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, 1:00PM to 1:50PM
Haury Anthropology Building, Rm 216

Instructor Information

Kevin Anchukaitis
Associate Professor, School of Geography and Development
Room S514, Environment and Natural Resources Building 2 (ENR2)
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Office Hours: Monday, 3pm to 5pm, ENR2 S514 or by appointment

Forest Carter
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Room S572, Environment and Natural Resources Building 2 (ENR2)
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Office Hours: Wednesday at 12:00, Friday at 2:00

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

Required Text

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

In addition, I'll ask you to read (for Monday, October 10) 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

Quizzes (10%)

Throughout the semester, I will periodically ask you to complete an in-class quiz on topics covered that day or the day before in class. I'll then call on one or two people to share their answers with the class, explain a concept, or elaborate on their understanding of a topic. There will be 12 quizzes, and I will drop 2. Missed quizzes can not be taken later, however, except in the case of a prior excused absence. These quizzes provide you with another way of understanding the material and help you prepare for the exams.

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 (20%)

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 26th 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 you 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 28th (5pm) and once by Wednesday, November 30 (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 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

Late Work Policy

Work that is turned in after the deadline can only earn 50% of the possible points. Work turned in more than 1 week later receives no credit. You may petition me in writing for an exception if you feel you have a compelling reason for turning work in late. 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.

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:
http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences preapproved by the UA Dean of Students (or dean's designee) will be honored. See:
http://uhap.web.arizona.edu/policy/appointed-personnel/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.

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 http://policy.arizona.edu/education-and-student-affairs/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 22	Introduction Syllabus & Logistics What is Climate?	*Login to D2L, view the syllabus & course schedule*
Wednesday, August 24	Climate and Energy in the Earth System	Reading: Hidore, Chapter 1, Pages 3-13
Friday, August 26	Earth's Energy Balance and Composition of the Atmosphere	*Deadline to post introduction to Discussion @D2L*
Monday, August 29	Earth's Energy Balance and Composition of the Atmosphere	**Writing Exercise #1, Personal Climate Observations, due**
Wednesday, August 31	Earth's Energy Balance and Composition of the Atmosphere	
Friday, September 2	Energy in the Earth System: Time, space, and seasons	Reading: Hidore, Chapter 1, Page 13; Chapter 2, Pages 21-34
Monday, September 5	*No Lecture*	*Labor Day*
Wednesday, September 7	Atmospheric Motion and Convection	**Analytical Assignment #1, Energy Balance, due**
Friday, September 9	Atmospheric Motion and Convection	Reading: Hidore, Chapter 3
Monday, September 12	Pressure, Winds, and Atmospheric Motion	Reading: Hidore, Chapter 4
Wednesday, September 14	Pressure, Winds, and Atmospheric Motion	
Friday, September 16	The General Circulation of the Atmosphere	
Monday, September 19	The General Circulation of the Atmosphere	**Writing Exercise #1 Revision Due**
Wednesday, September 21	The General Circulation of the Atmosphere	Reading: Hidore, Chapter 5 , 6
Friday, September 23	The General Circulation of the Atmosphere	
Monday, September 26	General Circulation of the Ocean and Atmosphere	**Analytical Exercise #2, Atmospheric Circulation, due**
Wednesday, September 28	the El Nino Southern Oscillation	*Last Day to Post 1st Climate Article and Analysis to Discussion @ D2L*
Friday, September 30	ENSO and The Biosphere	

Monday October 3	Carbon in the Climate System	**Analytical Exercise #3, El Nino prediction**
Wednesday, October 5	Carbon in the Climate System	
Friday October 7	**Midterm Exam**	
Monday, October 10	Observations of Recent Climate Change	Reading: IPCC WG1 AR5 Summary for Policymakers
Wednesday, October 12	Observations of Recent Climate Change	
Friday, October 14	*No Lecture*	
Monday, October 17	The Long-Term Climate Record: Paleoclimatology	Reading: Hidore, Chapters 9 and 10
Wednesday, October 19	The Long-Term Climate Record: Paleoclimatology	
Friday, October 21	Modeling Future Climate & the enhanced greenhouse effect	**Analytical Exercise #4, Recent climate change, due**
Monday, October 24	Modeling Future Climate & the enhanced greenhouse effect	
Wednesday, October 26	Modeling Future Climate & the enhanced greenhouse effect	Reading: Hidore, Chapter 11
Friday, October 28	Climate change in Arizona and the western UA	**Writing Exercise #2, Climate modeling, due**
Monday, October 31	Climate change in Arizona and the western UA	
Wednesday, November 2	Climate change at high latitudes	
Friday, November 4	Climate change at high latitudes	**Writing Exercise #3, Water in the West, due** Reading: Hidore, Chapter 12
Monday, November 7	Glaciers	
Wednesday, November 9	Sea level rise	
Friday, November 11	*No Lecture*	*Veterans Day*
Monday, November 14	Sea level rise	**Analytical Exercise #5, Global warming, due**
Wednesday, November 16	Hurricanes and tropical climate change	Reading: Hidore, Chapter 8, Pages 141-149
Friday, November 18	Corals and ocean acidification	

Monday, November 21	Food and forests	Reading: Hidore, Chapter 20
Wednesday, November 23	*No lecture*	**Writing Exercise #4, Natural Disasters, due**
Friday, November 25	*No Lecture*	*Thanksgiving*
Monday, November 28	Climate policy – Mitigation	
Wednesday, November 30	Climate policy - Adaptation	*Last Day to Post 2nd Climate Article and Analysis to Discussion @ D2L*
Friday, December 2	Geoengineering	
Monday, December 5	Geoengineering	**Writing Exercise #5, Climate Justice, due**
Wednesday, December 7	Summary and Review	*Last Day of Lecture*
Thursday, December 8	Review session (TBA)	
Monday, December 12	**Final Exam**	**1pm to 3pm in the normal classroom. See also links 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 2016 Final Exam Schedule and the University and Faculty Senate Final Exam Regulations and Information are here:
https://www.registrar.arizona.edu/courses/fall-2016