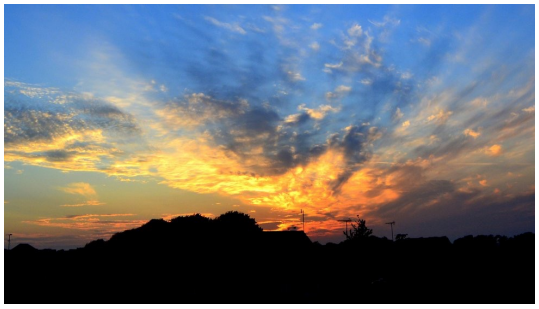
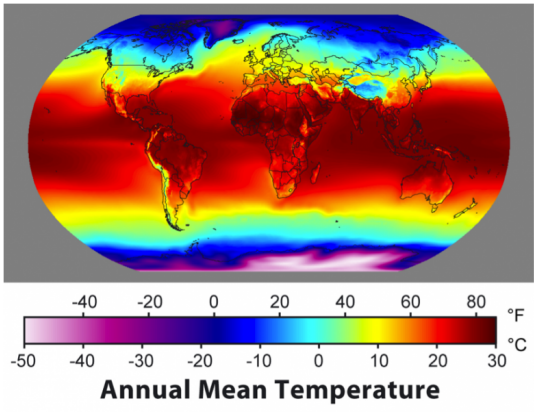
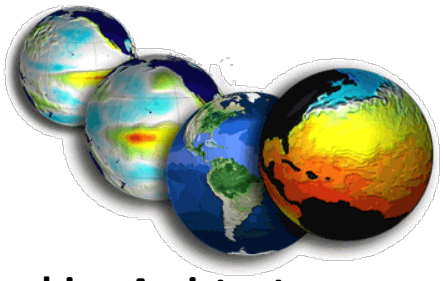
METR 4523

Climate and the General Circulation

Spring 2026
T/Th 10:00 - 11:15 AM
NWC 5600







Instructor

Dr. Jason C. Furtado
Email: jfurtado@ou.edu
Office: NWC 5240
Office Hours: By appointment. Book an appointment here.

Teaching Assistant

Mastooreh Ameri (NWC 3101)
maameri@ou.edu

Course Description

***Climate* has a long-lasting impact on our lives, including how we live, the energy we use, what we eat, and our overall cultural values. The Earth climate system is made up of multiple complex interactions across multiple media. Understanding Earth's energy balance and how it is altered is a major tenet of this class.**

METR 4523 is a course for upper-level meteorology and science majors. This course will present a *qualitative and quantitative* presentation of various climate and general circulation phenomena. Topics covered include the global and land-surface energy balance, the hydrologic cycle, atmospheric and ocean dynamics, climate feedbacks, modes of climate variability, and climate change.

Overall, this course will help students gain a scientific understanding of the fundamentals of the general circulation of Earth, its physical climate aspects, and understand why climate is changing. Thus, the student will be prepared to engage intelligently in discussions of the Earth climate system. Applications of this knowledge to, e.g., future climate change, will also be discussed.

LEARNING OUTCOMES

By the end of the course, students will be able to:

1. Provide an accurate description of the key drivers of the Earth physical climate system and link them to global temperature and precipitation patterns as observed today.
2. Identify and describe physically the major features of atmospheric and oceanic circulations on Earth.
3. Identify the dominant patterns of climate variability in the Earth climate system and their associated teleconnections.
4. Analyze and evaluate past and future climate change on Earth, including major drivers and the models used to make such assessments.

Prerequisites

Grade of C or better in MATH 2443, MATH 3413, PHYS 2524, and METR 4233.

Required Textbook

Global Physical Climatology. 2nd Edition. Dennis L. Hartmann. [Available as PDF files from on the Canvas course site. You may also purchase it at the OU Bookstore from your favorite vendor.]

Course Web Page

The web page will be accessible via https://canvas.ou.edu (log on using your OU 4+4). There you will find course materials, assignments, grades, and news and announcements about the course.

