UH starts**
2	1/16	**L1:** Course Syllabus & Introduction	**UIUC starts**
	1/18	**L2:** The past as prologue: why study paleoclimatology	Schmidt et al. 2014, *Climates of the Past*
3	1/23	**L3:** Paleoclimate forcings & CMIP experimental setup	Kageyama et al. 2017, Geosci.Model.Dev. Discuss.
	1/25	**L4:** Climate model development: Governing equations & Numerical Frameworks	No Reading
4	1/30	**L5:** Climate model development: Parameterizations	
	2/1	**L6:** Basic components of an Earth System Model Pt1	
5	2/6	**L7:** Basic components of an Earth System Model Pt2	
	2/8	**L8:** Model genealogy & uncertainty	Knutti et al. 2013, GRL
6	2/13	**L9:** Model tuning	Schmidt et al. 2017, *Geosci. Model Dev.*
	2/15	**L10:** Paleoclimate simulations, Introduction to EdGCM	
7	2/20	**L11:** Paleoclimate experiments with EdGCM	
	2/22	**L12:** Paleoclimate proxies, an overview: High resolution	Jones et al. 2009, *The Holocene*
8	2/27	**L13**: Paleoclimate proxies, an overview: Low resolution	Marcott et al. 2013, *Science*
	3/1	**L14:** Proxy age control	Reimer et al. 2013, *Radiocarbon*
9	3/6	**L15:** Proxy forward models	Evans et al. 2013, *Quat. Sci. Rev.*
	3/8	**L16:** Proxy transfer functions	Juggins and Birks, TECULS v5, 2012
10	3/13	**L17:** Proxy syntheses	PAGES2k, 2013, *Nature Geoscience*
	3/15	**L18:** Downloading and working with proxy data	No Reading
11	3/20	**UIUC Spring Break (meet separately these weeks)** **L19:** Data-Model Comparison: introduction and motivation	Phipps et al. 2013 *Journal of Climate*
	3/22	**L20:** Data-model Comparison: statistical tools, problems and uncertainties	Tierney and DiNezio 2013 *Nature Geoscience*
12	3/27 3/29	**UH Spring Break (meet separately these weeks)**	
13	4/3	**L21**: short (10-15 minute) project proposals/discussions	No Reading
	4/6	**L22**: short (10-15 minute) project proposals/discussions	No Reading

14	4/10	**L23**: Data-Model Comparison: Downloading and analyzing PMIP3 data	Brannocot et al. 2012 *Nature Climate Change*
	4/12	**L24**: Intro to Paleoview, a Data-Model Comparison tool	Fordham et al. 2017 *Ecography*
15	4/17	**L25:** Data-Model Comparison: Downloading and working with Trace-21 simulation	Liu et al., 2009 *Science*
	4/19	**L26:** Data-Model Comparison: tools and techniques for analyzing complementary paleoclimate data	No Reading
16	4/24	**L27:** In class work on personal projects, troubleshooting w/ instructors, classmates	No Reading
	4/26	**L28:** In class work on personal projects, troubleshooting	No Reading
17	5/1	**L29**: Final project presentations	No Reading
	5/3	**L30:** Final project presentations	No Reading
18	**5/11**	**Final Exam DUE**	

Reading List:

Date	Class	Reading
1/18/18	L2	Schmidt et al. 2014, *Climates of the Past*
1/23/18	L3	Kageyama et al. 2017, Geosci.Model.Dev. Discuss.
2/8/18	L8	Knutti et al. 2013, GRL
2/13/18	L9	Schmidt et al. 2017, *Geosci. Model Dev.*
2/22/18	L12	Jones et al. 2009, *The Holocene*
2/27/18	L13	Marcott et al. 2013, *Science*
3/1/18	L14	Reimer et al. 2013, *Radiocarbon*
3/6/18	L15	Evans et al. 2013, *Quaternary Science Reviews*
3/8/18	L16	Juggins and Birks 2012, Tracking Environmental Change Using Lake Sediments volume 5
3/13/18	L17	PAGES2k 2013, *Nature Geoscience* + online supplemental material
3/20/18 UIUC 3/27/18 UH	L19	Phipps et al. 2013 *Journal of Climate*
3/22/18 UIUC 3/29/18 UH	L20	Tierney and DiNezio 2013, *Nature Geoscience*
4/10/18	L23	Brannocot et al., 2012 *Nature Climate Change*
4/12/18	L24	Fordham et al 2017, *Ecography*
4/17/18	L25	Liu et al., 2009, *Science*