GEOGRAPHY 5901
Climate System Modeling: Basics and Applications

Days & times: Tuesdays and Thursdays 9:35 to 10:55 AM
Room: Derby Hall 1116

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Office hours: Tuesdays 11:30 AM to 1:30 PM, or by appointment

Objectives

This is a general overview of Climate System Models (CSM), tools used to understand past and present climate and to make predictions of future climate states. The course will discuss the different types of models, their usual applications, weaknesses and strengths. It will also present in detail the distinct subcomponents (atmosphere, ocean, land surface, biosphere, land and sea-ice) that make up CSMs. The required parameterizations will be considered. While no programing (or code writing) will have to take place, the course has a hands-on component where students will design experiments and evaluate output from the University of Victoria Earth System Climate Model (UVic ESCM).

Expected learning outcomes include:

a) Basic understanding of the main energy and mass fluxes that determine the state of the global climate system.
b) Familiarity with the main CSM categories (Energy Balance, Radiative-Convective, Intermediate Complexity and Fully Coupled Global Climate Models) their strengths and weaknesses.
c) Knowledge of what type of questions different CSMs can help answer.
d) The ability to design experiments and interpret results from simple CSM simulations.

Course Materials

Suggested reference textbook:
A Climate Modelling Primerm – 4th edition, Kendal McGuffie e Ann Henderson-Sellers, John Wiley & Sons (ISBN 0-470-85750-1)
Earlier editions: While some of the discussed themes are only found in the 4th, earlier editions contain a large amount of the material presented in class.

Other useful references:
Class notes from Prof. Andreas Schmittner – to be provided to class by instructor.

Introduction to climate dynamics and climate modeling, Goosse H., P.Y. Barriat, W. Lefebvre, M.F. Loutre and V. Zunz.
Freely available online at: http://www.climate.be/textbook.

Climate Change and Climate Modeling, J. David Neelin, Cambridge University Press (ISBN 978-0-521-60243-3)

Climate System Modelling, K. E. Trenberth, Cambridge University Press
(ISBN 9780521128377)

Carmen web page:

You will be alerted in class about updates on our Carmen class web page. The schedule of activities (lectures, discussions, due dates for different activities) will be posted on the Carmen class web page and will be updated as the class progresses. Lecture slides will be posted as pdf files.

Evaluation

Term Paper (individual)	35%
Parameterization report (group)	20%
UVic ESCM experiment report (group)	20%
Take home exam on climate dynamics (individual)	15%
Class participation (individual)	10%

Term paper: Each student will choose a theme related to climate modeling and prepare a five thousand word report and an associated 15-20 minute presentation on it. While textbooks and manuals could be used, the main references for the report should come from the scientific literature. Themes are flexible and (hopefully) related to individual student interests.

Some examples*: "How climate models simulate sea-ice dynamics"; "The effects of large scale deforestation from climate models", "Simulations of the Paleocene-Eocene Thermal Maximum", "Modeling the Martian Climate", "The response of Ocean pH to CO_2 emissions as seen by climate models", "Performance of CMIP models over the last two IPCC reports".

Students should contact the instructor for help in choosing a theme (or making sure the selected theme is viable) and finding the pertinent literature.

Presentations will take place during the last lectures and **the written report is due on April 23, the date of our last lecture**.

*really just examples and not given here as an attempt to steer students towards these themes.

Groups: Freely formed by students with a maximum size of 3 individuals. Group composition can change for each assignment.

Parameterization report – A processes that require parameterization will be assigned by the instructor to each group. The group will hand in a written portion (2500 words) and make a 5-10 minute presentation to the class.

UVic ESCM report - Groups will select, under the instructor's guidance, an experiment to be performed by a 100-year simulation of the UVic ESCM. A brief (3-4 pages, including figures) report of what constituted the experiment and its main results should be handed in and presented by the group to the class in a 5-10 minute presentation.

Take home exam – Students will have two days to write the exam.

Class participation – greatly determined by discussions during student presentations.

Late work policy

Unless otherwise stated, all assignments should be handed at the end of the lecture on the due date *and are expected to be stapled*. A 40% penalty will be applied to any individual or group work handed in up to one week after the due date. *Work that is eight or more days late will not be accepted.*

Course policies:

You are expected to adhere to the policies described in the OSU Student Code of Conduct: http://studentaffairs.osu.edu/resource_csc.asp

Students who anticipate missing an exam must make arrangements with the instructor at least *one week prior.* You are allowed one un-excused absence. An excused absence requires written documentation (doctor's excuse) or prior permission to be absent. I will consider your requests on a case-by-case basis.

An Important Note about Plagiarism and Academic Misconduct:

Plagiarism and other forms of cheating will not be tolerated. University rules provide severe penalties for academic misconduct, ranging from course failure to dismissal from the university. University rules are found in the handbook used in all survey courses: "University Survey - A Guidebook and Readings for New Students." Any questions about this policy, or your grade, should be brought directly to the instructor.

Disability Statement

Students with physical or learning disabilities requiring alternative accommodations for completing course requirements must make these arrangements in consultation with the University Office of Disability Services (150 Pomerene Hall, 2-3307) and the *instructor at the beginning of the semester.*

Lecture sequence and assignment schedule:

Theme 1: Brief introduction to the climate system (class notes)
- Forcings
- Energy Balance
- Feedbacks

Jan 27 - Take home climate dynamics exam handed out
Jan 29 - Take home climate dynamics exam due at the start of the lecture.

Theme 2: Historic overview of climate modeling - Chaps. 1 and 2**
- Model types
- The concept of sensitivity
- Parameterizations

Theme 3: Energy Balance Models (EMB) - Chap. 3
- Adimensional and one-dimension EMBs
- Box Models
- EMBs and glacial cycles - Snow Ball Earth and Pleistocene glaciations

February 26 – Parameterization report presentations (written report due)

Theme 4: Earth System Models of Intermediate Complexity (EMICs) - Chap. 4
- Radiation and energy flux
- Sensitivity experiments
- Radiative-Convective Models
- Types of EMICs

Theme 5: Brief Overview of the University of Victoria Earth System Model

March 26 – UVic ESCM report presentations (written report due)

Theme 6: Fully coupled models - Chap. 5
- Modeling the atmosphere, ocean and cryosphere
- Modeling the land surface
- Modeling atmospheric chemistry
- Modeling ocean biology and chemistry
- Intercomparison projects

April 16, 21 and 23 – Term Project presentations. Written portion due on April 23.

**Readings relate to chapters numbers from the text's 4th edition.