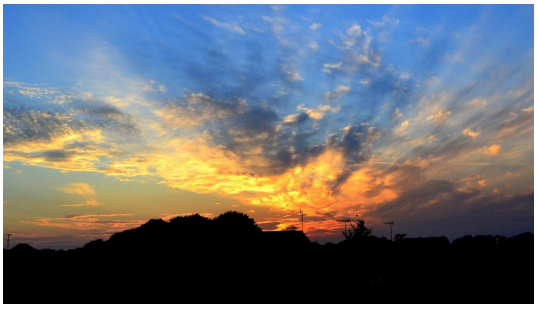
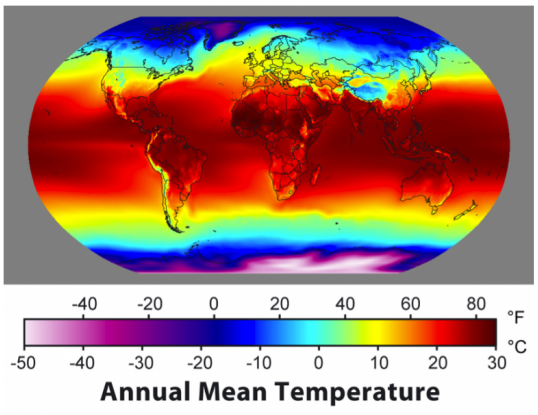
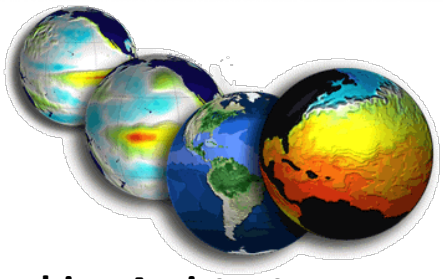
# METR 4803

# Physical Meteorology III - Radiation and Climate

**Fall 2019**
**MWF 10:00 - 10:50 AM**
**NWC Rm. 5600**





## Instructor

**Dr. Jason C. Furtado**
**Office:** National Weather Center (NWC) Rm. 5240
**Phone:** 405.325.1391
**Email**: jfurtado@ou.edu
**Twitter:** @wxjay
**Office Hours:** By appointment.

## Teaching Assistant

**Matt Rogers (NWC Rm. 5357)**
m.rogers@ou.edu
**Office Hours:** Mon & Fri 3-4 PM

## 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 4233/4803** is a course for upper-level meteorology and science majors. This course will present a qualitative and quantitative presentation of various radiation and climate processes and their impact on the environment. Topics covered include the global and land-surface energy balance, the hydrologic cycle, ocean dynamics, climate feedbacks, modes of climate variability, and climate change.

Overall, this course will help students gain a scientific understanding of the climate of Earth, its physical aspects, and understand why climate is changing. Thus, the student will be prepared to engage intelligently in discussion of climate and climate change. Applications of this knowledge to other aspects of meteorology (e.g., sub-seasonal forecasting, future climate change projections) will also be discussed.

# 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. Evaluate and understand the global and surface energy balance of Earth and how changes in the Earth's physical climate system alter these balances.
3. Examine the role of land-atmosphere-ocean interactions in shaping the Earth climate system.
4. Identify and understand the 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

METR 3123 and 3233 [C or better] and MATH 2934 or equivalent [i.e., you have to have a working knowledge of calculus for this course].

## Required Text

*Global Physical Climatology.* 2nd Edition. Dennis L. Hartmann. [Available for purchase at the bookstore or online. A copy is also on reserve in the NWC library.]

## 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% |
| **Midterm Exam:** | 20% |
| **Final Exam:** | 20% |
| **In-Class Worksheets:** | 15% |

**HOMEWORK ASSIGNMENTS.** Assignments will be given roughly every 1.5-2 weeks. Most homework assignments will contain both quantitative and qualitative questions. One or two assignments will involve reading and critiquing journal articles on topics relevant to the course. Some problem sets will also include a **programming** component, where students will have to design 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 and will have access to Python via SoM Computer Lab computers to complete the assignments. Alternatively, you can install a copy of Python on your own computer (see the SoM IT staff for assistance). **Note:** The professor and the TA are **not** responsible for debugging any code.

