Paleoclimate Model-Proxy Synthesis

ATMO 640, CRN:89374

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Office hours: TR after class or by appointment

TR 13:30-14:45
SAKAM B102

What we'll cover

PART I

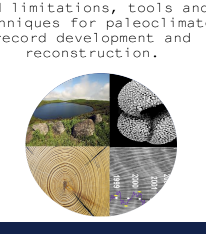
INTRO TO CLIMATE MODELING

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.

PART II

PALEOCLIMATE PROXIES

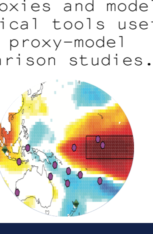
types of proxies, advantages and limitations, tools and techniques for paleoclimate record development and reconstruction.



PART III

MODEL-PROXY SYNTHESIS

Hypothesis-testing using both proxies and models. Statistical tools useful in proxy-model comparison studies.



A detailed day-to-day schedule of classes can be found at the end of this syllabus, and is posted on laulima under the syllabus tab

Student Learning Objectives

#1 Explain 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.

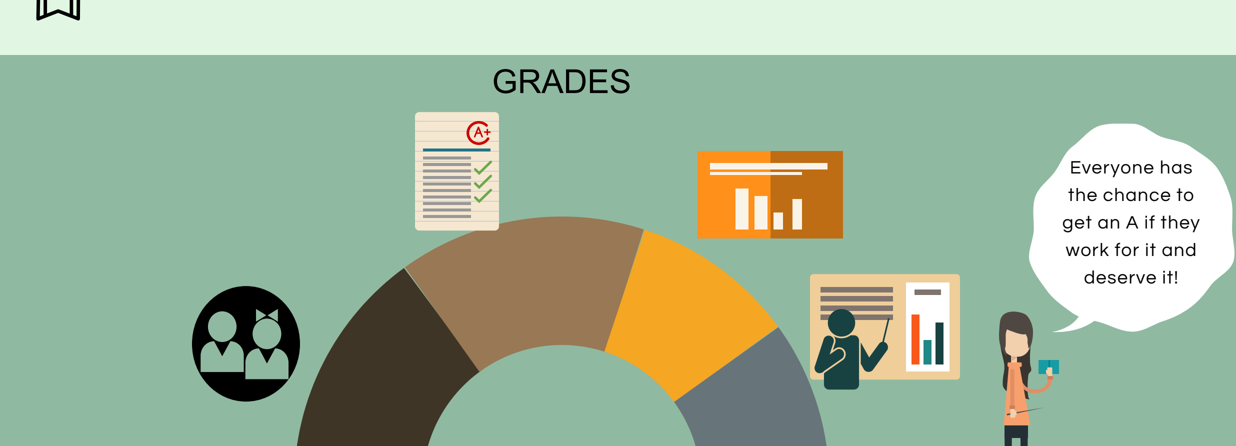
#2 Be able to develop hypotheses about past climate changes and design model experiments to assess them.

#3 List the features, advantages, and limitations of various paleoclimate proxies and of the global climate models used in paleoclimate studies.

#4 Employ tools and techniques for paleoclimate record development and reconstruction.

#5 Perform proxy-model comparison studies and proxy-model syntheses.

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



REQUIREMENTS

- graduate standing (seniors: email the instructor for consent)
- Laptop with required software installed
- lecture notes, term project resources & readings distributed by the instuctor on laulima
- some background in computer programming languages & statistical analysis is desirable, but not required

Where to obtain required software:

EdGCM Model: Simple climate model to be run on your laptop- http://edgcm.columbia.edu/download-edgcm/
NCL: Free software for data analysis & visualization- https://www.ncl.ucar.edu/
Panoply: Data viewer for geo-referenced and other arrays- https://www.giss.nasa.gov/tools/panoply/
Matlab: SOEST Graduate students have free access to Matlab via RCF

NCL will not work on Windows machines.
If needed, the class will meet and work on the machines at the ATMO computer lab (HIG 310) for the NCL classes

CLASS RESOURCES

- No required textbook
- Lecture notes will be posted on laulima after each class
- Class readings & term project resources also on laulima

TERM PROJECT

A final, capstone data-model comparison project will be worth 40% of your grade.

Deliverables:

a group-written scientific poster (made in Google Slides)

a final oral presentation (in class).

We will discuss this project in class throughout the semester and you will work both in and out of class on your part of the project, and the creation of the poster and presentation.

FINAL EXAM

The final exam (30% of final grade) will be take home and will test your ability to reproduce the results of a published proxy model-comparison study using paleoclimate data, model data, and statistical techniques covered in the course.

HONOR CODE: COLLABORATION IS NOT PERMITTED. YOU ARE NOT ALLOWED TO MAKE COPIES OF THE EXAM, DISCUSS OR SHARE THE EXAM WITH OTHERS IN THIS CLASS OR OUTSIDE THIS CLASS. IF YOU ARE CAUGHT IN DISHONEST BEHAVIOR, YOU WILL FAIL THE EXAM. NO EXCEPTIONS.

Course Policies

ATTENDANCE
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.

PARTICIPATION
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.

