

GEOG 430/530 The Climate System

Spring 2024

This course is intended for upper-level undergraduates and graduate students and intensively reviews the fundamental physical processes that control the features and patterns of variability and change in the Earth's climate system with a particular focus on energy in the Earth system. The course includes hands-on experience and exploration including quantitative evaluation of physical climate processes and analysis of climate observational and model data. Specific topics include the Earth's energy balance and the greenhouse effect and the role of the biosphere and carbon cycle in controlling energy and temperature in the Earth system, the circulation of the oceans and atmosphere, observations of past and present climate change and simulation for predicting future climate, and specific anticipated impacts of future climate change including drought, glacier and ice sheet changes, and sea level rise.

The goal of the course is to provide students with an *intensive* and *physically-based* understanding of the fundamental processes that control climate variability and climate change at a range of temporal and spatial scales. Students will develop process-based knowledge, learn to quantitatively evaluate climate data, and provide them with the necessary understanding of the physical, chemical, and dynamical processes and phenomena of the climate system to incorporate these within their own scholarship and research.

This syllabus and course schedule are subject to change.
Please check regularly for updated information on D2L
Last Updated 7 January 2024

Locations and Times

Tuesday and Thursday 12:30PM to 1:45PM
ENR2 Room S230
Course materials online via D2L (<http://d2l.arizona.edu>)

Instructor Information

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Laboratory of Tree Ring Research
Room S514, Environment and Natural Resources Building 2 (ENR2)
Room 419, Bannister Tree Ring Lab Building
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Office Hours

Office Hours: with advance notice on Tuesday between 3pm to 5pm or by appointment

Course Information

Prerequisites

Undergraduates: GEOG230 or the equivalent or permission of instructor. Graduates: Degree-seeking in good standing and with continuing graduate student status. The instructor reserves the right to administratively drop any student who he considers to be behaving in a threatening or disruptive manner.

Course Objectives

This course has the following learning objective:

- Factual: You will acquire knowledge related to processes and phenomena of the Earth's climate system

- Conceptual: You will develop understanding of fundamental principles foundational theories, and general physical and qualitative models concerning the climate system.
- Procedural: You will learn how and when to apply subject-specific knowledge and skills, concepts, and scientific reasoning when interpreting or evaluating observations of, theories on, and claims about the climate system. You will be able to differentiate between magnitudes of effects or processes, identify reasonable inferences or conclusions, and recognize likely outcomes, based on your understanding of the integrated climate system.
- Metacognitive: You will learn how to develop strategies to analyze data, and learn how to critique (and accept criticism) of your technical and scientific writing

Undergraduate Learning Outcomes

For Geography undergraduate majors (GEOG 430), this course addresses the following learning outcomes:

1. Demonstrate knowledge of core principles of physical geography in climatology and water resources
2. Recognize the key factors influencing global and regional climate in the past, present, and future.
3. Evaluate linkages between the natural environment and human systems
4. Demonstrate ability to create, refine, and interpret graphical data.
5. Understand human dimensions of environmental issues
6. Understand causes and effects of regional and global environmental change.
7. Understand concepts required for success in an environmental profession

Recommended Text

There is no required textbook for this course; however, *particularly for graduate students*, I recommend purchasing *Global Physical Climatology*, 2nd Edition, by Dennis Hartmann, available online. Any additional required readings will be posted on D2L.

Assignments and Methods of Assessment

Lab Exercises: [50%] These 6 assignments ask you to analyze data about the climate system, develop hypotheses, make observations, and justify conclusions. These are an opportunity for you to apply what you've learned in class to new but related data, observations, phenomena, or situations. The exercises will be available simultaneously with designated class ('lab') periods as part of the normal course schedule, and will be due approximately a week afterwards. Unless otherwise stated for a specific assignment, you may work with *up to one* additional person (therefore, a maximum group size of two) on these assignments. When appropriate, graduate students are very strongly encouraged to make use of a high-level programming language (R, Python, or MATLAB, etc) when completing their assignments. I will drop the lowest grade, so each lab is essentially worth 10% of your grade.

