Department of Atmospheric Science
ATMO 449: Climate modeling, data analysis, and applications
Fall 2025

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Virtual Office: after class or by appointment **Physical Office:** HIG 335; by appointment

I. Course description

ATMO 449: Intro to Climate Modeling is offered by the Atmospheric Sciences Department and is cross-listed with the Department of Civil & Environmental Engineering (CEE 449) and satisfies the UH Manoa requirements for Sustainability Courses (SUST 449).
The goal of this course is to bring together in a collaborative setting people from different disciplines (Environmental Sciences, Data Science, Engineering, etc.) who will be trained in the fundamentals of modeling of climate with a focus on using climate model output for real-world applications.

- What are the basic concepts of climate variability and change?
- What are climate models?
- What climate phenomena affect extreme rainfall, wind, sea levels in Hawai‘i and around the world, and how do we simulate them using models?
- Where can we find climate model output data and how can we use them to answer problems related to infrastructure, agriculture, hazard mitigation, pollution control, environmental risk assessment?

II. Course Information, Policies and Resources

a. **Attendance policy:** *Students who are enrolled in this course, but never attend will be flagged by the course instructor for non-participation before the last day to add/drop (for 100% tuition refund) deadline. Flagged students will be administratively dropped by the Office of the Registrar. Any changes to a student's enrollment status may affect financial aid eligibility and can result in the return of some of all of federal student financial aid.*

   This is an online synchronous class; therefore, you should not have anything else scheduled on either Tuesdays or Thursdays at 3:00pm-4:15pm. The class meets online on Thursdays. You will most likely need to attend the virtual office hours on Tuesdays or use this time to meet with your teammates for your projects. Typically, the class needs more guidance during the second half of the semester, after lecture videos have concluded and classes are more hands-on.

b. **Statement on Disability: KOKUA Program** If you have a disability and related access needs, please contact the KOKUA Program (Office for Students with Disabilities) at 956-7511, KOKUA@hawaii.edu, or go to Room 013 in the Queen Lili‘uokalani Center for Student Services. Please know that I will work with you and KOKUA to meet your

access needs based on disability documentation. Kokua's services are confidential and offered free of charge.

c. **Academic Integrity and Ethical Behavior: Office of Student Conduct** Cheating, plagiarism, or other forms of academic dishonesty are not permitted within this course and are prohibited within the System-wide Student Conduct Code (EP 7.208). Examples include: fabrication, falsification, cheating, plagiarism, and use of improper materials. Any incident of suspected academic dishonesty will be reported to the Office of Student Conduct for review and possible adjudication. Additionally, the instructor may take action in regards to the grade for the deliverable or course as they see fit.
d. **Office of Title IX**: (808) 956-2299 / t9uhm@hawaii.edu / https://manoa.hawaii.edu/titleix/
e. **Department of Public Safety**: (808)956-6911 (Emergency) / (808)956-8211 (Non-Emergency) http://manoa.hawaii.edu/dps/
f. **UH System Basic Needs** include food and housing, childcare, mental health, financial resources and transportation, among others. Student basic needs security is critical for ensuring strong academic performance, persistence and graduation and overall student well being. If you or someone you know are experiencing basic needs insecurity, please see the following resources: UH System Basic Needs
g. **Student Success Resources:** The Division of Student Success (DSS) houses student support services to build success inside and outside the classroom. If you want learning assistance, academic advising, career resources and guidance, counseling, family and relationship support, identity-based support, services for underrepresented groups, health and wellness services, opportunities for leadership growth, and community engagement, you will find this and more in DSS, (808) 956-3290, https://manoa.hawaii.edu/studentsuccess/departments/

III. Course Content and Learning Objectives

Course Content

The course will cover the following subjects:

1. **Basics of the climate system:** basic mechanisms of climate variability and change at the spatial and temporal timescales of interest for engineering applications and decision-making
2. **Basics of climate modeling:** governing principles & components of climate models, complexity, parameterizations, resolution, model tuning & model uncertainty
3. **Climate data analysis & applications:** processing & analysis of climate model output, visualization of climate data, model intercomparison and data use in climate science & environmental engineering applications.

