

GEOG 230 OUR CHANGING CLIMATE

Kevin Anchukaitis

Welcome to GEOG230 'Our Changing Climate'!

There are a few important documents on D2L that will guide you through this course. The first is this *overview* (this document you're reading right now), which contains my overall goals for the class as well as descriptions of the syllabus and course schedule. I want the lectures, activities, assignments, and exams to assist us in achieving the course goals and objectives, give us an idea of where we're going, and what we hope to accomplish along the way, and allow us to understand and integrate the information, concepts, and methods we'll discuss in lecture.

Next is the *syllabus* – this contains important information about the class, including how to contact me, my office hours, information about the textbook, the type of assignments and grading approach, and links to important information about campus resources available to all students. The *syllabus* is -- in part -- a statement of *policies* from the University, the College, the School, and from me, so please review it early in the class and consult it frequently if you have any questions. Finally, there is the *course schedule*, which is a detailed, day-by-day description of the topics we'll cover and any assignment due dates. This *course schedule* is subject to change, to adapt to current events or change the balance of topics we cover, but I'll inform you in advance whenever there are any changes to the plan.

Overview

The goal of the course is to provide you with the opportunity to gain an understanding of the processes that control climate variability and climate change at a range of temporal and spatial scales. Together we will develop the knowledge and conceptual understanding to allow you to independently evaluate claims about the condition and behavior of Earth's climate system in the past, present, and future.

There are three broad categories of knowledge, skills, and competencies that we'll cover during this class. First, we'll deal with developing factual knowledge about the climate system, so that we come to understand (and can use) terminology and deploy fundamental facts about the different parts of the climate system. Second, we want to expand our knowledge to important concepts – this includes things like understanding positive and negative feedbacks, how different parts of the earth system are joined to one another and influence each other, and how theoretical ideas apply in the 'real world' of the climate system. Finally, the major objective is to be able to apply these facts and concepts. This means being able to take what you've learned in general and apply it in new situations – this is the *really* fun part.

Ultimately, I want you to be able to read a newspaper, a blog, or to listen to a speech, and be able to make a scientific judgment about the accuracy of what is being stated. I also want you to be able to add several analytical and scientific 'tools' in your growing set of skills, ones that will serve you no matter what career path you follow.

For those of you continuing on in geography and other earth and environmental sciences, this course can serve as a foundation from which you can expand your knowledge, develop even more powerful analytical tools, and establish a broad base in earth systems sciences.

Planning for the unknown – this class and the continuing COVID-19 pandemic

The pandemic continues to affect all of our lives. Some of us are doing better than others, but everyone has struggled at some with something during this pandemic and there appear to be renewed challenges this semester as well. We may still feel unbalanced. We're still dealing with new and difficult responsibilities. You may know people that have tested positive for COVID-19, have been really sick, or perhaps have even died. We're feeling uncertain about things.

In the midst of all this, I'm fully committed to making sure that you get everything you wanted from this class. I will do my best to make any accommodations I can to help you finish the coursework and to learn and understand all of the course materials. I will be as flexible as I possibly can be regarding assignments - so if you are having trouble for any reason at all, please reach out to me or to our Andy, our teaching assistant. You don't have to share any personal information with us, but you are always welcome to reach out if you need help inside or outside of this class. (I hope you'll also give us some latitude if we're forgetful or things don't work quite right the first time we try them).

I want you to learn a ton of awesome things about the climate system in this class, how it is changing, and what we might be able to do about it, and my overarching goal is that we do that while also ensuring we all remain healthy, safe, and secure this semester. For that reason, we'll take it week-by-week, be as flexible as possible, and evaluate conditions on campus and directions from the administration as time goes on. I really hope things might look a lot more like 'normal' later in the semester.

If you have any concerns, questions, ideas, or would just like to chat, please contact me (kanchukaitis@arizona.edu) and setup a time for us to get together.

