

GEOG 230 OUR CHANGING CLIMATE
Kevin Anchukaitis
MWF 1:00 to 1:50pm, Education Building, Room 318

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.

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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.

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Locations and Times

Monday, Wednesday, and Friday, 1:00PM to 1:50PM
Education Building, Room 318

Instructor Information

Kevin Anchukaitis
Associate Professor, School of Geography and Development
Room S514, Environment and Natural Resources Building 2 (ENR2)
Office Phone: (520) 626-8054
Email: kanchukaitis@email.arizona.edu

Office Hours: Monday, 3pm to 5pm, ENR2 S514 or by appointment
Communications concerning class via official UA email addresses.

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

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.

For Geography 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

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

Required Text

Climatology: An Atmospheric Science (3rd Edition) Hidore, Oliver, Snow & Snow

Availability: Recommended purchase (new or used) or rental online:

<http://www.amazon.com/gp/product/0321602056>

<http://www.powells.com/biblio/72-9780321602053-0>

In addition, I'll ask you to read (for Friday, October 16) the Intergovernmental Panel on Climate Change's 'Summary for Policymakers' from their 2013 Report (Working Group 1, Fifth Assessment Report):

http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

Methods of Evaluation

Analytical Exercises (20%)

These 5 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. There are a total of 5 of these assignments. 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 5 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, review articles, 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%)

In-class (short) 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 study sheet will be available prior to the exam.

Final Exam (30%)

The final exam will be comprehensive (that is, cover topics throughout the semester, including from the Midterm). Format is short answers, potentially including sketches and analysis of scientific figures or schematics. 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 can be scheduled if there is sufficient interest.

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 28th 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 by Wednesday, September 30 (5pm) and once by Wednesday, December 2 (5pm). More details will be provided in class.

Grading Policy

University policy regarding grades and grading systems is available at:

<http://catalog.arizona.edu/2015-16/policies/grade.htm>

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 <http://catalog.arizona.edu/2015-16/policies/grade.htm#I> and <http://catalog.arizona.edu/2015-16/policies/grade.htm#W> respectively.

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

Course Format and Teaching Methods

Lecture with additional small group activities, in-class discussion, and web-based discussion.

Required/Recommended Knowledge

Official course requisites: Two 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 contract and to sign the Honors Course Contract Request Form. The form is available at <http://www.honors.arizona.edu/documents/students/ContractRequestForm.pdf>.

Late Work Policy

As a rule, work will not be accepted late except in case of documented emergency or illness. You may petition me in writing for an exception if you feel you have a compelling reason for turning work in late.

Attendance Policy

The UA's policy concerning Class Attendance and Administrative Drops is available at:

<http://catalog.arizona.edu/2015-16/policies/classatten.htm>

The UA policy regarding absences on and accommodation of religious holidays is available at

<http://deanofstudents.arizona.edu/policies-and-codes/accommodation-religious-observance-and-practice>.

Absences pre-approved by the UA Dean of Students (or Dean designee) will be honored. See:

http://uhap.web.arizona.edu/chapter_7#7.04.02

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. Students who miss class due to illness or emergency are required to bring documentation from their healthcare provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

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.

The Arizona Board of Regents' Student Code of Conduct, ABOR Policy 5-308, prohibits threats of physical harm to any member of the University community, including to one's self. See:

<http://policy.arizona.edu/threatening-behavior-students>.

Accessibility and Accommodations

It is the University's goal 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 Disability Resources (520-621-3268) to establish reasonable accommodations. For additional information on Disability Resources 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.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

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/academic-integrity/students/academic-integrity>.

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

<http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

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:

<http://catalog.arizona.edu/2015-16/policies/aaindex.html>

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: <http://www.registrar.arizona.edu/ferpa/default.htm>

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.