A **final group project** is required. Groups will choose an environmental engineering/science problem of their interest, such as regional precipitation, temperature variability and extremes, environmental conditions for renewable energy deployment, wind strength and/or direction, etc. They will identify and download climate data, analyze the data and use them as input for the

problem of choice. The overarching goal is a term project that illustrates the use of climate modeling and output to answer a specific regional- or global-scale problem, and identifies and assesses the uncertainty in the project findings and proposed solutions.

Course Learning Objectives

1. Describe basic principles of the climate system, its components, and important climate phenomena affecting regional and global climate at seasonal, interannual, decadal, and centennial time scales.
2. 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, present and future climates.
3. List the features, advantages, and limitations of global climate models.
4. Access climate model data of interest, compare with observational data, and perform basic climate data processing online and offline.
5. Perform intermodel comparison studies and process climate model output for use in applications.
6. Assess and effectively communicate uncertainty in climate model simulations and projections of future climate.
7. Prepare and present a climate model study as they would in a scientific conference.

IV. Required Texts and Readings

1. There is no required textbook for this course. Lecture notes, class reading, and term project resources are posted on Lamakū

V. Course Assignments, Evaluation and Grading

- **Assignments:** Worth 30% of the grade. Assignments must be completed in order to receive a passing grade. Students are encouraged to collaborate on the assignments and discuss with classmates and the instructor in the online forum, but answers to the questions must be their own.
  Assignments are due at 4:55pm (16:55) on Fridays.

  Late assignment policy: You are allowed two late assignments without a grade discount. After these, no late assignments will be accepted, and you will receive a zero for each unsubmitted assignment.

- **Participation:** Worth 10% of the grade. Consists of comprehension questions, surveys, and completion of online modules.
- **Term Project:** Worth 30% of the grade. Project deliverables include a project design sheet, step-by-step reports and milestones throughout the semester to ensure project completion, a final recorded oral presentation (~10 minutes), and a short "lightning" (3-4 minutes) in-class oral presentation.

- **Final Exam:** Worth 30% of the grade. The final exam will be take-home and will test your ability to use climate model data for intermodel comparison, model-data comparison and the application of the statistical techniques covered in the course.
- **Grading scheme:** Grading will not necessarily be on a curve. Everyone has the chance to get an A if they work for it and deserve it!

%	Grade	%	Grade
>100	A+	73-76.9	C
93-99.9	A	70-72.9	C-
90-92.9	A-	67-69.9	D+
87-89.9	B+	63-66.9	D
83-86.9	B	60-62.9	D-
80-82.9	B-	<59.9	F
77-79.9	C+		

VI. Calendar

*Course calendar and content may be subject to change.

Module	Date	Topic	Comments/Readings
1	8/26	**1.1:** Course Syllabus & Introduction **1.2:** HPC set-up	
	8/28	**Zoom:** Intro and HPC set-up	web/python
2	9/2	**2.1:** Earth's energy balance (EBMs)	
	9/4	**Zoom:** EBM lab and modules Term project examples/brainstorming/team selection	python
3	9/9	**3.1:** Climate change: Shortwave Radiation **3.2:** Climate change: Longwave Radiation	
	9/11	**Zoom:** Build Your Own Earth **Project deliverable:** Submit your research question and team	web
4	9/16	**4.1:** Anthropogenic Climate change **4.2:** A historical perspective	
	9/18	**Zoom:** The Charney Report discussion & term project examples **Project deliverable:** Submit literature review	
5	9/23	**5.1:** Climate Sensitivity and Feedbacks (theory). **5.2:** Important Climate Feedbacks	
	9/25	**Zoom:** Climate feedback exercise	python