Grading

Homework Assignments:	45%	**In-Class Worksheets:**	15%
Midterm Exam:	20%	**Final Exam:**	20%

Final course grades (rounded to the nearest integer):

A: 90-100+% **B:** 80-89% **C:** 70-79% **D:** 60-69% **F:** < 60%

HOMEWORK ASSIGNMENTS. Assignments will be given approximately every 1.5-2 weeks. Assignments will contain both quantitative and qualitative questions. One or two assignments will involve writing a critique or summary. Some questions will also include a **programming** component, where students will have to write and/or work with existing code to complete a task. The language of choice for this course will be **Python**. All students should have a working knowledge of Python from earlier METR courses. **Note:** The professor and the TA are **not** responsible for debugging any code. Students have access to Python in the METR computer lab or via the OU JupyterHub: **https://jupyter.lib.ou.edu/**.

Please show all of your work on the assignments for full credit. Final answers should have the proper units and be boxed (when appropriate). Explanations should be in complete sentences with proper grammar and punctuation. If requested, well-labeled, aesthetically appealing maps and plots are expected with a programming assignment. While I encourage students to work together on assignments, each student must turn in their own original assignment for a grade. Late homework submissions will be assessed **5% per day** in penalty points unless prior approval has been given for turning in an assignment late. Assignments will **not** be accepted more than a week after the due date without prior approval. **All assignments will be turned in via Gradescope** (link on the Canvas course site).

MIDTERM/FINAL EXAMS. These exams will cover material from roughly each half of the semester. The format of the exams will be a mixture of multiple choice, quantitative problems, and short answer. The final exam is *not comprehensive* per se. However, as with many sciences, concepts "build upon" each other, so you will be required to have some knowledge of earlier concepts. All exams are closed book unless otherwise stated. You may use a calculator as an aid on the exam. Makeup exams are allowed with my permission.

IN-CLASS WORKSHEETS. Collaborative learning is an excellent way to understand scientific concepts. Occasionally, we will work on problems and questions in small groups (~2-4 students) during class and then collectively discuss the answers. These in-class worksheets will be turned in and graded, so please come to class ready to participate actively.

Course Mechanics

COURSE STYLE. The overall structure of the class will consist of traditional lectures covering major topics. Lectures will feature Powerpoint slides and handwritten notes. All slides will be made available on Canvas after the class meeting. Questions and interactions during class are welcome and highly encouraged. Occasionally, we will have group discussion / "think-pair-share" questions during lecture to reinforce concepts and encourage critical thinking. These types of interactions also foster collaborative learning, which is important in the sciences. While certain interactions are graded, others will not be.

However, your active participation will contribute positively to your performance in the class.

ASSIGNMENTS. Homework assignments and worksheets will be made available electronically to students via Canvas. Completed assignments will be uploaded for grading to **Gradescope**. Information for submitting assignments is on Canvas. For assignment submissions, consider the following:

- Unless otherwise indicated, you may **type** or **handwrite (legibly)** your assignments**.** Also, please use **blank white paper** (lined is OK) for your answers.
- For **worksheets**, you can type or write the answers in the space provided in the Word document, scan, and upload the completed worksheet. Alternatively, follow the instructions for homework assignments (see below).
- For **homework assignments**, the solution to a new problem **must start on a new page**. This is very important for uploading your assignment to Gradescope.
- Put your name on the top of **each and every page** of your assignment.
- If you **typed** your assignment, you can upload PDF copies of the answers. If you **handwrite** your assignment, you can scan the pages (e.g., using Scannable or any other free app) OR take **clear photos** of each page for uploading.