Exams [30%] Two exams worth 30% total of your final grade (15% each). Format is short answers including calculations, making and interpreting diagrams and sketches, and analysis of scientific figures or schematics. A study sheet will be posted prior to each exam.

Term Paper [20% (includes presentations for graduate students)]

Students will propose (20 points) and write (100 points) an analytical paper on a topic of their choice related to the class (typical length will be 10 to 15 pages, 10 to 12 point font, 1.5 or double spaced, normal margins). The paper should incorporate and explore some physical, quantitative aspect of planetary climate systems. Such a paper can take several forms. Students may chose to explore in-depth a controversial or developing area of climate science, synthesizing up-to-date literature and evaluating the relative merits of scientific data, methods, and conclusions. Student may also undertake their own quantitative analysis of some climate or environmental data, describing the data sources,

methods, results, and conclusions in the manner of a peer-review manuscript. Finally, students may choose to examine a specific policy or management topic in light of the relevant aspects of the physical climate system. Such a paper could, for instance, evaluate or develop a policy or management plan reflecting the observed or expected impact on some aspect of the climate system, ecosystem, or human population. There is considerable latitude in developing this paper, *so long as the topic and analysis is grounded in a physical and quantitative understanding of the climate system* and goes beyond simply summarizing existing or general knowledge.

The students will first develop a brief (1-2 paragraphs) proposal and summary (or Précis) prior to writing the paper itself (this Précis is due Thursday, April 4th on D2L and is worth 20 points of the total assignment grade). Students must also have a complete first draft reviewed by another student in the class. This draft, comments, and markup should be turned in with the final paper (100 points on the total assignment grade) by May 3rd on D2L.

Graduate students will also create and deliver a lightning talk on their term paper during the last class period.

Graduate Student Supplement [Required for Graduate Credit] Graduate students will be required to complete up to 8 additional readings from the primary scientific literature and complete a 1 to 2 page guided response related to each. Assignments and reading will be posted on D2L.

Grade polices and Letter Grade Distribution:

University policies regarding grades and grading systems are available at:

<https://catalog.arizona.edu/policy/courses-credit/grading/grading-system>

Grade distribution for this course:

A: 90% and above

B: 80% to 89%

C: 70% to 79%

D: 65% to 69%

E: below 65%

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <https://catalog.arizona.edu/policy/courses-credit/grading/grading-system>. Please be aware of deadlines for requesting these grades. Requests for reconsideration of a grade received on a paper, project, or exam must be made to the instructor no later than 1 week after the assignment is made available to be returned to the student. Whether a reconsideration will be granted is entirely at the discretion of the instructor.

Late Work Policy

Assignments that are not completed or handed in on time, without prior arrangement with the instructor, can receive no more than 50% of the assigned points and may receive an automatic zero depending on the assignment. Assignments not completed within 1 week of the original deadline, without prior arrangement with the instructor, will always receive no points for the assignment.

University Policies

Course Communications

All communications concerning class are via your official UA email addresses. It is the student's responsibility to regularly check for email communications concerning class information and policies, and to contact the instructor from the student's official UA email address.

Course materials

Course materials will be available online via D2L (<http://d2l.arizona.edu>)

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at <https://catalog.arizona.edu/policy/registration-tuition-fees/registration-enrollment/change-schedule>. The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable: <http://policy.arizona.edu/human-resources/religious-accommodation-policy>. Absences pre-approved by the UA Dean of Students will be honored.

Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all class meetings. Absences may affect a student's final course grade. If you anticipate being absent, are unexpectedly absent, or are unable to participate in class online activities, please contact me as soon as possible. To request a disability-related accommodation to this attendance policy, please contact the Disability Resource Center at (520) 621-3268 or drc-info@email.arizona.edu. If you are experiencing unexpected barriers to your success in your courses, the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office is located in the Robert L. Nugent Building, room 100, or call 520-621-7057.

