Stanford | Pre-Collegiate Studies

COURSE SYLLABUS

COURSE: CLIMATE CHANGE: PROJECTIONS AND UNCERTAINTY

INSTRUCTOR: LEXI ARLEN

Email: arlenlex@stanford.edu

I am a third-year PhD student at Stanford working with Professor Earle Wilson. After completing an undergraduate degree in math, I began my PhD in Earth System Science intending to use my analytical toolbox to understand how Earth's climate will continue to change under increased greenhouse gas emissions. I have become fascinated by the processes that govern sea ice fracture, which I hope will lead to improvements in the representation of sea ice in climate models. I have a passion for teaching, holding various positions over the past ten years, from coaching youth gymnastics to mentoring higher-level undergrad mathematics. When I'm not researching sea ice or teaching, you can find me climbing, running, or skiing in the mountains.

LEARNING OBJECTIVES

By the end of this course, you will understand the physics of climate change, learn how to code a simple climate model in Python, and conduct research on climate projections. The first week will cover the physics that causes anthropogenic emissions to warm the planet while the second week will focus on the uncertainties in future climate that scientists are working to address.

COURSE OVERVIEW

Beginning with an introduction to past and present climate change, this course will delve into the radiative physics underlying the greenhouse effect. Students will code their own model of Earth's energy balance in Python to demonstrate how greenhouse gases raise Earth's equilibrium temperature. Armed with the physical intuition for anthropogenic climate change, we will discuss the more complex models composing the Coupled Model Intercomparison Project (CMIP) that are used to inform the IPCC reports. Working in teams, students will read research papers to create a final presentation on how the signal of climate change manifests itself on a particular component of the Earth system. By the end of this course, students will feel confident in their ability to discuss the science, nuance, and uncertainty associated with Earth's changing climate.
Prerequisites: algebra and exposure to Python

ASSIGNMENTS

After the office hours window is up, a quiz will be available on Canvas for you to complete. You may use your notes from the lecture as well as any material on the Canvas page to complete the quiz, but you may not use any online resources. You can take the quiz as many times as you need in order to get full credit. After most classes, you will be asked to write a 1-page summary of the material covered and include any questions about the class material. Additional homework assignments may involve reading, writing, and/or

coding. Homework should take between 1 and 3 hours. If you are having difficulty finishing the homework in this time frame, please reach out to me.

The course will culminate in a final project. In a team of two to three, you will research how the signal of climate change manifests itself on a particular component of the Earth system. Some class time during the second week will be allocated for project work. During the final day of the course, you will present your findings.

No grades will be given for the homework assignments or final project.

CLASS STRUCTURE

Lectures will be 2 hours with a 5-minute break halfway through. Office hours will be after class each day for one hour (unless we decide otherwise).

STUDENT EXPECTATIONS

My expectations for you are chosen to enable you to meet the learning objectives of this course. If you are unable to meet any of these expectations or if they do not make sense to you, please come ask me.

IN CLASS

It is expected that you join every class on time and participate thoughtfully in in-class exercises and discussions. Students in the course come from a diversity of backgrounds and we ask that you treat everybody with respect and an open mind.

Your camera should be on unless you have received an exception from me. Please try to keep yourself muted unless you are speaking. Questions are encouraged – aim to ask at least one question per lecture. The best way to ask a question is using the raise hand feature on Zoom.

Unfortunately, we do not allow family members to sit in the course, so you should be in a room by yourself or with headphones in.

HOMEWORK

You are expected to try your best on all homework assignments. All parts of each problem should be attempted, but it is okay if you do not reach a final answer. It is more important that you show your work leading up to your answer rather than obtaining the correct answer. Much of the work in this course will build upon itself, so if you are confused about a topic, please ask for help early! Office hours are a great place to ask clarifying questions about lecture material. We will also use Canvas Discussions to facilitate discussion on homework and course materials. When creating a discussion, please include the day of the course the question pertains to. Please do not post code or explicit solutions to problems. Ideally, I would like to see that every student both asks and answers at least one question. Lastly, working in groups is encouraged, but the work you submit must be your own.

FINAL PROJECT

This course will culminate in a final project where you will research the impact of climate change on a component of the Earth System. On a team of two to three students, you will work to synthesize how scientists track this component of the Earth system and uncertainties around how they project climate change to impact it. You are each expected to be valuable group members that contribute equally to the research paper and presentation. More details will be provided during the first week of the class.

COURSE RESOURCES

All information related to the course will be available on the Canvas page. The course notes are organized on a Notion webpage. Class meetings will be on Zoom and offline discussions will be on the Ed platform.

There are no mandatory texts for this course. The list below contains optional resources that might help paint a broader picture of climate on Earth.

- The Climate Laboratory by Brian Rose
- The Climate Demon by R. Saravanan
- Climate and the Ocean by Geoffrey Vallis
- Global Warming Science by Eli Tziperman

GENERATIVE AI POLICY

Generative AI is an exceptional tool, reshaping how we work by maximizing efficiency. However, I believe the best learning is slow learning. For this reason, the use of Generative AI is prohibited to enhance your learning except under the following circumstances. Some assignments in this course will require use to Generative AI. Additionally, if you choose to include a data analysis component in your final project, you may use AI to help you code, so long as you cite it. If you are unsure of policies regarding generative AI, please ask for clarification. We are all adjusting to changes by the introduction of AI tools; if you disagree with this policy and would like to use AI in other parts of this course, please come talk to me during office hours.

ACCOMMODATIONS SYLLABUS STATEMENT

Students who may need accommodations based on the impact of a disability must initiate the request with the Office of Accommodations and Accessibility by submitting the SPCS Courtesy Accommodation request form provided to them during enrollment. The Office of Accommodations and Accessibility will evaluate the request, recommend reasonable accommodations, and communicate with the student and their instructional teams. The student's parent or legal guardian should contact the Office of Accommodations and Accessibility (ohsaccommodations@stanford.edu) should they have any questions regarding the accommodation process.

Stanford | Pre-Collegiate Studies

SCHEDULE

Lecture: 0800-1000 PST
Office hours: 1000-1100 PST

Day	Topic
7/7/25	Introduction, the Earth, and the atmosphere
7/8/25	The atmosphere and ocean
7/9/25	The cryosphere, biosphere, and lithosphere
7/10/25	Observations of climate change in the past and present
7/11/25	Radiative Physics
7/14/25	Earth's energy balance and the greenhouse effect
7/15/25	Modeling the influence of climate change on Earth's Energy Balance
7/16/25	Global Climate Models I
7/17/25	Global Climate Models II
7/18/25	Final Presentations

** subject to change