Although things are better than they were a year ago at this time, this is going to be another challenging semester in various ways – let's continue to support each other and be generous with one another.

GEOG 230 OUR CHANGING CLIMATE

This course examines the fundamental physical processes that control the features and patterns of variability and change in the Earth's climate system. Specific topics include the Earth's energy balance and the greenhouse effect, the circulation of the oceans and atmosphere, the role of life (the biosphere) in modifying the climate system, simulation modeling using computers for predicting future climate, and global and regional patterns of climate variability and change observed and expected as a consequence of human influences on the Earth System.

The goal of the course is to provide students with the opportunity to gain an understanding of the processes that control climate variability and climate change at a range of temporal and spatial scales. Students will develop the knowledge and conceptual understanding to allow them to independently evaluate claims about the condition and behavior of Earth's climate system in the past, present, and future.

Communications concerning class via official UA email addresses.
Course materials online via D2L (<http://d2l.arizona.edu>)

Locations and Times

Monday, Wednesday, and Friday, 11:00AM to 11:50AM
Modern Languages 311

Classroom Attendance and Mask Policy

If you feel sick or may have been in contact with someone who is infectious, please stay home. Except for seeking medical care, avoid contact with others and do not travel.
Notify your instructors if you will be missing class. [Testing for is available on campus](#).
Please visit the [UArizona COVID-19](#) page for regular updates and all the information you might need on masking, vaccines, and testing. *Masks must be worn in the classroom until further notice.*

Instructor Information

Kevin Anchukaitis
Professor, School of Geography, Development, and Environment
Office Phone: (520) 626-8054
Email: kanchukaitis@arizona.edu
Office Hours: By appointment using the Calendly App on our D2L page

Andrew Zimmer
Graduate Teaching Assistant, School of Geography, Development, and Environment
Email: azimmer@email.arizona.edu
Office Hours: TBD

Course Objectives and Expected Learning Outcomes

This course has the following expected learning outcomes:

Factual: You will acquire basic knowledge related to the Earth's climate system

Conceptual: You will develop understanding and awareness of fundamental principles, basic and foundational theories, and general physical and qualitative models concerning the climate system. In particular, you will be able to analyze feedbacks between different elements of the climate system – including human influences.

Procedural: You will learn how and when to apply subject-specific knowledge, 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.

The course fulfills General Education: Tier 2 Natural Sciences requirements. Tier Two courses provide a more in-depth examination of topics/concepts introduced in your Tier One courses. As a Tier Two course, GEOG 230 integrates a writing component.

Additionally, for Geography (B.S) undergraduate majors, 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

For Environmental Studies (B.A) undergraduate majors, this course addresses the following learning outcomes:

1. Gain a full breadth of knowledge in the field of Environmental Studies.
2. Understand concepts required for success in an environmental profession.
3. Understand human dimensions of environmental issues.
4. Understand relationships between human activities and environmental/health sustainability. Understand causes and effects of regional and global environmental change.

Topics

Introduction to the Climate System

Energy and the Earth System

The General Circulation of the Atmosphere and Oceans

Climate and energy in space and time

Carbon and the influence of life on climate

The Long-Term Climate Record

Observations of historical and recent climate change
Climate modeling and the enhanced (anthropogenic) greenhouse effect
Regional climate change and variability in the western United States
Cryosphere, glaciers, and sea ice
Tropical storms and extreme events
Ocean acidification
Climate policy, mitigation, adaptation, geoengineering

Optional Text

There is no required textbook for this class, but students who benefit from an additional written source can purchase *Climatology: An Atmospheric Science* (3rd Edition) by Hidore, Oliver, Snow & Snow (<https://www.amazon.com/Climatology-Atmospheric-John-J-Hidore/dp/0321602056>)

Methods of Evaluation

Quizzes (10%)

Throughout the semester, I will periodically ask you to complete an in-person or online quiz on topics covered in recent lectures or class sections. I will drop at least 2 of these quizzes to accommodate missed classes or illness. These quizzes provide you with another way of understanding the material and help you prepare for the exams.