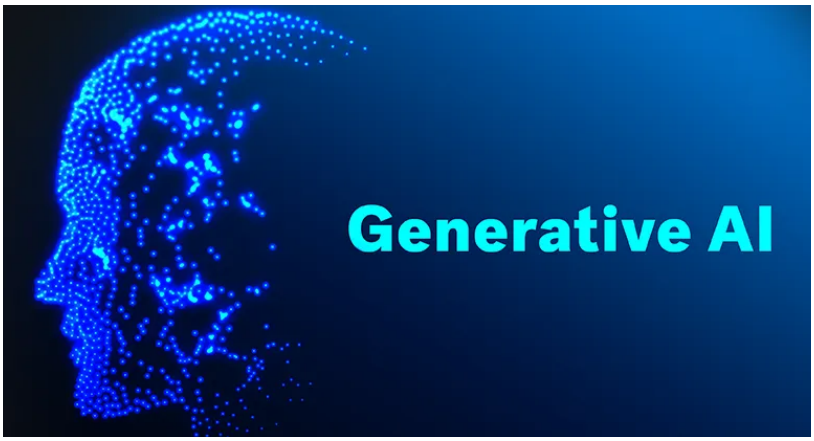
EXAMS. There will be a midterm exam and a final exam in the course. Specific details about each exam will be provided in class at a later time.

OFFICE HOURS. Office hours with Dr. Furtado are by appointment and can be in-person or via Zoom. Please use this **Bookings site** to schedule an appointment.

COMMUNICATION PLAN. Email will be the primary form of communication. The professor and TA will respond to emails within 24 hours if sent on weekdays; 48-72 hours if sent on weekends or holidays. To make seeing your email easier, please start the subject line of the email with **[METR 4523]**.

EXPECTATIONS OF THE STUDENT

- Arrive to class on time and prepared to learn.
- Submit assignments and take exams on time.
- Be courteous and respectful to other students.
- Refrain from using your cell phone (texting or calling) or using social media during class. Also, keep side conversations to a minimum.
- Take an **active role** in learning and **ask questions** when needed.
- Seek assistance from the professor and the TA if you do not understand the material and/or need help with an assignment.



Generative AI Policy

We learn best when we are actively engaged in the process of completing all aspects of an assignment. Additionally, the hallmarks of a good scientist are to: (1) think critically, (2) approach scientific questions with inquisitive, original thoughts, (3) apply your learned technical skills to analyze and address the problem, and (4) effectively communicate the results. Thus, even the brainstorming and initial hypothesis building and understanding stages of a problem are times of discovery that is an integral part of your learning. To empower you to fully engage in the learning process, **unless otherwise directed, the use of Generative AI, including, but not limited to, ChatGPT, CoPilot, ClaudeAI, Gemini, and Grammarly AI**, **is considered a violation of the academic integrity policy for this course**. As the use of Generative AI to assist in completing any aspect of work for this course is prohibited, this includes using Generative AI to answer worksheet and homework questions, write code for data analysis, write or edit papers, and to take your quizzes or exams. If using an e-book or search engine that has integrated Generative AI, then you should not rely on the Generative AI output and engage instead with the source material.

To implement this policy, exams have been designed to either occur in a controlled environment (such as in-class or with Lockdown Browser) or so that it is unlikely that one can be successful in completing an assignment using Generative AI.

Resources are available to help you where you might otherwise want to use Generative AI, including: Academic Success Center, subject specific research support (see resources by subject), and simple grammar or spell check tools. I also want you to reach out to me if you have any questions or concerns.

If you have any questions about this policy or what counts as Generative AI, please talk with me.

Consequences for Violating the Generative AI Usage Policy: Any usage of Generative AI in this course may be considered a violation of the academic integrity policy for this course and could result in a zero for an assignment, exam, or a failing grade on the course.

Copyright Statement for In-Person or Online Courses

Sessions of this course may be recorded or live-streamed. These recordings are the intellectual property of the individual faculty member and may not be shared or reproduced without the explicit, written consent of the faculty member. In addition, privacy rights of others such as students, guest

lecturers, and providers of copyrighted material displayed in the recording may be of concern. Students may not share any course recordings with individuals not enrolled in the class or upload them to any other online environment.

Reasonable Accommodation Policy

The University of Oklahoma (OU) is committed to the goal of achieving equal educational opportunity and full educational participation for students with disabilities. If you have already established reasonable accommodations with the Accessibility and Disability Resource Center (ADRC), please log into iAdvise to request your semester accommodations as soon as possible and contact me privately, so that we have adequate time to arrange your approved academic accommodations.

