

METR 4523

Climate and the General Circulation

Spring 2023
TR 10:30 - 11:45 AM
NWC 5600

Instructor

Dr. Jason C. Furtado (he/him)

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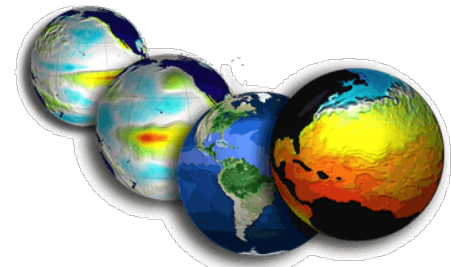
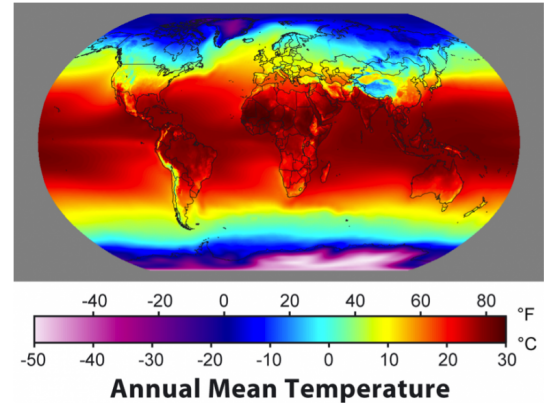
Office Hours: By appointment

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.



Teaching Assistant

Melanie Schroers

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GOALS

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

1. Explain the basic principles of how the Earth physical climate system functions.
2. Examine the role of land-atmosphere-ocean interactions in shaping the Earth climate system.
3. Identify and physically understand major features of atmospheric and oceanic circulations.
4. Identify and understand dominant patterns of climate variability in the Earth climate system.
5. Interpret and explain past and future climate change on Earth, based on the synthesis of the above.

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 or purchase/rent it 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%
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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. In preparing 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. We will use Gradescope for our exams. Specific details will be provided at a later time.

OFFICE HOURS. Office hours with Dr. Furtado are by appointment and can be in-person or via Zoom. Please use the Bookings site (<https://outlook.office365.com/owa/calendar/METR4523ClimateandtheGeneralCirculation@ou.edu/bookings/>) 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]**.

- 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.

EXPECTATIONS OF THE STUDENT



Land Acknowledgement

Long before the University of Oklahoma was established, the land on which the University now resides was the traditional home of the “Hasinai” Caddo Nation and “Kirikirʔi:s” Wichita & Affiliated Tribes. We acknowledge this territory once also served as a hunting ground, trade exchange point, and migration route for the Apache, Comanche, Kiowa and Osage nations. Today, 39 tribal nations dwell in the state of Oklahoma as a result of settler and colonial policies that were designed to assimilate Native people. The University of Oklahoma recognizes the historical connection our university has with its indigenous community. We acknowledge, honor and respect the diverse Indigenous peoples connected to this land. We fully recognize, support and advocate for the sovereign rights of all of Oklahoma’s 39 tribal nations. This acknowledgement is aligned with our university’s core value of creating a diverse and inclusive community. It is an institutional responsibility to recognize and acknowledge the people, culture and history that make up our entire OU Community.

Reasonable Accommodation Policy

The Accessibility and Disability Resource Center (ADRC) is committed to supporting students with disabilities to ensure that they are able to enjoy equal access to all components of their education. This includes your academics, housing, and community events. If you are experiencing a disability, a mental/medical health condition that has a significant impact on one or more life functions, you can receive accommodations to provide equal access. Possible disabilities include, but are not limited to, learning disabilities, AD(H)D, mental health, and chronic health. Additionally, we support students with temporary medical conditions (broken wrist, shoulder surgery, etc.) and pregnancy. To discuss potential accommodations, please contact the ADRC at 730 College Avenue, (ph.) 405.325.3852, or adrc@ou.edu.

Copyright Statement for Recordings of Course Sessions

Sessions of this course may be recorded or live-streamed with permission of the instructor. 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.



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 or textbooks. 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.