Analytical Exercises (20%)

These 4 assignments ask you to plot and 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. They are a chance for you to stretch your analytical legs a bit. The exercises will be available approximately a week before their due date. Grading rubrics will be presented with each assignment, and grading will focus on application of ideas from class, logical and reasonable analyses, original thought, and clarity of expression. *Unless otherwise stated for a specific assignment, you may work with up to one additional person (a maximum group size of two) on these assignments.*

Writing Exercises (20%)

These 4 assignments are an opportunity for you to practice your professional writing while also giving you a chance to delve deeper into topics covered in the class. Writing assignments include personal narratives, persuasive essays, critical analyses, and informed opinion. The exercises will be available approximately a week before their due date. Grading rubrics will be presented with each assignment and grading will be based on clarity of expression, format, organization, original thought, and items specific to the nature of the assignment. *These exercises are to be done by you alone, unless otherwise specified.*

Midterm Exam (20%)

Online (D2L) exam covering basic concepts covered in class up until that point. Format is short answers, potentially including sketches and analysis of scientific figures or schematics. A review session will be scheduled.

Final Exam (20%)

The online (D2L) final exam will be comprehensive (that is, cover topics throughout the semester, including from the Midterm). Format is short answers. The goal of the final exam is to allow you to apply what you've learned during the semester (and not simply regurgitate facts!). A study sheet will be provided prior to the exam. A review session will be scheduled.

Online Discussions (10%)

You will have the opportunity to participate in online discussions during the semester:

1. The first opportunity will be to introduce yourself – tell us a bit about your background, your interests, what you'd like to do in the future, and how you got interested in the class. Due date for you to post your introduction is Friday, August 27th by 5pm.

2. The other component of the online discussion asks you to identify articles in major *mainstream* media (including but not limited to: New York Times, Washington Post, LA Times, Wall Street Journal, USA Today, BBC, CBS, NBC, ABC, The Atlantic, The New Yorker, Slate, CNN, Reuters, the Associated Press, Mashable, The Guardian, Quartz, VICE News, Vox, The Christian Science Monitor, major local newspapers or television stations, etc.), write a summary in your own words, (1 paragraph) and analysis of the article (1 to 2 paragraphs), and then post the link, your summary, and your analysis of the article to the discussion group. In your analysis, you should place the article in the context of what we've discussed in class – does the article seem scientifically reasonable? Are the descriptions consistent with what we've learned (so far) in class? Does the article describe natural climate variability, human-caused climate change, or a mixture of both? What are the uncertainties discussed in the article? What are the consequences for society, politics, economics, agriculture, recreation, food, water, ecosystems, animals, etc.? I'm asking you to do this twice during the semester, once in the first part of the class, once in the second. More details will be provided in class.

COVID-19 Specific Policies:

Face coverings are required in our classroom

As of the first week of class and per University of Arizona's [Directive](#), **face coverings that cover the nose, mouth, and chin are required to be worn in all indoor spaces where it is not possible to adequately and continuously maintain social distance, including classrooms.** Any student who violates this directive will be asked to put on a mask or immediately leave the learning space and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved. The [Disability Resource Center](#) is available to explore [face coverings and accessibility considerations](#) if you believe that your disability or medical condition precludes you from utilizing any face covering or mask option. DRC will explore the range of potential options as well as remote course offerings. Should DRC determine an accommodation to this directive is reasonable, DRC will communicate this accommodation with your instructor.

Classroom Attendance

- If you feel sick or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructors if you will be missing a course meeting or an assignment deadline.
- Non-attendance for any reason does **not** guarantee an automatic extension of due date or rescheduling of examinations/assessments. Please communicate and coordinate any request directly with your instructor.
- If you must miss the equivalent of more than one week of class, you should contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.
- Voluntary, free, and convenient [COVID-19 testing](#) is available for students on Main Campus.
- If you test positive for COVID-19 and you are participating in on-campus activities, you must report your results to Campus Health. To learn more about the process for reporting a positive test, visit the [Case Notification Protocol](#).
- COVID-19 vaccine is available for all students at [Campus Health](#).
- Visit the [UArizona COVID-19](#) page for regular updates.