If you have not yet established services through ADRC, but have a documented disability and require accommodations, please complete ADRC's pre-registration form to begin the registration process. ADRC facilitates the interactive process that establishes reasonable accommodations for students at OU. For more information on ADRC registration procedures, please review their website. You may also contact them at (405) 325-3852 or adrc@ou.edu, or visit www.ou.edu/adrc for more information.

Note: disabilities may include, but are not limited to, mental health, chronic health, physical, vision, hearing, learning and attention disabilities, pregnancy-related. ADRC can also support students experiencing temporary medical conditions.

Academic Misconduct

Cheating is strictly prohibited at the University of Oklahoma. Simply put, it devalues your degree and ends up marring your character and reputation. As a member of the OU community, it is your responsibility to protect your educational investment by knowing and following the rules. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at http://integrity.ou.edu/students.html.

To be successful in this class, all work on examinations and assignments must be **yours and yours alone**. You may work together on homework assignments and in-class group exercises, but you must submit your own original work for grading. On exams, you **are not** permitted to use your notes,

textbooks, or any Generative AI tools. Should you see someone else engaging in this behavior, I encourage you to report it to myself or directly to the Office of Academic Integrity Programs. That student is devaluing not only their degree, but yours, too. Be aware that I am obligated to report academic misconduct, which I will not hesitate to do. Sanctions for academic misconduct can include expulsion from the University and an F in this course. **BOTTOM LINE:** Don't cheat - it's not worth it.

Religious Observances

It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty. [See Faculty Handbook 3.15.2]

Title IX Resources and Reporting Requirement

The University of Oklahoma faculty are committed to creating a safe learning environment for all members of our community, free from sex-based discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking, in accordance with Title IX. There are resources available to those impacted, including: speaking with someone confidentially about your options, medical attention, counseling, reporting, academic support, and safety plans. If you have (or someone you know has) experienced any form of sex-based discrimination or violence and wish to speak with someone confidentially, please contact OU Advocates (available 24/7 at 405-615-0013) or University Counseling Center (M-F 8 a.m. to 5 p.m. at 405-325-2911).

Because the University of Oklahoma is committed to the safety of you and other students, and because of our Title IX obligations, I, as well as other faculty, Graduate Assistants, and Teaching Assistants, are mandatory reporters. This means that we are obligated to report sex-based violence that has been disclosed to us to the Institutional Equity Office. This means that we are obligated to report sex-based violence that has been disclosed to us to the Institutional Equity Office. This includes disclosures that occur in: class discussion, writing assignments, discussion boards, emails and during Student/Office Hours. You may also choose to report directly to the Institutional Equity Office. After a report is filed, the Title IX Coordinator will reach out to provide resources, support, and information and the reported information will remain private. For more information regarding the University's Title IX Grievance procedures, reporting, or support measures, please visit Institutional Equity Office at 405-325-3546. s, reporting, or support measures, please visit Institutional Equity Office at 405-325-3546.

Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please please request modifications via the Institutional Equity Office website or call the Institutional Equity Office at 405/325-3546 as soon as possible. Also, see the Institutional Equity Office FAQ on Pregnant and Parenting Students' Rights for answers to commonly asked questions.

Final Exam Preparation Period

Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's Final Exam Preparation Period policy.

Mental Health Support Services

Support is available for any student experiencing mental health issues that are impacting their academic success. Students can either been seen at the University Counseling Center (UCC) located on the second floor of Goddard Health Center or receive 24/7/365 crisis support from a licensed mental health provider through TimelyCare. To schedule an appointment or receive more information about mental health resources at OU please call the UCC at 405-325-2911 or visit University Counseling Center. The UCC is located at 620 Elm Ave., Room 201, Norman, OK 73019.

Emergency Protocol

During an emergency, there are official university procedures that will maximize your safety.