Title IX Resources and Reporting Requirement

Anyone who has been impacted by gender-based violence, including dating violence, domestic violence, stalking, harassment, and sexual assault, deserves access to resources so that they are supported personally and academically. The University of Oklahoma is committed to offering resources to those impacted, including: speaking with someone confidentially about your options, medical attention, counseling, reporting, academic support, and safety plans. If you would like to speak with someone confidentially, please contact OU Advocates (available 24/7 at 405.615.0013) or another

confidential resource (see “Can I make an anonymous report?”). You may also choose to report gender-based violence and discrimination through other means, including by contacting the Institutional Equity Office (ieo@ou.edu, 405.325.3546) or police (911). Because the University of Oklahoma is committed to the safety of you and other students, I, as well as other faculty, Graduate Assistants, and Teaching Assistants, are mandatory reporters. This means that we are obligated to report gender-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. For more information, please visit the Institutional Equity Office.

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 contact your professor or the Accessibility and Disability Resource Center at 405.325.3852 as soon as possible. Also, see the Institutional Equity Office FAQ on Pregnant and Parenting Students’ Rights (<https://www.ou.edu/eoo/faqs/pregnancy-faqs>) 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 (<https://apps.hr.ou.edu/FacultyHandbook#4.10>).

Mental Health Support Services

If you are experiencing any mental health issues that are impacting your academic performance, counseling is available at the University Counseling Center (UCC). The Center is located on the second floor of the Goddard Health Center, at 620 Elm Rm. 201, Norman, OK 73019. To schedule an appointment call 405.325.2911. For more information please visit <http://www.ou.edu/ucc>.



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.

[Link to Severe Weather Refuge Areas](#) , [Severe Weather Preparedness - Video](#)

Armed Subject/Campus Intruder: If you receive an OU Alert to shelter-in-place due to an active shooter or armed intruder situation or you hear what you perceive to be gunshots:

1. **GET OUT:** If you believe you can get out of the area WITHOUT encountering the armed individual, move quickly towards the nearest building exit, move away from the building, and call 911.
2. **HIDE OUT:** If you cannot flee, move to an area that can be locked or barricaded, turn off lights, silence devices, spread out, and formulate a plan of attack if the shooter enters the room.
3. **TAKE OUT:** As a last resort fight to defend yourself.

For more information, visit <http://www.ou.edu/emergencypreparedness.html>

[Shots Fired on Campus Procedure - Video](#)

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	Textbook Readings
1	Jan 17, 19	Course Introduction / Math & Thermodynamics Review	Chapter 1
2	Jan 24, 26	Energy Balance & Surface Energy Budget (Review)	Chapters 2 & 4
3	Jan 31, Feb 2	Hydrologic Cycle / Evaporation / Water Balance	Chapter 5
4	Feb 7, 9	General Circulation of the Atmosphere (Mean Meridional Cells / Jet Stream)	Chapter 6
5	Feb 14, 16	General Circulation of the Atmosphere (Roles of Waves and Energy Conversion)	Chapter 6
6	Feb 21, 23	Ocean Dynamics	Chapter 7
7	Feb 28, Mar 2	Ocean Dynamics / Boundary Currents	Chapter 7
8	Mar 7, 9	The Thermohaline Circulation MIDTERM EXAM	Chapter 7
9	Mar 14, 16	SPRING BREAK [NO CLASSES]	
10	Mar 21, 23	Modes of Climate Variability	Chapter 8 & Select Readings
11	Mar 28, 30	Modes of Climate Variability / ENSO Dynamics	Chapter 8 & Select Readings
12	Apr 4, 6	Introduction to Climate Change / Climate Feedbacks	Chapters 9 & 10
13	Apr 11, 13	Climate Feedbacks	Chapters 9 & 10
14	Apr 18, 20	Climate Change: Observed and Natural Forcings	Chapter 12
15	Apr 25, 27	Climate Models: Simple and Complex	Chapters 11 & 13
16	May 2, 4	Climate Change: Future Projections and Implications	Chapters 11 & 13

FINAL EXAM: WEDNESDAY, MAY 10, 2023 8:00 AM - 10:00 AM