DATE	TOPIC	ASSIGNMENTS
Monday, August 24	Introduction Syllabus & Logistics What is Climate?	<i>Login to D2L, view the syllabus & course schedule</i>
Wednesday, August 26	Climate and Energy in the Earth System	<u>Reading: Hidore, Chapter 1, Pages 3-13</u>
Friday, August 28	Earth's Energy Balance and Composition of the Atmosphere	<i>Deadline to post introduction to Discussion @D2L</i>
Monday, August 31	Earth's Energy Balance and Composition of the Atmosphere	Writing Exercise #1, Personal Climate Observations, due
Wednesday, September 2	Earth's Energy Balance and Composition of the Atmosphere	
Friday, September 4	Energy in the Earth System: Time, space, and seasons	<u>Reading: Hidore, Chapter 1, Page 13; Chapter 2, Pages 21-34</u>
<i>Monday, September 7</i>	<i>No Lecture</i>	<i>Labor Day</i>
Wednesday, September 9	Atmospheric Motion and Convection	Analytical Assignment #1, Energy Balance, due
Friday, September 11	Atmospheric Motion and Convection	<u>Reading: Hidore, Chapter 3</u>
Monday, September 14	Pressure, Winds, and Atmospheric Motion	<u>Reading: Hidore, Chapter 4</u>
Wednesday, September 16	Pressure, Winds, and Atmospheric Motion	
Friday, September 18	The General Circulation of the Atmosphere	
Monday, September 21	The General Circulation of the Atmosphere	
Wednesday, September 23	The General Circulation of the Atmosphere & Ocean	Reading: Hidore, Chapter 5, 6
Friday, September 25	Ocean Circulation and the El Nino Southern Oscillation	Analytical Exercise #2, Atmospheric Circulation, due
Monday, September 28	the El Nino Southern Oscillation	
Wednesday, September 30	the El Nino Southern Oscillation and the biosphere	<i>Last Day to Post 1st Climate Article and Analysis to Discussion @ D2L</i>
Friday, October 2	The Biosphere	Analytical Exercise #3, El Nino prediction, due

Monday October 5	Carbon in the Climate System	
Wednesday, October 7	Carbon in the Climate System	
Friday October 9	Midterm Exam	
Monday, October 12	<i>No Lecture</i>	
Wednesday, October 14	Observations of Recent Climate Change	
Friday, October 16	Observations of Recent Climate Change	Reading: IPCC WG1 AR5 Summary for Policymakers
Monday, October 19	The Long-Term Climate Record: Paleoclimatology	<u>Reading: Hidore, Chapters 9 and 10</u>
Wednesday, October 21	The Long-Term Climate Record: Paleoclimatology	
Friday, October 23	Modeling Future Climate & the enhanced greenhouse effect	Analytical Exercise #4, Recent climate change, due
Monday, October 26	Modeling Future Climate & the enhanced greenhouse effect	
Wednesday, October 28	Modeling Future Climate & the enhanced greenhouse effect	<u>Reading: Hidore, Chapter 11</u>
Friday, October 30	Climate change in Arizona and the western UA	Writing Exercise #2, Climate modeling, due
Monday, November 2	Climate change in Arizona and the western UA	
Wednesday, November 4	Climate change at high latitudes	
Friday, November 6	Climate change at high latitudes	Writing Exercise #3, Water in the West, due <u>Reading: Hidore, Chapter 12</u>
Monday, November 9	Glaciers	
<i>Wednesday, November 11</i>	<i>No Lecture</i>	<i>Veterans Day</i>
Friday, November 13	Sea level rise	Analytical Exercise #5, Global warming, due
Monday, November 16	Sea level rise	
Wednesday, November 18	Hurricanes and tropical climate change	<u>Reading: Hidore, Chapter 8, Pages 141-149</u>
Friday, November 20	Corals and ocean acidification	

Monday, November 23	Food and forests	Reading: Hidore, Chapter 20
Wednesday, November 25	Writing Review Workshop	Writing Exercise #4, Natural Disasters, due
<i>Friday, November 27</i>	<i>No Lecture</i>	<i>Thanksgiving</i>
Monday, November 30	Climate policy – Mitigation	
Wednesday, December 2	Climate policy - Adaptation	<i>Last Day to Post 2nd Climate Article and Analysis to Discussion @ D2L</i>
Friday, December 4	Geoengineering	
Monday, December 7	Geoengineering	Writing Exercise #5, Climate Justice, due
Wednesday, December 9	Summary and Review	<i>Last Day of Lecture</i>
Friday, December 11	Review session (TBA)	
Monday, December 14	Final Exam	1pm to 3pm in the normal classroom. See also 'Exam Rules' link in Notes, below.

Notes:

1. The course schedule is subject to change, based on the interests of the students, current events, or to ensure certain topics receive sufficient time and attention.
2. Assignments refer to the day they are due or when the suggested reading should be completed.
3. For reading assignments, 'Hidore' refers to: *Climatology: An Atmospheric Science* (3rd Edition) by Hidore, Oliver, Snow & Snow, 3rd Edition
4. IPCC WG1 AR5 Summary for Policymakers (link will also be provided in class and in the syllabus):
http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf
5. The complete Fall 2015 Final Exam Schedule -- For classes scheduled Monday, Wednesday, and Friday is here:
<https://www.registrar.arizona.edu/schedule2154/exams/mwf.htm>

6. The University and Faculty Senate provide Final Exam Regulations and Information here:

<https://www.registrar.arizona.edu/schedule2154/exams/examrules.htm>