Assignment and Grading Policy for Students Who Register Late

Students who register late for the course will be required to complete all assignments. Due dates for assignments given prior to the student adding the course will be agreed upon by both student and the instructor.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.). Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <https://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>. Your instructor takes this extremely seriously.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit <http://drc.arizona.edu>. If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See <https://deanofstudents.arizona.edu/student-rights-responsibilities/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at: <https://lib.arizona.edu/research/write-cite/plagiarism>.

Selling or posting without permission class notes and/or other course materials for other students or to a third party (e.g. such as Chegg) is not permitted without the instructor's express written consent. Violations to this are subject to the Code of Academic Integrity and may result in sanctions to anyone providing

or using such materials, including loss of credit in the class. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. Finally, this conduct may also constitute copyright infringement. **UA Nondis-**

crimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see <https://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>. Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination toward others.

Additional Resources for Students

UA Academic policies and procedures are available at:
<http://catalog.arizona.edu/policies>.

Student Assistance and Advocacy information is available at:
<https://deanofstudents.arizona.edu/support/student-assistance>

Confidentiality of Student Records

Please see the University's policy on the confidentiality of student records here: <https://registrar.arizona.edu/privacy-ferpa/ferpa>

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Course Schedule

Date	Content and Assignments
Thursday, January 11	Course Logistics Introduction to the Earth's Climate System Introduction to Climate Data
Tuesday, January 16	Radiative Balance I
Thursday, January 18	Radiative Balance II
Tuesday, January 23	Radiative Balance III Introduction to Lab (#1) Radiative Balance
Thursday, January 25	Greenhouse gases, climate forcing, and the carbon cycle I
Tuesday, January 30	Greenhouse gases, climate forcing, and the carbon cycle II
Thursday, February 1	Greenhouse gases, climate forcing, and the carbon cycle III Introduction to Lab (#2) Greenhouse gases, climate forcing, and the carbon cycle Lab (#1) Due
Tuesday, February 6	Greenhouse gases and water in the climate system Fundamentals of Latent and Sensible Heating I
Thursday, February 8	Fundamentals of Latent and Sensible Heating II Adiabatic Processes Lab (#2) Due
Tuesday, February 13	No Class - Kevin at 'Cities on Volcanoes'
Thursday, February 15	No Class - Kevin at 'Cities on Volcanoes'
Tuesday, February 20	Introduction to Vertical Motion, Convection, and Turbulent Fluxes Surface Energy Balance I
Thursday, February 22	Surface Energy Balance II
Tuesday, February 27	Surface Energy Balance III Introduction to Lab (#3) Surface Energy Balance
Thursday, February 29	Introduction to General Circulation I
Tuesday, March 5	No Class - Spring Break
Thursday, March 7	No Class - Spring Break
Tuesday, March 12	General Circulation II
Thursday, March 14	General Circulation III Introduction to Lab (#4) General Circulation Lab (#3) Due
Tuesday, March 19	General Circulation IV Summary and Synthesis Lab (#4) Due
Thursday, March 21	Climate Variability and Climate Observations I
Tuesday, March 26	Climate Variability and Climate Observations II Introduction to Lab (#5) Climate Variability and Climate Observations Midterm due in class

Date	Content and Assignments
Thursday, March 28	Paleoclimatology and Climate Forcing I
Tuesday, April 2	Paleoclimatology and Climate Forcing II Introduction to Lab (#6) Paleoclimate and Climate Forcing Lab (#5) Due
Thursday, April 4	No Lecture - Kevin at University of Tennessee Term Paper Précis Due on D2L
Tuesday, April 9	Introduction to Climate Modeling
Thursday, April 11	Future Climate Change: Hydroclimate Future Climate Change: Wildland Fire
Tuesday, April 16	No Class - AAG
Thursday, April 18	No Class - AAG
Tuesday, April 23	Future Climate Change: Cryosphere Future Climate Change: Sea Level Rise Future Climate Change: Tropical Cyclones
Thursday, April 25	Lab (#6) Due Future Climate Change: Tropical Cyclones Future Climate Change: Extremes and Compound Hazards Synthesis and the Future
Tuesday, April 30	Graduate Student Lightning Talks Final Exam due in class
Friday, May 3	Final Term Papers due on D2L