Please show all of your work on your 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-commented and neat code are expected when turning in 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.

**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-style questions. 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, and you may only use a calculator as an aid on the exam. No makeup exams will be given unless the instructor allows.

**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 collected and graded, so please come to class ready to participate actively.

## Course Style

The overall structure of the class will consist of traditional lectures covering major topics. 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.

- Arrive to class on time and prepared to learn.
- Submit assignments timely and take exams on the day scheduled.
- 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

## Reasonable Accommodation Policy

The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodation in this course are requested to speak with me as soon as possible. Students with disabilities must be registered with the Disability Resource Center (DRC) prior to receiving accommodations in this course. The DRC is located in University Community Center (730 College Ave). Phone: 405.325.3852. E-mail: drc@ou.edu. The National Weather Center has also set up a DRC-approved space for taking exams. Once registered, please notify the instructor if you wish to use this space for taking exams or quizzes.

## 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. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at http://integrity.ou.edu/students.html. If you are caught cheating, I am obligated to report it. 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.

To be successful in this class, all work 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.

## Religious Holidays

University policy allows for excused absences for students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required classwork that may fall on religious holidays. Any student who has a religious holiday fall on one of the exam days, please see the instructor no later than one week before the exam so as to make other arrangements.

## Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/ domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405.325.2215 or smo@ou.edu. Incidents may also be reported confidentially to OU Advocates (405.615.0013) 24 hours a day, 7 days a week. Please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies may be directed to: Bobby J. Mason, University Equal Opportunity Officer and Title IX Coordinator at 405.325.3546 or bjm@ou.edu. For more information, please visit http://www.ou.edu/eoo.html.

## Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy- or childbirth-related issues, please contact the instructor or the Disability Resource Center at 405.325.3852 as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html 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).

## 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 | Readings |
|---|---|---|---|
| **1** | Aug 19, 21, 23 | Course Introduction / Math & Thermodynamics Review | Chapters 1 & 2 |
| **2** | Aug. 26, 28, 30 | Global Energy Balance | Chapters 2 & 3 |
| **3** | Sept 4, 6 | Global Energy Balance / Atmospheric Absorption **LABOR DAY - SEPT 2 - NO CLASS** | Chapters 2 & 3 |
| **4** | Sept 9, 11, 13 | Atmospheric Absorption & Emission | Chapter 3 |
| **5** | Sept 16, 18, 20 | Radiative Transfer / Surface Energy Balance | Chapters 3 & 4 |
| **6** | Sept 23, 25, 27 | Surface Energy Budget / Boundary Layer | Chapter 4 |
| **7** | Sept 30 Oct 2, 4 | Hydrologic Cycle / Land-Atmosphere Interactions | Chapter 5 |
| **8** | Oct 7, 9 | Evaporation / Water Balance **FALL DAY - OCT 11 - NO CLASS** | Chapter 5 |
| **9** | Oct 14, 16, 18 | **MIDTERM EXAM** Atmospheric Motions & Fluxes | Chapters 6.1 - 6.4 |
| **10** | Oct 21, ***23, 25*** | Atmospheric Motions / General Circulation of the Ocean | Chapters 6-7 |
| **11** | Oct 28, 30 Nov 1 | Ocean Dynamics | Chapters 6.5, 7, & 8 |
| **12** | Nov 4, 6, 8 | Modes of Climate Variability | Chapter 8 & Select Readings |
| **13** | Nov 11, 13, 15 | ENSO Dynamics / Intro to Climate Change | Chapters 8, 10, & Select Readings |
| **14** | Nov ***18, 20, 22*** | Climate Change + Feedbacks | Chapters 10 & 12 |
| **15** | Nov 25 | Climate Change **THANKSGIVING - NOV 27, 29 - NO CLASS** | Chapters 12 & 13 |
| **16** | Dec 2, 4, 6 | Climate Change Projections / Climate Models | Chapters 11-13 & Select Readings |

**FINAL EXAM: MONDAY, DECEMBER 9, 2019 8:00 AM - 10:00 AM NWC Rm. 5600**

**Note:** Dates in **bold** and *italic* are dates that Professor Furtado expects to be out of town. TA Matt Rogers will be teaching classes those days.