		Project deliverable: Submit list of project datasets and variables	
6	9/30	**6.1:** Climate Variability-Interannual. Mechanisms, Impacts, Modeling	
		6.2: Intro to Climate Datasets and Climate Variability Calculations	python
	10/2	**Zoom:** Connecting Climate Variability & Change to Applications	
		Project deliverable: Submit list of project outputs/deliverables	
7	10/7	**7.1:** Climate model development: Dynamical Core	
		7.2: Climate model development: Parameterizations	
	10/9	**Zoom:** Term project resources & discussion	
		Project deliverable: Submit list of methods/tools	
8	10/14	**8.1:** Climate model development: Model tuning.	
		8.2: Model genealogy & uncertainty	Knutti et al. 2013
	10/16	**Zoom:** Knutti et al. discussion.	
		Project deliverable: Submit Term project proposals	
9	10/21	**9.1:** Basic components of an Earth System Model.	
		9.2: Intro to Climate Databases and raw Model output (CMIP). Example analysis: Temperature & wind changes in HI (model intercomparison)	python
	10/23	**Zoom:** Example discussion (python), Term project feedback in breakout rooms.	
		Project milestone: complete model-obs comparison (as needed)	
10	10/28	**10.1:** Control experiments and model skill	panoply
		10.2: Equilibrium, transient & single-forcing experiments	python
	10/30	**Zoom: Single-forcing exercise discussion.**	
		Project milestone: analyze future projections	
11	11/4	**11.1:** Climate data analysis & visualization in Python	
		11.2: Examining ENSO simulations in a CMIP6 model	python
	11/6	**Zoom: ENSO simulation exercise discussion.**	
		Project milestone: connection with applications	
12	11/11	Veterans Day	
		12.1: KNMI climate explorer. Online processing: Observations	web
	11/13	**Zoom:** KNMI climate explorer exercises (feedback)	web

		Project deliverable: Submit progress report; amend proposal if needed
13	11/18	**12.1:** Term Project components and Feedback: Write a scientific abstract
	11/20	**Zoom:** Breakout rooms and project guidance
14	11/25	**13.1:** Project completion, feedback
	11/27	**Thanksgiving**
15	12/2	**14.1:** Class overview & outlook. Knowledge Survey
	12/4	**Zoom:** Class overview & outlook. Presentation tips & logistics
16	12/9	**5:00pm Deadline to submit presentation videos. NO EXCEPTIONS.** Assignment: Watch and critique presentations.
	12/11	**Zoom:** Lightning presentations. Take Home Exam passed out and discussed
		Project deliverable: Submit presentations and code (if applicable). Last day of instruction
17	**12/16**	**exam period**
	12/18	**Final Exam & Project Poster (extra credit) DUE @ 4:15 pm**

University of Hawai‘i at Mānoa (UHM) TITLE IX SYLLABUS INFORMATION
UHM is 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 experiences any of these, UHM has staff and resources on campus to support and assist you. Staff also can direct you to resources in the community. Here are some:

If you wish to remain **ANONYMOUS**, speak with someone **CONFIDENTIALLY**, or would like to receive information and support in a **CONFIDENTIAL** setting, contact: (* **Confidential Resource**)

Counseling & Student Development Center* (808) 956-7927
• manoa.hawaii.edu/counseling/

Respondent Support (808) 956-4392 • PAUrs@hawaii.edu

Student Parents at Mānoa (SP@M)* (808) 956-8059 • manoa.hawaii.edu/studentparents/

UH Confidential Advocacy* • advocate@hawaii.edu

University Health Services Mānoa* (808) 956-8965 • hawaii.edu/shs/
http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to **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:

Director and Title IX Coordinator
Hawai‘i Hall 124
2500 Campus Road
Honolulu, HI 96822
(808) 956-2299
t9uhm@hawaii.edu

As a member of the University faculty, I am **required to immediately report** any incident of sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and I cannot guarantee confidentiality, you will still have options about how your case will be handled. My 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. For more information regarding sex discrimination and gender-based violence, the University's Title IX resources and the University's Policy, EP 1.204, go to: http://www.manoa.hawaii.edu/titleix/