Academic advising

If you have questions about your academic progress this semester, please reach out to your academic advisor (<https://advising.arizona.edu/advisors/major>). Contact the Advising Resource Center (<https://advising.arizona.edu/>) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@arizona.edu

Life challenges

If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be

helpful. The [Dean of Students Office](#) can be reached at (520) 621-2057 or DOS-deanofstudents@email.arizona.edu.

Physical and mental-health challenges

If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Remaining flexible

If pandemic conditions warrant, the University may require that we return to remote operations. If that is the case, we will notify you by D2L Announcement and email that we are moving to remote operations.

Other University Policies:

Grading Policy

University policy regarding grades and grading systems is available at: <https://catalog.arizona.edu/policy-type/grade-policies>

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 incompletes (I) and withdrawal (W) must be made in accordance with university policies which are available at <https://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <https://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

Requests that I reconsider the grading of any individual assignment must be made within 48 hours of that assignment being returned.

Late Work Policy

Work that is turned in after the posted deadline can only earn 50% of the possible points. Work turned in more than 1 week later receives no credit. You may petition me for an exception if you feel you have a compelling reason for turning work in late (as might be expected during the continuing pandemic). If you anticipate being absent or unavailable on the day an assignment is due, please arrange to turn in your assignment prior to the deadline.

Required/Recommended Prerequisites

Official course prerequisites: A courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).

Honors Credit

Students wishing to contract this course for Honors Credit should email me to set up an appointment to discuss the terms of the contact and to sign the Honors Course Contract Request Form. Additional information is available here:

<http://www.honors.arizona.edu/future-students/honors-credit-across-campus>

Attendance Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable:

<https://policy.arizona.edu/human-resources/religious-accommodation-policy>

Absences preapproved by the UA Dean of Students (or the dean's designee) will be honored.

Participating in course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings.

Makeup Policy for Students Who Register Late

Students who register for the class late will be required to complete all assignments due prior to their registration date. The schedule and modified due date for these assignments will be agreed upon between the instructor and student at the time the student registers.

Classroom Behavior

To foster a positive learning environment, *please* do not text, chat, make phone calls, play games, read the newspaper, or surf the web during lecture and discussion. Please refrain from disruptive conversations with people sitting around them during lecture. Students who continue to disrupt despite being asked to cease this behavior 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>

Accessibility and Accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please

contact the Disability Resource Center (520-621-3268, <https://drc.arizona.edu>) to establish reasonable accommodations.

Student Code of Academic Integrity

Students are responsible for ensuring their own work and conduct meets the University's Standards.

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:

<http://deanofstudents.arizona.edu/codeofacademicintegrity>

<https://deanofstudents.arizona.edu/policies/code-academic-integrity>

The University Libraries have some excellent tips for avoiding plagiarism available at:

<https://new.library.arizona.edu/research/citing/plagiarism>

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA email to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student email addresses. This conduct may also constitute copyright infringement.

Additional Resources for Students

UA Non-discrimination and Anti-harassment policy:

<http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

UA Academic policies and procedures are available at:

<https://catalog.arizona.edu/policies>

Student Assistance and Advocacy information is available at:

<http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Confidentiality of Student Records

University policies are available here: <https://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa>

Subject to Change Statement

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

Part 1: What is the climate system and how does it work?