Severe Weather: If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather

1. ***LOOK*** for severe weather refuge location maps located inside most OU buildings near the entrances.
2. ***SEEK*** refuge inside a building. Do not leave one building to seek shelter in another building that you deem safer. If outside, get into the nearest building.
3. ***GO*** to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows.
4. ***GET IN, GET DOWN, COVER UP.***
5. ***WAIT*** for official notice to resume normal activities.

Additional Weather Safety Information is available through the Department of Campus Safety.

The University of Oklahoma Active Threat Guidance

The University of Oklahoma embraces a Run, Hide, Fight strategy for active threats on campus. This strategy is well known, widely accepted, and proven to save lives. To receive emergency campus alerts, be sure to update your contact information and preferences in the account settings section at one.ou.edu.

RUN: Running away from the threat is usually the best option. If it is safe to run, run as far away from the threat as possible. Call 911 when you are in a safe location and let them know from which OU campus you're calling from and location of active threat.

HIDE: If running is not practical, the next best option is to hide. Lock and barricade all doors; turn off all lights; turn down your phone's volume; search for improvised weapons; hide behind solid objects and walls; and hide yourself completely and stay quiet. Remain in place until law enforcement arrives. Be patient and remain hidden.

FIGHT: If you are unable to run or hide, the last best option is to fight. Have one or more improvised weapons with you and be prepared to attack. Attack them when they are least expecting it and hit them where it hurts most: the face (specifically eyes, nose, and ears), the throat, the diaphragm (solar plexus), and the groin.

Please save OUPD's contact information in your phone.

- **NORMAN campus**: *For non-emergencies call (405) 325-1717. For emergencies call (405) 325-1911 or dial 911.*
- **TULSA campus**: *For non-emergencies call (918) 660-3900. For emergencies call (918) 660-3333 or dial 911.*

Fire Alarm/General Emergency

If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates:

1. ***LEAVE*** the building. Do not use the elevators.
2. ***KNOW*** at least two building exits.
3. ***ASSIST*** those that may need help.
4. ***PROCEED*** to the emergency assembly area.
5. ***ONCE*** *safely outside,* ***NOTIFY*** *first responders of anyone that may still be inside building due to mobility issues.*
6. ***WAIT*** for official notice before attempting to re-enter the building.

OU Fire Safety on Campus

Tentative Class Schedule

Week	Dates	Topic	Readings
1	Jan 20, 22	Course Introduction / Math & Thermodynamics Review	Chapter 1
2	Jan 27, 29**	Energy Balance & Surface Energy Budget	Chapters 2 & 4
3	Jan 28, 30	Hydrologic Cycle / Evaporation / Water Balance	Chapter 5
4	Feb 3, 5	General Circulation of the Atmosphere (Mean Meridional Cells / Jet Stream)	Chapter 6
5	Feb 10, 12	General Circulation of the Atmosphere (Roles of Waves and Energy Conversion)	Chapter 6
6	Feb 17, 19	Ocean Dynamics	Chapter 7
7	Feb 24, 26	Ocean Dynamics / Boundary Currents	Chapter 7
8	Mar 3, 5	The Thermohaline Circulation	Chapter 7
9	Mar 10, 12	Modes of Climate Variability **MIDTERM EXAM**	Chapter 8 & Select Readings
10	Mar 17, 19	**SPRING BREAK [NO CLASSES]**	
11	Mar 31, Apr 2	Modes of Climate Variability / ENSO Dynamics	Chapter 8 & Select Readings
12	Apr 7, 9	Introduction to Climate Change	Chapters 9 & 10
13	Apr 14, 16	Climate Feedbacks	Chapters 9 & 10
14	Apr 21, 23	Climate Change: Observed and Natural Forcings	Chapter 12
15	Apr 28, 30	Climate Models: Simple and Complex	Chapters 11 & 13; Select Readings
16	May 5, 7	Climate Change: Future Projections and Implications	Chapters 11 & 13; Select Readings

FINAL EXAM: WEDNESDAY, MAY 13, 2026 8:00 AM - 10:00 AM

***AMS Annual Meeting in Houston, TX*