PLAGIARISM
Academic dishonesty will not be tolerated. If you are caught plagiarizing, you will fail the assignment, and possibly the course. In egregious cases, the instructor may file an official complaint with the Dean of Students office, which may end up on your permanent student record or lead to suspension from the program.

TECHNOLOGY
Unless you are working on your laptop on in-class exercises, the use of electronic devices is not allowed. Turn off/silence and store ALL non-required devices before the start class. Failure to comply will negatively affect your participation score.

DECORUM
You are expected to be courteous and respectful of your fellow students and your instructors. Listen carefully, acknowledge other perspectives thoughtfully and focus on the quality of arguments, avoiding ad hominem attacks. Discriminatory language and disruptive behavior will not be tolerated.

DISABILITY ACCESS

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

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

TITLE IX

As a member of the University faculty, your instructor is required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator.

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.

Schedule

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

Week	Date	Topic	Comments/Readings
1	1/14	**L1:** Course Syllabus & Introduction	
	1/16	**L2:** The past as prologue: why study paleoclimatology	Schmidt et al. 2014, *Climates of the Past*
2	1/21	**L3:** Paleoclimate forcings & CMIP experimental setup	Kageyama et al. 2017, Geosci.Model.Dev. Discuss.
	1/23	**L4:** Climate model development: Governing equations & Numerical Frameworks	No Reading
3	1/28	**L5:** Climate model development: Parameterizations	
	1/30	**L6:** Basic components of an Earth System Model Pt1	
4	2/4	**L7:** Basic components of an Earth System Model Pt2	
	2/6	**L8:** Model genealogy & uncertainty	Knutti et al. 2013, GRL
5	2/11	**L9:** Model tuning	Schmidt et al. 2017, *Geosci. Model Dev.*
	2/13	**L10:** Paleoclimate simulations, Introduction to EdGCM	
6	2/18	**L11:** Paleoclimate experiments with EdGCM	
	2/20	**L12:** Data-Model Comparison: Downloading and analyzing PMIP3 data	Brannocot et al. 2012 *Nature Climate Change*
7	2/25	**L13:** Getting started plotting and analyzing model data in NCL	
	2/27	**L13:** Getting started plotting and analyzing model data in NCL	
8	3/3	**L14:** Paleoclimate proxies, an overview: High resolution	Jones et al. 2009, *The Holocene*
	3/5	**L15:** Paleoclimate proxies, an overview: Low resolution	Marcott et al. 2013, *Science*
9	3/10	**L16:** Proxy age control	Reimer et al. 2013, *Radiocarbon*
	3/12	**L17:** Proxy forward models	Evans et al. 2013, *Quat. Sci. Rev.*
10	3/17	**Spring Break**	
	3/19		
11	3/24	**L18:** Proxy Transfer Functions	Juggins and Birks, TECULS v5, 2012
	3/26	**No class- Kuhio Day**	
12	3/31	**L19:** Proxy syntheses	PAGES2k, 2013, *Nature Geoscience* Donders, 2008
	4/2	**L20:** Term project introduction/discussion	
13	4/7	**L21:** Data-Model Comparison: introduction and motivation	Phipps et al. 2013 *Journal of Climate*
	4/9	**L22:** Data-Model Comparison: tools and techniques for analyzing complementary paleoclimate data	Tierney and DiNezio 2013 *Nature Geoscience*
14	4/14	**L23:** Intro to Paleoview, a Data-Model Comparison tool	Fordham et al. 2017 *Ecography*
	4/16	**L24:** Data-Model Comparison: Downloading and working with Trace-21 simulation Pt1	Liu et al., 2009 *Science*
15	4/21	**L25:** Data-Model Comparison: Downloading and working with Trace-21 simulation Pt2	No Reading
	4/23	**L26:** Inter-model comparisons, the impact of resolution & model complexity	No Reading
16	4/28	**L27:** In class work on term project, troubleshooting w/ instructor, classmates	No Reading
	4/30	**L28:** In class work on term project, troubleshooting	No Reading
17	5/5	**L29:** In class work on term project, troubleshooting	No Reading
	5/7	**L30:** Final project presentation Take Home Exam passed out	
18	5/14	**Final Exam DUE**	

Reading List:

Class	Reading
L2	Schmidt et al. 2014, *Climates of the Past*
L3	Kageyama et al. 2017, *Geosci.Model.Dev. Discuss.*
L8	Knutti et al. 2013, *GRL*
L9	Schmidt et al. 2017, *Geosci. Model Dev.*
L12	Brannocot et al. 2012 *Nature Climate Change*
L14	Jones et al. 2009, *The Holocene*
L15	Marcott et al. 2013, *Science*
L16	Reimer et al. 2013, *Radiocarbon*
L17	Evans et al. 2013, *Quaternary Science Reviews*
L18	Juggins and Birks 2012, Tracking Environmental Change Using Lake Sediments volume 5
L19	PAGES2k 2013, *Nature Geoscience* + online supplemental material
L21	Donders et al. 2008 *Quaternary Science Reviews*
L22	Phipps et al. 2013 Journal of Climate
L23	Tierney and DiNezio, 2013
L24	Fordham et al. 2017, *Ecography*
L25	Liu et al., 2009, *Science*