EVSC 4559/7559 Climate Modeling and Analysis (3 credits)
Fall 2021
Tuesday/Thursday 12:30-1:45 pm
111 New Cabell Hall

Instructors

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(Zoom link on Collab, or 380 Clark)

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Course Description

This course will introduce students to the numerical, statistical, and computational methods used to model variability and change in Earth's climate system. The course will provide a conceptual understanding of the physical principles underlying successful Earth system models and teach students mathematical and computational techniques necessary to interpret and analyze model output for a variety of environmental sciences applications.

The course will be structured as follows:

- Tuesday classes will primarily be lectures covering the basics of how climate models work, as well as the underlying scientific theory.
- Thursday classes will primarily be practical sessions designed to practice the concepts learned in lectures. At the beginning of each practical session, students will be given an assignment to work on during class time with classmates or individually.

To apply the knowledge from the course, students will work on a semester-long project to interpret and analyze climate model output to answer a research question related to their individual interests. Undergraduate students enrolled in EVSC 4559 will form project teams and work on the final project in small groups of 2-4 students. Graduate students enrolled in EVSC 7559 will be expected to perform the semester project independently and to apply it to a research question related to their own research. Throughout the semester, students will learn how to use a computer program (MATLAB) to read in the climate data necessary to answer their research questions, conduct some meaningful statistical analysis to interpret their data, and write up their results into a final paper.

Prerequisites

Prior experience with computer programming is not required.

Textbooks and Resources

There is no required textbook for this class. Some useful textbooks and resources for reference are:

Goosse H., P.Y. Barriat, W. Lefebvre, M.F. Loutre and V. Zunz, (2008-2010). *Introduction to Climate Dynamics and Climate Modeling*. Online textbook available at http://www.climate.be/textbook.

Goosse, H. (2015). *Climate System Dynamics and Modelling.* Cambridge University Press.

Neelin, J. D. (2012). *Climate Change and Climate Modeling*. Cambridge University Press.

Brian Rose's (Univ. at Albany) online lecture notes on climate modeling: http://www.atmos.albany.edu/facstaff/brose/classes/ATM623_Spring2015/Notes/index.html

Assessment and Evaluation

In-class assignments (40%): Thursday classes will primarily be practical sessions designed to practice the concepts learned in lectures. At the beginning of each practical session, students will be given an assignment to work on during class time with classmates or individually. Assignments will be due by 9 am on the following Thursday. Practical sessions will include assignments only on days as advertised on the Collab course schedule. Due dates for all assignments are also included on the schedule on Collab.

Final project (60%): Students will work on a semester-long project to interpret and analyze climate model output to answer a research question related to their individual interests. Undergraduate students enrolled in EVSC 4559 will form project teams and work on the final project in small groups of 2-4 students. Graduate students enrolled in EVSC 7559 will be expected to perform the semester project independently and to apply it to a research question related to their own research. The semester project will be completed in stages:

Project Proposal (10%) due at the start of class on Tuesday 10/19: Each undergraduate project team and graduate student will select a topic of interest and conduct a literature review motivating a research question to answer. (4-6 pages, double-spaced, including at least 10 references from peer-reviewed literature)

Rough Draft (10%) due at the start of class on the Tuesday before Thanksgiving (11/23): Each undergraduate project team and graduate student will turn in a completed rough draft of their final project.

Final Presentation (10%) during the last two days of class (12/2 and 12/7): Each undergraduate project team and graduate student will present a 10-15 minute presentation summarizing their results to classmates.

Final Project (25%) due Thursday 12/16 by 5 pm. The project must include plots that were made using statistical methods that were covered during the semester, and the discussion of the results must incorporate a discussion of at least 5 physical processes that were covered during the course's lectures throughout the semester. The detailed requirements for the final project will be provided at a later date.

Peer Assessment (5%):

- For undergraduate students enrolled in EVSC 4559, each student will individually complete an assessment of the contributions of each member of their project team to the overall success of their team project. This participation assessment statement will be due at the same time as the final project (Thursday 12/16 at 5 pm).
- For graduate students enrolled in EVSC 7559, each student will write a journal-style peer review of one classmate's rough draft, due at the start of class on Thursday, 12/2.

Grading Scale

A+: 99-100	A: 93-98	A-: 90-92
B+: 87-89	B: 83-86	B-: 80-82
C+: 77-79	C: 73-76	C-: 70-72
D+: 67-69	D: 63-66	D-: 60-62

F: Less than 60

Course Outline

Concepts	*Tools*
Introduction to Earth's Climate System	Introduction to Climate Data/NetCDF
Simple Energy Balance Models	Manipulating Climate Data in MATLAB
History of Climate Modeling	Basic Programming Techniques
Modeling the Atmosphere	Basic Numerical Methods
Modeling the Ocean/Cryosphere	Statistical Techniques
Modeling the Land/Carbon Cycle	
Coupling, Model Tuning, and Model Evaluation	
Climate Feedbacks and Climate Change Assessment	

A detailed course outline is provided under the Schedule tab on the course Collab website. Please check the outline regularly as it will be updated throughout the semester with lecture notes and assignments.

Questions??
Class participation and asking questions in class is strongly encouraged.

Questions outside of class can be addressed to either of the instructors via email, or during office hours. Please schedule an appointment to meet with the instructors outside of office hours.

Technology Policy
To complete the in-class assignments and final project, you'll need access to a computer with the MATLAB software package installed. MATLAB can be installed for free by all currently enrolled UVA students. Directions can be found at: https://data.library.virginia.edu/research-software/matlab/. Be sure to also download the Statistics and Machine Learning toolbox and the Mapping toolbox.

If you have a laptop on which you can install MATLAB, please bring it to all the Thursday practical session classes. If you do not have regular access to a laptop that you can bring to class, please contact us, and alternative arrangements can be made.

Inclusivity
We are committed to creating a course that is inclusive in its design. If you encounter any barriers, please let us know immediately so we can determine if there is a design adjustment that can be made. We are happy to consider creative solutions.

If you are a student with a disability, or think you may have a disability, you are also welcome to initiate this conversation with the Student Disability Access Center (SDAC). SDAC works with students with disabilities and faculty members/TAs to identify reasonable accommodations. Please visit their website for information and to start the application process. If you have already been approved for accommodations through SDAC, please send us your accommodation letter and meet with us so we can develop an implementation plan together.

Non-discrimination policy
UVA policy prohibits discrimination based on age, color, disability, gender identity, marital status, national or ethnic origin, political affiliation, race, religion, sex (including pregnancy), sexual orientation, veteran status, and family medical or genetic information. The University of Virginia prohibits sexual and gender-based harassment, including sexual assault, and other forms of inter-personal violence. If you experience harassment based on any of these factors, please contact the UVA Office for Equal Opportunity and Civil Rights at (434) 924-3200; for further information see http://eocr.virginia.edu.