#	DAY	TOPIC	ASSIGNMENTS DUE
1	Monday, August 23	Introductions and Our Changing Climate	Read the Syllabus and Course Schedule
2	Wednesday, August 25	Energy and the Climate System	
3	Friday, August 27	The Links between Energy and Temperature	<i>Deadline to post introduction to Discussion @D2L</i>
4	Monday, August 30	Energy finds its way into the Earth System	
5	Wednesday, September 1	The Simplest Climate Model	Writing Assignment #1 <i>Initial Draft Due</i>
6	Friday, September 3	Modeling the Greenhouse Effect!	
	Monday, September 6	<i>Labor Day - No Class</i>	
7	Wednesday, September 8	Energy inside the Earth System I	
8	Friday, September 10	Simple Surface Energy Patterns!	
9	Monday, September 13	Fluid Dynamics	Analytical Exercise #1 Due
10	Wednesday, September 15	Water in the Earth System	
11	Friday, September 17	The Surface Energy Balance	
12	Monday, September 20	Vertical Motion in the Atmosphere	
13	Wednesday, September 22	Horizontal Motion in the Atmosphere	Writing Assignment #1 <i>Revisions Due</i>
14	Friday, September 24	The General Circulation	
15	Monday, September 27	Atmospheric Circulation and Rainfall	
16	Wednesday, September 29	Exam #1 Review!	
<p>Exam #1 on D2L <i>No lecture on October 1st</i> Exam opens Friday, October 1st at 11am and closes Monday, October 4th at 11am</p>			

Part 2: How is our climate changing?

#	DAY	TOPIC	ASSIGNMENTS DUE
17	Monday, October 4	Carbon in the Climate System	
18	Wednesday, October 6	Changing our Atmosphere	
19	Friday, October 8	Observations of Climate Change I	
20	Monday, October 11	Observations of Climate Change II	Analytical Exercise #2 Due
21	Wednesday, October 13	Introduction to Climate Modeling	
22	Friday, October 15	Predictions of Climate Change	<i>Final day to post 1st discussion on media article about climate change</i>
	Monday, October 18	<i>No class</i>	
	Wednesday, October 20	<i>No class</i>	
23	Friday, October 22	How do we know that these changes are unusual?	Writing Exercise #2 (Climate Predictions) Due
24	Monday, October 25	Long-term reconstructions of climate change	
25	Wednesday, October 27	Climate change in Arizona and across the West	
26	Friday, October 29	Climate Change in Arizona and across the West II	
27	Monday, November 1	Climate change and glaciers	Analytical Exercise #3 Due
28	Wednesday, November 3	Climate change and sea level rise	
29	Friday, November 5	Hurricanes and Tropical Storms	
30	Monday, November 8	Ocean acidification	
31	Wednesday, November 10	Agriculture and Food Security	
32	Friday, November 12	Forests and Fire	

33	Monday, November 15	Extreme Events I	Writing Exercise #3 (Water in the West) Due
34	Wednesday, November 17	Extreme Events II	
35	Friday, November 19	Impacts, Hazards, and Vulnerability	
	Monday, November 22	<i>No Class – Thanksgiving Recess</i>	
	Wednesday, November 24	<i>No Class – Thanksgiving Recess</i>	
	Friday, November 26	<i>No Class – Thanksgiving Recess</i>	

Part 3: What might we do about it?

#	DAY	TOPIC	ASSIGNMENTS DUE
36	Monday, November 29	Climate policy - mitigation	Writing Exercise #4 (Justice) Due
37	Wednesday, December 1	Climate policy - adaptation	
38	Friday, December 3	Climate policy – emissions and interests	
39	Monday, December 6	Climate policy – the cutting edge	
40	Wednesday, December 8	Our changing climate – why it is important and what we might do about it	Analytical Exercise #4 (Climate futures) Due today
	Thursday, December 9	<i>Optional review session</i>	<i>Final day to post 2nd discussion on media article about climate change</i>
<p>Exam #2 on D2L Exam opens Friday, December 10th at 11am and closes Monday, December 13th at 1 pm</p>			

Notes:

1. The course schedule is subject to change based on current events or to ensure certain topics receive sufficient attention.
2. Assignments refer to the day they are due on D2L